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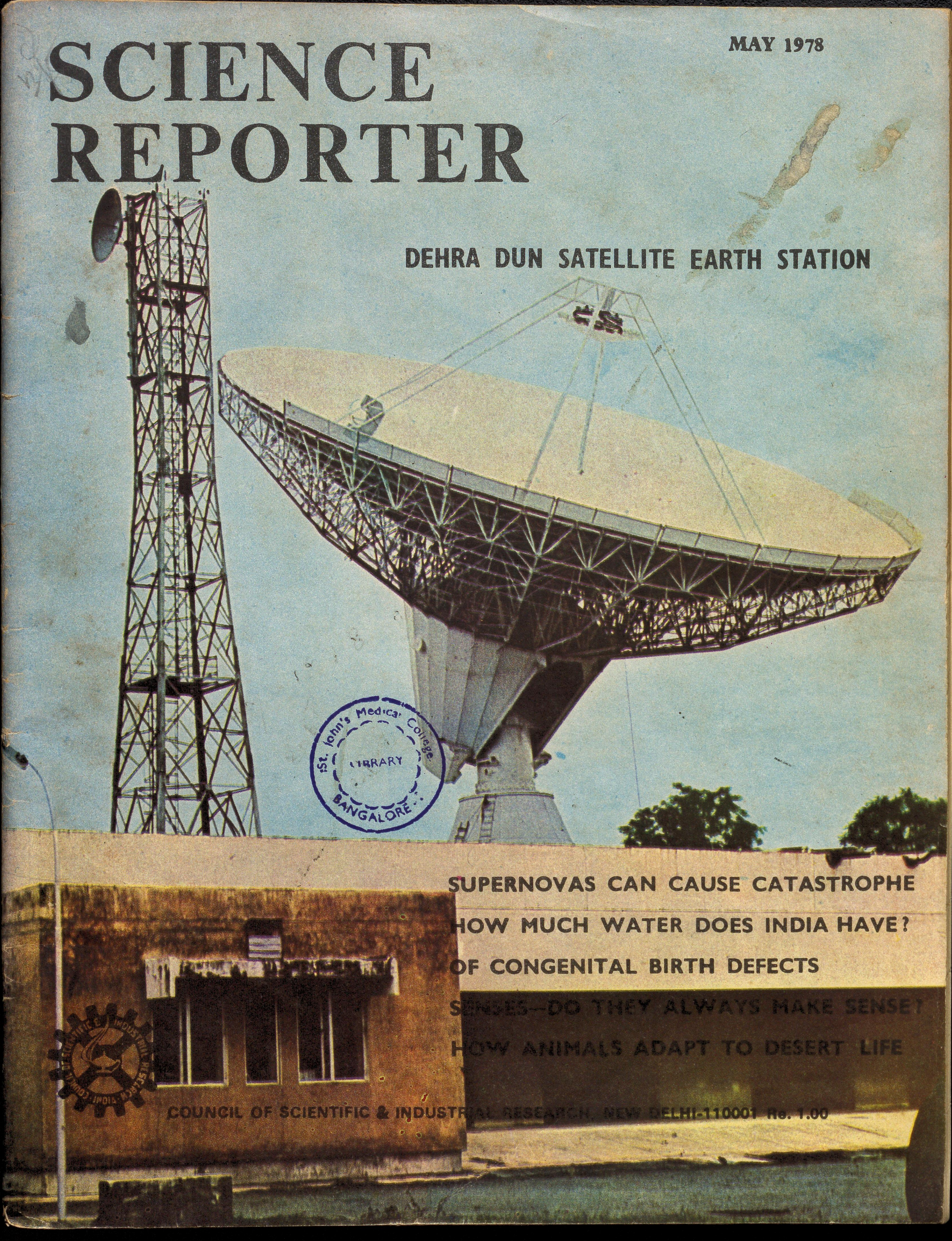

DEHRA DUN SATELLITE EARTH STATION

SUPERNOVAS CAN CAUSE CATASTROPHE

HOW MUCH WATER DOES INDIA HAVE?

OF CONGENITAL BIRTH DEFECTS

SENSES—DO THEY ALWAYS MAKE SENSE?

HOW ANIMALS ADAPT TO DESERT LIFE

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LETTERS

Solar energy

Sir, I learnt a lot from the article **The sun for everyone** by C. V. Suryanarayana (*S.R.*, Jan. 1978). I want to know the detailed mechanism of transformation of solar energy into electricity. Is there any centre that produces electricity from solar energy in India? How do solar cells convert solar energy into electricity? Can they store electricity?

P. K. B. P. MAHAPATRA
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Ouat, Bhubaneswar

At present there is no centre that produces electricity from solar energy in India.

The question about solar cells requires an elaborate answer.

The solar cells work only when the sun shines. They cannot store electricity. There are separate storage systems; for example, the output of an array of solar cells can be used to charge a battery which can be discharged at night. Similarly, there are other devices which store electricity obtained from solar cells.

C. V. SURYANARAYANA
CECRI, Karaikudi, Tamil Nadu

Primes

Sir, I refer to the letter of S. K. Gurtu (*S.R.*, Jan. 1978).

Many readers are not aware of the fact that 1 is not a prime. Even those who are aware of it do not know exactly why 1 is not taken as a prime number. A prime number is defined as "a number greater than 1, not divisible by any number other than itself and one."

1 is deliberately avoided from the set of prime numbers owing to the fundamental theorem of arithmetic which states that every number can be *uniquely* expressed as a product of powers of primes.

For example, $58=2\times 29$

$72=2^3\times 3^2$

$50=2\times 5^2$, etc.

but if we consider 1 to be a prime number, then uniqueness is not guaranteed;

For example, $58 = 2\times 29\times 1$

$= 2\times 29\times 1^4$, etc.

1 is not, as such, considered a prime number.

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Drugs from plants

Sir, The article **Vegetable raw materials for drug industry** by Renupada Nandi (*S.R.*, November 1977) contains useful information on different species of plants as sources of diosgenin and other kinds of steroid drugs. However, he did not make any mention of fenugreek (*Trigonella foenumgraecum*) which has good potential as a source of diosgenin used in the production of a wide range of modern drugs including oral contraceptives and other valuable byproducts. I would, therefore, like to supplement the article with some available information on fenugreek which is being evaluated as an alternative source of diosgenin.

The Tropical Products Institute (TPI) of London, in close cooperation with the Pyrethrum Board of Kenya, is currently evaluating the commercial viability of extracting diosgenin from fenugreek. Though the fact that it contains this important drug was discovered as early as in 1947, work on its extraction began in Britain only 10 years ago. Scientists of TPI strongly believe that the plant has many possibilities.

The current demand for diosgenin from the world pharmaceutical industry is about 1000 tons per annum. At present the major source is wild yams growing mainly in Mexico, Central America and the Himalayas. Though the wild yams are capable of yielding 3% to 5% diosgenin, there are fears that stocks would be seriously depleted because they cannot be harvested until three years after sowing. Besides, they require expensive staking and protection from pests, diseases and weeds. As such, a new source of disogenin is welcome and fenugreek can be an alternative.

Although the yield of diosgenin from fenugreek seeds is low (about 1%), the plant can be easily grown in a wide range of soils and climatic conditions in tropical as well as sub-tropical areas and can be harvested in a short period (about 6 months). In most parts of the world, two crops can be grown in a year, and an yield of about 3 tons of seeds per hectare can be obtained. There is no problem of major pests or diseases.

The Kenyan Project has started work on extraction of diosgenin from seeds, while efforts are being made by the TPI's Central London laboratories for using the full potential of the whole plant. Apart from diosgenin, a number of other commercially attractive products can be obtained. The seed germ contains a fixed oil similar to linseed oil which has useful applications in plant industry. The residual meal is rich in proteins and can have a potential use as animal feed. The dried plant, after removal of seeds, can be used as cattle fodder. Seed husk contains large quantities of gum that can be used as an adhesive and in the chemical industry. This type of integrated approach designed at complete utilization of the entire plant for producing valuable products makes fenugreek an attractive alternate source of diosgenin.

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II

Sir, I read with interest the note on **Vegetable raw materials for drug industry** (*S.R.*, Nov. 1977). The title appears comprehensive, but the contents are very much limited in scope. It refers to only one group—steroidal drugs; even in this respect, a very important class of steroidal glycosidal drugs from plants does not find mention. These cardioactive glycosides have no synthetic substitutes for their direct action upon the heart. In recent years, yet another group of steroidal lactones called 'Withanolides' have become useful as anti-inflammatory and antiarthritic as well as anticancer agents.

For the benefit of our readers, I would like to refer to interesting research work recently reported on the effect of post-harvest incubation of plant materials with plant-growth regulators; it has been shown that significant increase in the sapogenin contents is observed in the case of incubation of harvested tuber of *Dioscorea deltaoidea* and whole seed of *Trigonella foenumgraceum* (upto 35 per cent); in the case of powdered fruit wall and partially defatted seeds of *Balanites orbicularis*, it is upto 20 per cent. Even simple incubation with water appears to increase the sapogenin content of the plant materials.

These observations are valuable and may be applied for the extraction of useful steroidal phytochemicals for a better yield.

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Solar activity

Sir, In the article **What are sunspots?** (*S.R.*, Feb. 1978), sun's rotation period has been given as 27 days. This gives the impression that the sun, like the earth, is rotating like a solid body. It is not so. The period of rotation increases with solar latitude. The period at the equator is about 25 days, and at 35 degrees latitude it is about 27 days. Further lengthening of the period towards the poles is available from spectroscopic observations. The sun, as far as rotation is concerned, is more akin to the galaxies, since like them it shows differential rotation.

The author has stated the correlation between sunspots and growth of trees, magnetic storms and radio blackouts. Since the time of Heinrich Schwabe, the German amateur astronomer who in 1843 first noted the periodicity of phenomena on surface of the sun, numerous attempts have been made to correlate periodicity with changes in the average yearly temperature, auroras, changes in time of migration of swallows and starlings, wheat yields, and even social revolutions. About six years ago, Soviet researchers reported that deaths from heart diseases appeared to increase during periods of high solar activity, and last but not the least Stringfellow, an electrical engineer from U.K., about four years ago noted an interrelation between solar flares and lightning.

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pH

Sir, I cannot agree with the view of Nomita Sen (*S.R.*, Feb. 1978) that the lowest possible value of pH is 0 and the highest possible 14. It is true that the pH scale given in any pH meter is 0-14. But that does not mean that the lowest limit of pH is 0 and the highest 14. For example, the pH of an acid solution (fully dissociated) will be below zero when its concentration is above 100. Similarly for a fully dissociated base, the pH will be above 14 when its concentration is above 100. Sidney Siggia (*Organic Quantitative Analysis via Functional Groups*, 3rd Edn. John Willey and Sons, N.Y., p. 427) has referred to a pH of -0.10.

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Photographing atoms

Sir, The article **Can we see atoms?** by Gokulananda Mahapatra (*S.R.*, November 1977) was very interesting and informative. The author has mentioned that an electron microscope is unable to show an individual atom. I would like to mention that scientists at the University of Chicago have obtained first photograph of individual atoms in a molecular chain using a newly developed electron microscope that magnifies up to five million times. In this photograph two uranium atoms appear as relatively bright spots (*See*

S.R., Feb. 1971, p. 69).

S. SUJAKUMAR
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Oldest fossil

Sir, In (*S.R.*, Sept. 1977) under **Science Quiz**, answer to question No. 3 "According to geologists, how old is the oldest evidence of the existence of the organic material", has been given as 1750 million years. According to a recent report, an American Palaentologist, Elso Beghoorn has found fossilized alga resembling *Aphanocapsa* in black flint deposits at Figtree in Swaziland, which is believed to be 3500 million years old.

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Hormone action via ions

Sir, Action of certain hormones, both steroid and peptide, is facilitated through 'ions'. But this has not been described in the article **How hormones act?** by Chandrima Saha (*S.R.*, Jan. 1978).

Ecdysone (insect moulting) hormone and juvenile hormone (insect hormone for juvenile characters) have been shown to act via changing nuclear N:K concentration. Action of these two hormones could be seen on polytene chromosomes upto gene level as they form puffs (sites of mRNA synthesis) during metamorphosis in *Drosophila* and *Chironomus* (diptera). These hormone-specific puffs in Chironomus (midge) have been induced experimentally by changing the ionic composition of media in explanated larval salivary glands.

Many other hormones, i.e., neurohypophyseal peptides, mineralocorticoides, insulin and vasopressin also act via ions. For details, see Kroger, H., *Exp. Cell. Res.* (1966), **41**, 64; Kroeger, H., *Nemo. Soc. Endocrin.* (1967), **15**, 55-66; Mortimore, G.E., *Amerc. Jour. Physiol.* 200, 13, 15-19 and Riggs, T.R. (1964) in *Action of Hormones on Molecular Process*, John Wiley, NY, London.

H. S. RATHORE
Cell & Developmental Bio. Unit
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Cyanophages

Sir, Apropos of **Cyanophages—virus attacking blue-green algae** (*S.R.*, Jan. 1978), I would like to know :

Why does virus attack mainly blue green algae and sometimes green algae, e.g., Oedogonium?

How does the DNA of cyanophages differ from the general DNA with respect to constituents of nucleotides?

TARUN KUMAR GUPTA
C.M.P. Degree College
Allahabad

Phages are specific, although organisms with a common phage range may be phylogenetically related. For example, in the case of LPP-1 phage infecting the hosts *Lyngbya*, *Phormidum* and *Plectonema*, there is a close nucleotide homology between the three hosts, and there is a high degree of precision of base pairing in the reacting nucleotide sequence. The phages infecting the procaryotic systic systems do not infect eucaryotic systems.

The DNAs of cyanophages are linear double stranded, and do not seem to contain any odd base as a major constituent.

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Ashwagandha

Sir, This has reference to my article **Ashwagandha** (*S.R.*, June 1977) an ancient Indian drug, reported for its diverse therapeutic uses in our indigenous system of medicine. In addition to the uses already mentioned, recently its effectiveness in the treatment of various discases and as a rejuvenator has been shown, attributable to its ability to raise non-specific resistance as an adaptogen (O. P. Gupta, B. Singh and C. K. Atal, XXIX Indian Pharmaceutical Congress, Dec., 1977, Abst. C9, *Indian Journal of Pharmacy*, Nov.-Dec. 1977).

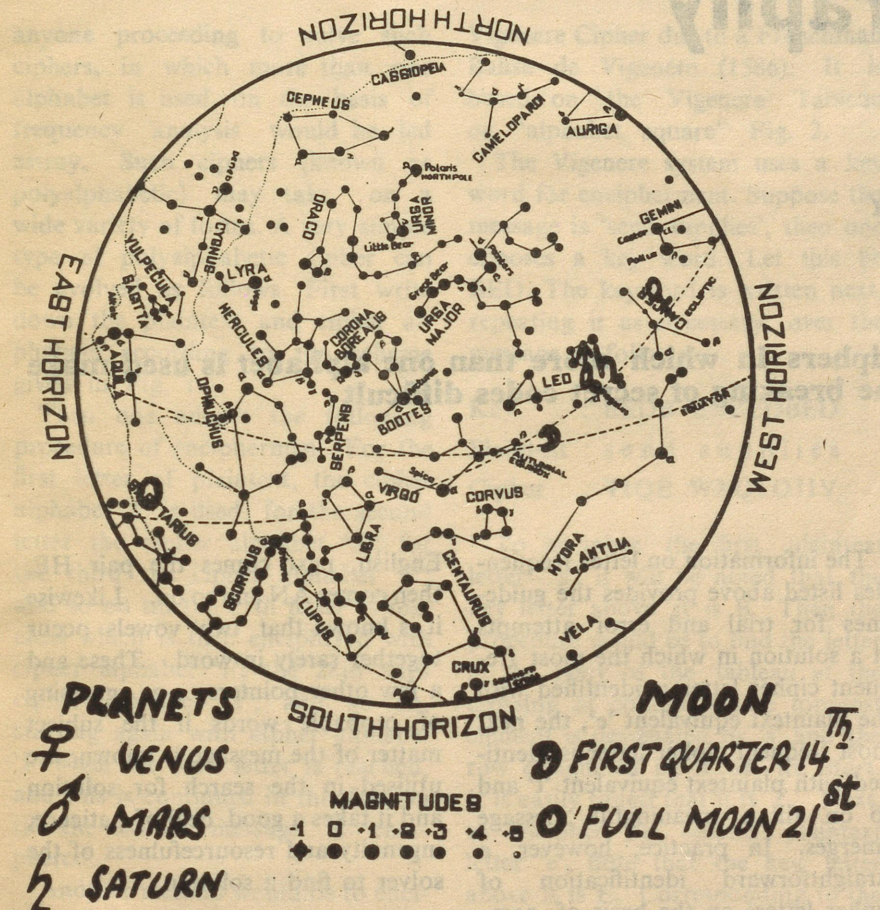
The concept of "a state of non-specifically increased resistance" of the organism—SNIR—was first introduced by Lazarav in 1947 at the 7th All Union Congress of Physiology, Biochemistry and Pharmacology in Moscow. He termed the medicinal substance causing SNIR an "adaptogen". Since then, for the past thirty years, a number of medicinal plants have been described under this category; the more important ones are *Eleutherococcus senticosus*, *Panax ginseng*, *Raphonticum carthamoides* and *Rhodiola rosea* (*Annual Review of Pharmacology*, 1969, Vol. 9, pp. 419-430.)

New substances of plant origin which increase non-specific resistance may be expected to be present in a number of Ayurvedic drugs, as certain Ayurvedic preparations are still found to be very effective in the treatment of some diseases

(*Contd. on page 302*)

Planets and their positions

June 1978



The moon

NEW moon occurs on 6th at 0-32 a.m. and full moon occurs on 21st at 2-01 a.m. I.S.T. The moon passes about Five degrees south of Venus on 9th, five and a half degrees south of Saturn, and about four degrees south of Mars on 12th.

The lunar crescent becomes first visible after the new moon day in the evening of 7th.

The moon is at apogee or farthest from the earth on 8th and at perigee or nearest to it on 21st.

The sun is at the summer solstice on 21st.

The planets

Mercury (Budha) is too near the sun to be visible during the first three quarters of the month. It is in superior conjunction with the sun on 14th. Thereafter, it reappears as an evening star and sets about an hour after sunset. It passes about two degrees north of Jupiter on 24th. It also passes five degrees south of the star Pollux (*Punarvasu*) on 29th. It moves from Taurus (*Vrisha*) to Cancer (*Karkata*) through Gemini (*Mithuna*). Its visual magnitude varies from -0.7 to -1.2.

Venus (Sukra), an evening star, sets about two hours after sunset during the month. It passes five degrees south of the star Pollux (*Punarvasu*) on 11th. It moves from Gemini (*Mithuna*) to Cancer (*Karkata*) Its visual magnitude is about -3.5.

Mars (Mangala), visible in the evening sky, sets about an hour before local midnight during the first half of the month and about two hours before it during the second half. It passes close to Staurn on 5th. It also passes very close to the star Regulus (*Magha*) in the night of 12th. It moves from Cancer (*Karkata*) to Leo (*Simha*). Its visual magnitude is about $+1.5$.

Jupiter (Brihaspati), visible in the evening sky, sets about one and a half hours after sunset during the first three quarters of the month. Thereafter it is too near the sun to be visible. It is in Gemini (*Mithuna*). Its visual magnitude is about -1.4.

Saturn (Sani), visible in the evening sky, sets, 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 Leo (*Simha*). Its visual magnitude is about $+0.8$.

(*Source*: Nautical Almanac Unit of the Meteorological Office, P-546, Block 'N' (1st floor), New Alipore, Calcutta-700053).

Polyalphabetic Ciphers

And Other Aspects of Cryptography

PRASANTA CHOUDHURY

Ciphers in which more than one alphabet is used make the breaking of secret codes difficult

IN an earlier article (**Cryptography —the science of secret writing** *S.R.*, March 1976), a few illustrations of simple substitution ciphers were given. It was also pointed out that the general method of solution of such ciphers consisted in identifying the cipher letters with their plain text equivalents by a process of trial and error in which frequency analysis of cipher letters plays a major role. It was observed that the letters in English language may be arranged into six groups in the order of frequencies given below :

1..........E
2..........T
3..........A, O, N, R, I, S
4..........H, D, L, F, C, M, U
5..........G, Y, P, W, B
6..........V, K, X, J, Q, Z

The information on letter frequencies listed above provides the guidelines for trial and error attempts at a solution in which the most frequent cipher letter is identified with the plaintext equivalent 'e', the next most frequent cipher letter is identified with plaintext equivalent 't' and so on till a meaningful message emerges. In practice, however, a straightforward identification of cipher letters on the basis of comparison of their frequencies alone would be a long and nearly interminable process, though the message intercepted may not be very long. So help is taken of other things such as comparison of frequency of letter pairs, letter triplets and so on. For instance, it is known that pair TH occurs most frequently in English, next comes the pair HE, then comes AN and so on. Likewise it is known that two vowels occur together rarely in word. These and a few other pointers, e.g., guessing of probable words if the subject matter of the message is known, are utilised in the search for solution and it takes a good deal of patience, ingenuity and resourcefulness of the solver to find a solution.

Polyalphabetic ciphers

By using more than one cipher alphabet, it is possible to distort the aforesaid image or pattern of letter frequencies observed in which a single cipher alphabet is used and which arise due to statistical properties of the concerned language. So

Sh. Choudhury is a popular science writer from Calcutta

Plaintext — a b c d e f g h i j k l m n o p q r s t u v w x y z

cipher 1 — A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
" 2 — B C D E F G H I J K L M N O P Q R S T U V W X Y Z A
" 3 — C D E F G H I J K L M N O P Q R S T U V W X Y Z A B
... ...
" 26 — Z A B C D E F G H I J K L M N O P Q R S T U V W X Y

Fig. 1

anyone proceeding to solve such ciphers, in which more than one alphabet is used, on the basis of frequency analysis would be led astray. Such ciphers (known as polyalphabetic) may take on a wide variety of forms. A very simple type of polyalphabetic cipher can be evolved as follows. First write down the plaintext and cipher alphabets according to the scheme given in Fig. 1.

Then one adopts the following procedure of encipherment. For the first letter of plaintext, the cipher alphabet '1' is used; for the second letter the cipher alphabet '2'; for the third the cipher alphabet '3'; and so on till the 27th letter is reached which is then enciphered with cipher alphabet '1', the 28th with cipher alphabet '2'; and so on, starting again with cipher alphabet '1' when the 53rd letter is reached, and this is continued in this fashion till the whole message is enciphered.

Another method would be to encipher first (say) four letters of plaintext with cipher alphabet '1'; the next four with cipher alphabet '2'; and so on for the whole message.

The St. Cyr Cipher mechanical cipher contrivance which was mentioned in the earlier article is easily adapted to the above two methods of polyalphabetic encipherment.

The vegenere cipher

The more perfect of the simpler types of polyalphabetic ciphers is the Vigenere Cipher due to a Frenchman Balise de Vigenere (1586). It is based on the Vigenere Tableau or "alphabet square" Fig. 2.

The Vigenere system uses a key word for encipherment. Suppose the message is 'send supplies', then one chooses a key word. Let this be BED. The keyword is written next, repeating it as necessary, over the message as follows:

Key : BEDB EDBEDBED
Plaintext : s e n d s u p p l i e s
Cipher : TIQE WXQTOJIV

To encipher the first plaintext letter 's', it will be noted that the key letter above it is B. Then the procedure would be to find the letter in the body of the tableau at the crossing of column whose topmost element is designated by 's' and the row designated by B at its start. It is easily found that it is T. Next, to encipher the second plaintext letter 'e', note that the key letter above it is E. Corresponding to the column 'e' and row E, one then finds the encipherment I. Then one proceeds likewise for the other letters, and gets the encipherment T I Q E W X Q T O J I V

The Vigenere tableau is easily adapted to a running key such as a text of a book, analogous to the repeating key case outlined above. One has first to write the chosen keytext above the plaintext message as in the above illustration and proceed likewise with the encipherment.

Decipherment of polyalphabetic ciphers

In polyalphabetic substitution, the 26 cipher letters A to Z in the enciphered message will have approximately equal frequencies, i.e., there will be no such thing as most frequent letter with an order of frequency groups as outlined in the beginning of this article. The curve of frequency will be quite flat without any distinctive peaks or troughs. The frequency analysis approach for monoalphabetic substitution therefore fails.

Methods of decipherment of polyalphabetic ciphers were discovered, by Friedrich Kasiski, a German, in 1863 and Auguste Kerckhoff, a Frenchman, in 1883. Kasiski's technique is applicable only for polyalphabetic ciphers with repeating key. Kerckhoff's technique is more general and can be employed for polyalphabetic ciphers with a running key such as the text of a book, or a repeating key. The first step in Kasiski's procedure consists in determining the length of the key, i.e., the number of letters in the key sequence. To find this, the cryptanalyst looks for repeated bits of cipher letters. In order that two cipher letters may repeat at some intervals, it is necessary that identical plain text of two letters must be enciphered by identical cipher alphabets. To illustrate with a simple example, suppose the plaintext message is "attack at dawn". Let the key be B E D. Then writing the key above the text and by using the Vigenere Square one has

Key : *BE* DBED *BE* DBED
Plaintext : *a t* t a c k *a t* d a w n
Cipher : *BX* WBGN *BX* GBAQ

It is clear that the text letters sequence 'at' has been enciphered in two cases by the same key letter *BE* resulting in two cipher repetitions, BX. Obviously such repetitions can only occur at intervals which are multiples of the length

	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o	p	q	r	s	t	u	v	w	x	y	z
A	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
B	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A
C	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B
D	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C
E	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D
F	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E
G	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F
H	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G
I	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H
J	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I
K	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J
L	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K
M	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L
N	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M
O	O	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N
P	P	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
Q	Q	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
R	R	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
S	S	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
T	T	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
U	U	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
V	V	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
W	W	X	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V
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Y	Y	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X
Z	Z	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y

Fig. 2. Vigenere tableau

of the key. So for a long cipher text if one finds, for example, that intervals of repetition of such cipher letters are 6, 18, 24, 36 letters apart, one must conclude that their key is 6 letters (the Highest Common Factor of 6, 18, 24, 36) long. Having found the length of the key, the cryptanalyst writes out the cipher message in as many columns as the length of the key. It is obvious that all letters in any one column will have been enciphered by the same key letter, hence by a single substitution alphabet. So if the length of the key be 6 then 1st, 7th, 13th, 19th letters will fall in a single column, 2nd, 8th, 14th, etc., letters in another; and so on. Letters in each such column are enciphered by a single substitution alphabet. Letters in each such column may then be subjected to a frequency analysis as in a monoalphabetic system, and the cipher letters in each column deciphered one by one. It is obvious that the cipher message must be lcng enough for a frequency analysis. Kerckhoff's technique, which, is applicable for both running key and repeating key is a little more involved and is therefore not discussed here.

Although polyalphabetic cipher system with repeating key is more vulnerable to decipherment than that with running key, it has the advantage in that encipherment may be done more quickly. The decipherment at the receiving end is also quicker than the running key.

So far only the case in which substitution is effected one letter at a time has been considered. Other systems employing substitution for two or more letters at a time are possible, as also systems using more than one substitution letters for a single plaintext letter. However, they are rather cumbersome and are not much employed in practice.

In the earlier article, a reference was made to the use of machines for enciphering and deciphering. Such machines known as rotor machines are very ingenious in the sense that they introduce a chain of polyalphabetic substitution one on the other with the result that more than several hundred billion letters can be enciphered before the first cipher alphabet repeats. Since cipher alphabet repetitions give the necessary clue in both the Kasiski and Kerckhoff techniques, the unusually large volume required for ultimate frequency analysis makes it quite secure against breaking of the cipher by either of these techniques. The result is that special techniques of solving this must be evolved and help is taken of mathematical and statistical techniques.

The volume of work involved in cryptography in modern times has become so great that electronic computers are used. It is believed that U.S. National Security Agency has more computers for this purpose than any other organisation in the world. These computers are used not merely to break the ciphers but also to determine which out of several cryptographic variations afford the greatest security.

Right from the 16th century onwards mathematicians like the Italian G. Cardan (1501-1576) and the Frenchman F.Vieta (1540-1603) (who was among the first European mathematicians to give the correct value of π upto ten decimal places) were interested in cryptography. In the 20th century, mathematicians tried their hand at employing such sophisticated tools as matrices. Now a days a sound mathematical background is considered essential in cryptographic work.

(*Continued on page 360*)

LATIKA S.R. BECKER

At temperatures near absolute zero, some normally resistive metals and alloys become superconductors

Near Absolute Zero-Expanding Applications

WE are all familiar with the three states of matter, solid, liquid and gas, in our everyday life (for example, ice, water and steam or vapour). Then there is the fourth state of matter: the plasma state, which originated in 1879 from W. Crookes' work on electrical discharges in low-temperature tubes. After that a new state—the fifth state of matter—was born. It is called superfluidity.

The superfluidity of liquid helium was discovered in 1937 by Peter L. Kapitza at the Institute for Physical Problems in Moscow. He found that liquid helium at a temperature of 2.2 °C above absolute zero changes from an ordinary liquid into one that has no viscosity at all. It can flow through narrow cracks or tiny tubes.

Both these involve the phenomenon of "frictionless flow"; in the metal the "fluid" consists of electrons, while in helium it consists of helium atoms.

In 1908, the Dutch physicist Heike Kamerlingh Onnes of the University of Leiden, the Netherlands, succeeded in cooling helium gas down to the liquid state. This led him to discover, in 1911, that superconductivity occurs in a number of normally resistive metals and alloys at various temperatures just above absolute zero (—273 °C) when they exhibit no electrical resistivity. Onnes observed that there was a steady fall of resistance of the metals as their temperature is lowered, until, at a temperature within a few degrees of absolute zero, the resistance falls to zero.

Superfluidity

When liquid helium is cooled to 2.2° above absolute zero (2.2 K), it undergoes another type of transition. The transition (point 2.2°) became known as the "lambda point". At this point, there is a sharp drop in heat capacity of the liquid. Liquid helium above this point is called helium-I, and below it, helium-II. This means that ordinary helium, designated as He-I, changes into superfluid, designated as He-II, at about 2.2° above absolute zero. Helium is the only substance which remains liquid under ordinary pressure at absolute zero; all other substances freeze if sufficiently cooled.

He-II has many other strange properties besides superfluidity. It conducts heat a thousand times better than copper. John A. Daunt and Kurt Mendelssohn at the University of Oxford demonstrated by direct experiment the phenomenon of the "creeping film" (Fig. 1).

In order to mathematically describe the flow phenomenon associated with liquid helium, it is necessary to treat it as a sort of two phase flow. One phase is the "normal fluid" which above the transition temperature moves like an ordinary viscous liquid. The other phase is the "superfluid", which below the transition temperature, moves as if it had no viscosity. The most important difference between the two phases is that the normal phase transports heat, whereas the superfluid phase is accompanied by no heat transfer whatsoever.

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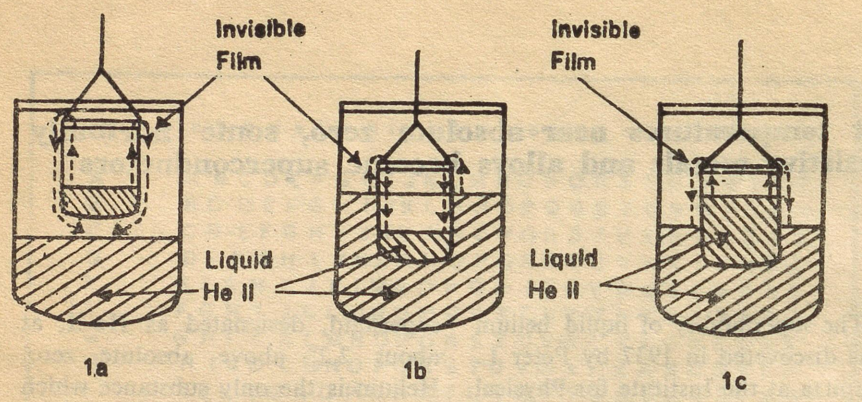

Fig. 1. Phenomena of creeping film : (a) When a beaker partially filled with helium II is raised above the level of a large bath of helium II, the contents of the beaker will creep over the brim in a thin film and drip into the larger vessel, eventually emptying the beaker; (b) If an empty beaker is partially dipped in a helium II bath, the superfluid liquid will flow into it until the level inside is the same as that on the outside; (c) Similarly, if the beaker is filled three-fourth with helium II and submerged partly in the larger vessel, the content of the beaker will flow out of it into larger vessel until the level inside is the same as that on the outside

It must be mentioned here that helium is not a single substance; it exists in two stable isotopes, viz., a common isotope helium-4 (^4He), and a rare isotope helium-3 (^3He). What has been said above refers to helium-4. In the ^4He nucleus, there are 2 protons and 2 neutrons—an even number of particles, but in ^3He nucleus, there are 2 protons and 1 neutron—an odd number of particles. These two isotopes differ in their quantum properties. In the terminology of physics, the ^4He atom is said to obey Bose-Einstein statistics (a statistical method invented by the Indian scientist S. N. Bose and Albert Einstein), whereas, the ^3He atom obeys Fermi-Dirac statistics. Although ^3He is present only to the extent of one part per million in natural helium, it is today readily available in pure form as a byproduct in the radioactive decay of hydrogen isotope, tritium. John C. Wheatley at the University of California has recently discovered that unlike ^4He, ^3He exhibits superfluid phases, but in contrast to ^4He only at temperatures of a few millikelvins. This research is of practical importance in selecting and processing materials for space exploration.

Superconductivity and its basic properties

Consider the normal conduction of electric current by a metal. Here the current is transmitted by motion of electrons. When a potential is applied between any two points on a material, a relatively large flow of conduction current takes place. The electrons collide with atoms in the metal's crystal lattice and this interaction constitutes the resistance. The resistance increases as the temperature increases, because the vibrating atoms in the metal lattice interfere with the electron's motion. This suggests that by reducing the temperature to absolute zero, resistance to the flow of electrons would drop to an undetectable level. But Onnes in 1911 found that the resistance, instead of decreasing continuously with falling temperature, vanished abruptly at several degrees above absolute zero. At these temperatures, some metals become superconductive with the ability of carrying large electric currents without resistance, and in a closed circuit can keep circulating the current without any additional power.

Onnes observed that the state of superconductivity cannot be attained above a certain critical temperature, T_c (also called transition temperature). T_c fell as the measuring current increased. Also, at any temperature below T_c, the superconductivity could be destroyed by imposing a magnetic field above a certain critical field, H_c. These effects are related, because the lowering of T_c by the current is due to magnetic field produced by the current. (The magnetic field may be applied externally or may arise from an electric current passing through the superconductor so that current it can sustain is limited to less than critical current J_c.) Graphically, the superconducting state therefore occurs within a surface passing through T_c, H_c and J_c as shown in Fig. 2.

One of the interesting properties of a superconductor, other than its zero resistance, is its diamagnetism. W. Meissner, a German physicist, discovered that superconducting materials, when placed in an external magnetic field less than the critical value, expelled magnetic flux. The way in which this occurs divides superconducting materials into two types. Certain metals which have low melting points, are mechanically soft, can be easily obtained pure, and display superconductive behaviour, are distinguished as Type-I or soft superconductors. Alloys and metals in which the superconductivity is affected by a

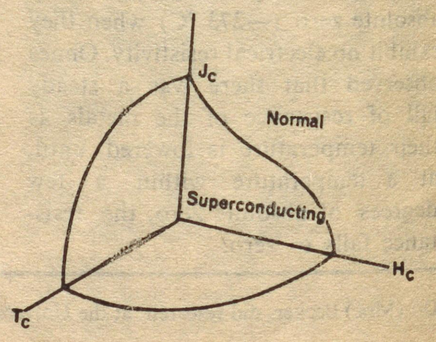

Fig. 2. A surface passing through J_c, H_c, T_c

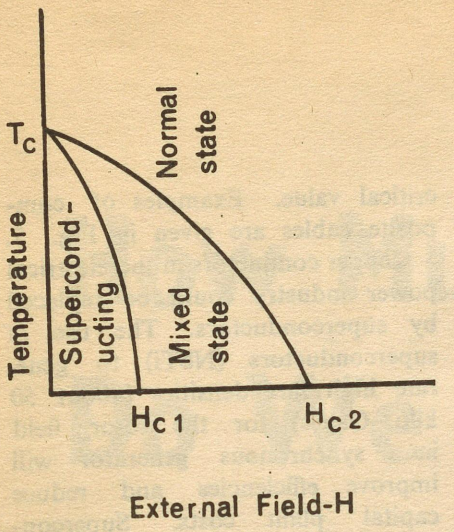

Fig. 3. The behaviour of Type II superconductors

magnetic field, are distinguished as Type-II or hard superconductors. In Type-I the magnetic field is excluded from the interior upto H_c; above H_c it penetrates fully into the sample and the superconductivity vanishes. Type-II superconductors possess two critical fields, a low H_{c1} at which partial penetration of magnetic field occurs, and a high H_{c2} at which normal electrical resistance is restored. Fig. 3 shows the behaviour of Type-II superconductors. The state of zero resistance occurs up to a surface passing through the points T_c , H_{c2} and J_{c2}. Type-II superconductors fulfill one of the requirements of a material for use in superconducting magnet as the superconductive state exists in the presence of the necessary high fields, upto H_{c2}. (Another requirement is that the material should also sustain a large transport current.)

Superconducting materials

Kamerlingh Onnes found that mercury becomes superconducting at 4.2° above absolute zero. Certain other metals are also found to become superconducting at different temperatures in the low range above absolute zero. Samples of superconducting materials are tested in capsules held in a coil cooled with liquid helium.

Table 1. Superconducting materials with their Transition Temperature (T_c) and Critical Field (H_c)

Material	T_c in °K	H_c in Gauss(G)	
Iridium (Ir)	0.14	19	
Titanium (Ti)	0.39	100	
Zirconium (Zr)	0.55	47	
Cadmium (Cd)	0.56	30	
Zinc (Zn)	0.85	53	
Aluminium (Al)	1.19	99	
Tin (Sn)	3.72	306	
Tantalum (Ta)	4.48	830	
Vanadium (V)	5.3	1020	
Lead (Pb)	7.2	803	
Niobium (Nb)	9.15	1960	
	T_c in °K	H_{c2}	H at 4.2 °K
Nb Ti	9.5	—	120 Kilo Gauss
Nb Zr	10.8	—	80 KG
Nb Sn	18.05	190 G	220 KG
Nb Al Ge	20.7	—	400 KG at 0 K

Superconductors have zero resistance and perfect diamagnetism below the transition temperature (T_c). The transition temperature at which a subtance becomes superconducting is related to the number of valence electrons possessed by its atoms (valence electrons are those electrons which are found in an outer unfilled shell). Around 1950, it was found that substances which became superconducting were elements or compounds which had an average of about two to eight valence electrons per atom. Within this range, materials with an odd number of valence electrons per atom become superconducting at the highest transition temperatures. Table 1 gives a summary of superconducting materials.

Apart from the search for new superconducting materials, a great amount of technical development is taking place in the application of known superconductors in industry.

Superconducting magnets

The most significant use of high-field superconductor (Type II) is in the production of large magnets with negligible power consumption. The principal applications in which superconducting magnet are used are as follows.

Magnetohydrodynamic (MHD) generators. MHD generator is a device which is used to convert heat into electrical power without the necessity of a turbine. Superconducting magnets offer an economic solution to this method of power generation. Power generation by MHD is attractive in India as there is an ample supply of coal. Large research projects on MHD generators are underway in the U.S.A, Japan and U.S.S.R. A just completed superconducting magnet, to be used in an existing conventional MHD generator in U.S.S.R., uses NbTi-Cu multifilament conductors

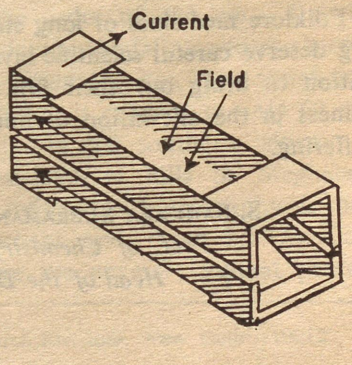

Fig. 4. Saddle coils for MHD generators

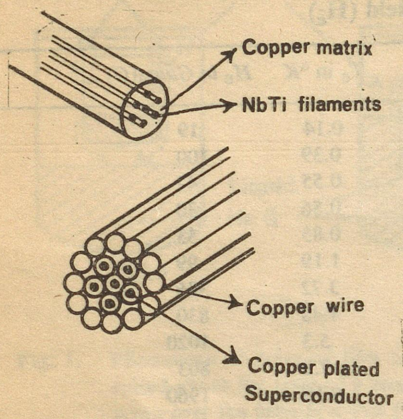

Fig. 5. Examples of composite cables

(superconducting cables). Fig. 4 shows the saddle coils for MHD generators.

Plasma and Nuclear Fusion. An important use of superconducting magnets will be in controlled thermonuclear fusion reactors. Recent experiments on the Tokamak fusion reactor, in which the plasma is confined to a toroidal magnetic field, indicate that higher confinement field results in larger values of one of its important parameters.

High-energy physics. Associated with particle accelerators are magnets of high field for bending and guiding the accelerated particle beams. Bubble and spark chambers used for particle detection also require high magnetic fields. American physicists have predicted that a superconducting accelerator for heavy ions is feasible. Use of superconducting metals in waveguides for radiowaves that accelerate protons is useful in saving power and time.

Superconductors in power transmission

Construction of stabilised superconducting wires or cables is of fundamental importance. Due to 'flux jumping' in the mixed state (Fig. 3) superconductor becomes unstable. To maintain superconductivity in the superconducting cable, the wires are embedded in a normal conductor (copper). Cooling is achieved efficiently with superfluid helium by a type of convection cooling. Copper provides a good thermal conduction path for heat to spread to superfluid helium so that the superconductor quickly restores its superconductivity by bringing the temperature below its critical value. Examples of composite cables are given in Fig. 5.

Copper conductors in the electrical power industry could be replaced by superconductors. The use of superconductors (NbTi) to generate high flux densities (about 50 kilo Gauss) for the rotor field in a synchronous generator will improve efficiencies and reduce capital plant costs. Superconducting coils can be very useful in the construction of lightweight motors and generators which can be utilized for space and marine applications. There are many uses of superconductors and they are already finding widespread applications in laboratory devices. Much research work is currently underway in developing the use of superconducting elements for electronic computers.

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LETTERS (*Continued from page* 294)

for which the correct aetiology of the causative organism is not known in modern medicine.

Folklore medicines of long standing deserve careful scientific investigation to bring out their full usefulness in the alleviation of human suffering.

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Food additives

Sir, The article **What are food additives?** (*S.R.*, January 1978) by G. B. Singh and S. K. Khanna makes interesting reading. But it has failed to take note of the investigation (*S. R.*, Oct. 1977, p. 662) that food preservative butylatedhydroxytoluene (BHT) can cause tumors in experimental animals. FDA of USA did not approve its inclusion in the approved list of the food additives pending further investigation to confirm the same.

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How Much Water Do We Have In India ?

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An inventory of Himalayan snow masses and glaciers that feed our northern rivers is called for for a correct estimate of India's water resources

AVAILABILITY of good quality water is one of the prime needs of man. As quantities of available fresh water are limited, it is important to make an inventory of fresh water resources and update information from time to time. As India is a land of extreme weather conditions—very cold to very warm, and extreme wetness to dryness — water yield per unit area in terms of run-off is very high and the per capita availability of water is low. It is, therefore, necessary to consider seriously all aspects of water management to optimise water use.

An appraisal of water resources is an important scientific information for integrated development of a country. In this article the present status of knowledge about water resources in India is discussed. Various components of a watershed model are outlined in Fig. 1.

Precipitation

Condensation of atmospheric vapour in the form f rain or snow is called precipitation. It is the primary source of all fresh water resources. In India, there are at present more than 4800 rain gauge stations to collect data on rains. The data are processed, analysed and published by India Meteorological Department. From these observations, it is estimated that 70% to 80% of the annual precipitation over our land occurs during the period of south-west monsoon (June to September), except in Tamil Nadu where major portion of rainfall occurs during post-monsoon season. It has been estimated that the Arabian Sea monsoon carries about 7700 km³ of moisture, while that of Bay of Bengal carries only about 3400 km³ of it. Out of this 11,100 km³ mositure carried by monsoons over the Indian sub-continent only 25% to 30% precipitates (i.e., about 3750 km³). This calculation of precipitation has been made by taking the annual average rainfall as 115 cm during a normal monsoon year. In non-monsoon months also there is a substantial amount of moisture over the country.

A wide disparity in the distribution of annual precipitation however exists over the country. In the higher reaches of Western Ghats, there are places which receive rainfall of the order of 600 cm. On the leeside, the rainfall decreases sharply and within 100 km, the annual precipitation is reduced to only 60 cm. Again, in the southern slopes of Khasi-Jayantia hills in Meghalaya the influence of orography is predominant and there are locations where the normal annual precipi-

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tation exceeds 1000 cm. On the northern side, the influence of Himalayan ranges is very much discernible in the rainfall pattern. In the sub-mountain regions of the north-west side rainfall decreases and, over west Rajasthan it is as little as 20 cm. Year to year variation in rainfall over different parts of the country is appreciable. To assess the dependability of annual rainfall, the coefficient of variation has been found to vary from 15% to 80% (Fig. 2). It is also estimated that about 33% of the cropped land area (total 142 million hectares) gets less than 75 cm, 36% between 75 cm and 115 cm and only 31% over 115 cm annual precipitation.

Winter in northern India is marked by snowfalls in the Himalayan ranges above 3000 m. The snowfall in the Himalayan river catchment area from December to March is a major factor contributing to the dry-weather seasonal flow of some rivers. There are more than 75 snowfall recording stations in this region. However, there is need to increase the network for snow observations in order to make quantitative estimates of water equivalent of snow masses.

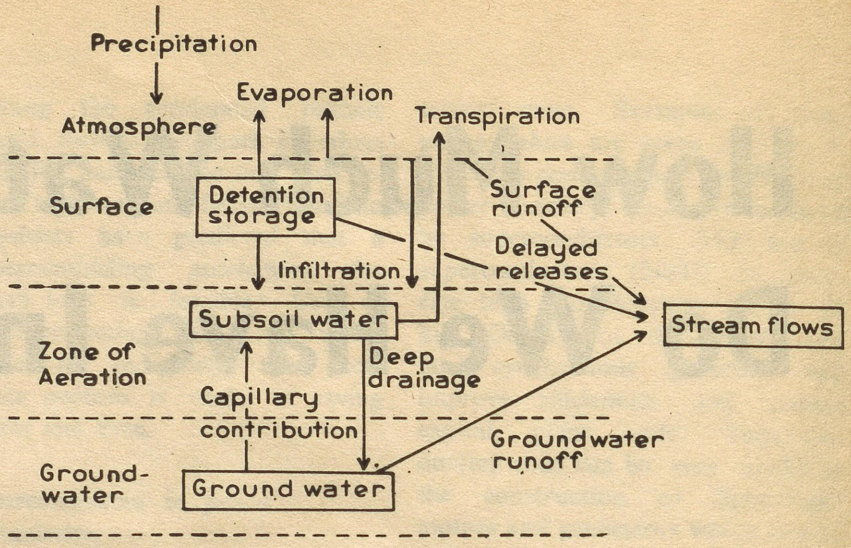

Fig. 1. Components of a watershed model

Surface water resources

Surface water resources are described under three sub-sections, viz., Himalayan snow, ice and glaciers; annual stream flows; and storage in natural and artificial lakes including tanks and ponds. Himalaya—the storehouse of snow has a profound influence not only on the climate of the sub-continent but also on the global circulation of moisture in atmosphere. The Himalayan mountain system is divided into three parallel longitudinal zones which have marked differences in their orographic features. They are called greater, lesser and outer Himalayas. The greater Himalaya has its main ranges rising above the snow line with an average elevation of 6100 m. This zone is composed of a continuous series of highly fossiliferrous marine sedimentary rocks of different ages and includes the world's highest mountain peaks, viz., Everest, K-2, Kanchanjunga, etc. The lesser Himalayas, with middle ranges (2600 m—4600 m) south of the greater Himalayas, are predominently composed of crystalline and metamorphic rocks. The outer Himalayas comprising the Siwalik ranges are composed of sedimentary deposits and lie between lesser Himalayas and the plains. They have an average elevation of 1000 m—1300 m.

The snow line, i.e., the lowest limit of perpetual snow on the side of Himalayas facing the plains of India, varies in altitude from about 4300 m on east to 588 m on west. On Tibetan side, it is about 1000 m higher due to absence of moisture in the monsoon winds that have traversed Himalayas.

In Ladakh, the snow line is at about 5500 m and in Hindukush about 5200 m. As the lesser Himalayas are below 4600 m, i.e., lower than the permanent snow line, they do not support glaciers. It is the greater Himalayas with their inner-most ranges above 6100 m that feed a multitude of glaciers, some of which are the longest in the world outside polar circles.

The Himalayan glaciers have large variations in size. Their length varies from a few km to more than 70 km. The glaciers descending traversely to the strike of the mountains are shorter in length with larger gradient, and descent to levels as low as 2150 m in Kashmir. On the other hand, glaciers which move in a direction parallel to the strike of the mountains have low gradients and they rarely descend below 4000 m. In general, glaciers in Eastern Himalaya never descend below 4000 m, in Central Himalayas not below 3650 m; in Western Himalaya they descend as low as 2150 m. The velocity of glacier flow has neen observed to vary from 2.5 m to a few metres per day. The variation in glacier activity, i.e., their advance or retreat may be secular, periodic, seasonal or accidental. It has neen observed that Karakoram and Himalayan glaciers show no evidence of any regular periodic variation corresponding to known weather cycles. A very rough estimate shows that our glaciers yield 3m to 12 m water equivalent on a

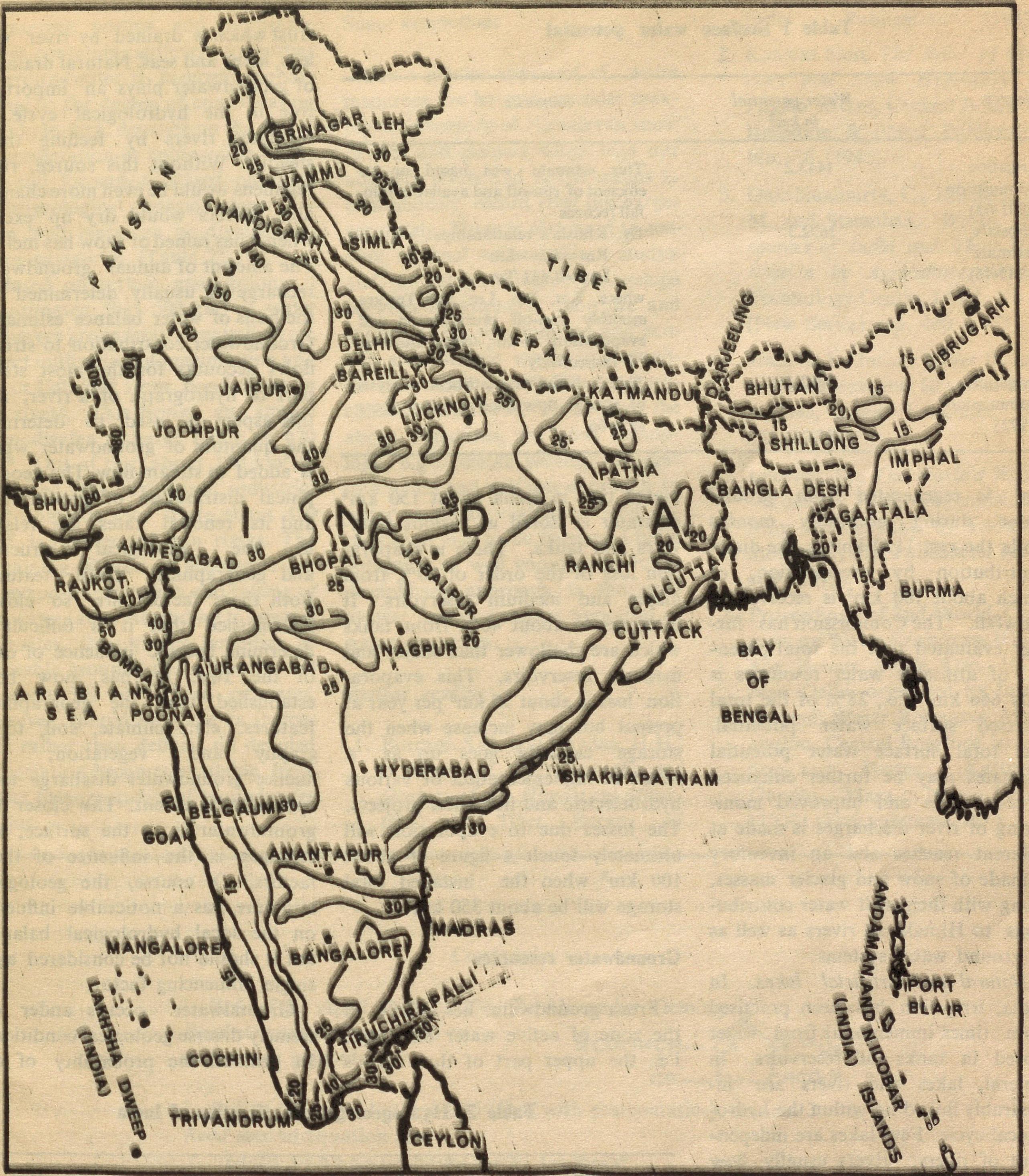

Fig. 2. Coefficient of variation of rainfall (annual)

long term basis. This means that a depth of 3m to 12 m of water multiplied by glacier area is the annual water yield. Normally, these glaciers yield a lot of water during dry and warm years while they store it during wet and cold years.

Stream discharges. In India, we have a variety of rivers and several estimates have been made of surface water potential based on the average annual discharge of river systems. (Table 1).

According to the estimates of Irrigation Commission (1972), 200 km³ of water is added to our rivers from catchments lying outside the national boundaries, 450

Table 1 Surface water potential

Source	*Water potential in km³*	*Remarks*
Irrigation Commission (1901-03)	1443.2	This estimate was based on coefficient of run-off and available rainfall records
Khosla's Estimate (1945-46)	1672.3	Dr. Khosla's relationships: $Rm = Pm - Lm$, $Lm = 0.481\ Tm$ where Rm, Pm, Lm and Tm are monthly run-off precipitation and evaporation in cm., temperature is °C respectively.
Irrigation Commission (1972)	1882.1	This is based on statistical analysis of stream flow data for the years 1954-66

km³ is regenerated from ground water during non-rainy months while the rest 1150 km³ is the direct contribution by precipitation, of which about 100 km³ is received as snowfall. The Commission has further evaluated that the total potential of utilisable water resources is only 666 km³, i.e., 28% of the total assessed surface water potential. The total surface water potential estimates may be further enhanced if continuous and improved monitoring of river discharges is made at different reaches and an inventory is made of snow and glacier masses, along with their melt water contributions to Himalayan rivers as well as to ground water systems.

Natural and artificial lakes. In India, irrigation has been practised from times immemorial from water stored in tanks and reservoirs. In general, lakes and rivers are inseparably linked up within the hydrological cycle. Few lakes are independent of rivers; rivers usually flow into, from or through them.

A characteristic feature of lakes is that more water is evaporated from their surface than from the surrounding land. Evaporation from lakes goes on all the time, but on the surrounding land there are periods when the top soil is dry and has no mositure to evaporate. It is estimated that in India about 150 km³ of water is stored in various reservoirs and tanks. There is evaporation loss of the order of 20% from major and medium reservoirs. It incerases to about 40% from tanks which are shallower than major and medium reservoirs. This evaporation loss is about 50 km³ per year at present but may increase when the storage capacity goes up as a result of implementation of various hydroelectric and irrigation projects. The losses due to evaporation will ultimately touch a figure of about 100 km³ when the installed total storage will be about 350 km³.

Groundwater resources

Fresh groundwater lies chiefly in the zone of active water exchange, i.e., the upper part of the earth's crust which is drained by river valleys, lakes and seas. Natural drainage of groundwater plays an important role in the hydrological cycle. It regulates rivers by feeding them steadily. Without this source, river regimens would be even more changeable. Rivers would dry up except when it has rained or snow has melted. The amount of annual groundwater recharge is usually determined on the basis of water balance estimates. Groundwater contribution to stream flows accounts for the most stable part of hydrograph of a river, and this aspect is used to determine the quantum of groundwater which is added to stream flow. The geographical distribution of groundwater and its renewal rates are related to the geological structure and geographical zonal features. Both these factors are so closely intermeshed that it is difficult to determine specific influence of each of the two. It has now been established that the geographical features, e.g., climate, soil, topography and vegetation, influence groundwater discharge to a considerable extent. The closer the groundwater is to the surface, the stronger is the influence of these factors. Of course, the geological structure has a noticeable influence on the local hydrological balance, but it should not be considered as a single influencing factor.

Groundwater occurs under extremely diverse geological conditions. In general, the probability of en-

Table 2. Hydrogeologic classification of India

Formations	*Geologic classification*	*Area (million km²)*
Consolidated	(i) Igneous & metamorphic rocks (crystalline rocks)	2.4
	(ii) Palaeo-Mesozoic sedimentary rocks	0.061
Semi consolidated	Semiconsolidated rocks and unconsolidated tertiary sediments	0.172
Unconsolidated	Unconsolidated quaternary sediments (alluvial tracts).	0.579

countering porous and permeable zones containing sufficient quantities of groundwater is inversely proportional to the degree of consolidation which, in turn, depends on the extent of cementation or compaction of the sub-soil formation. Based on these hydrogeological consideration, Indian land mass can be divided into three categories (Table 2).

Based on certain assumptions, it is estimated that 500 km^3 of water recharges groundwater annually from direct infiltration of precipitation and about 120 km^3 from flood flows in the rivers. This brings an annual groundwater recharge figure of 670 km^3. Out of this, about 130 km^3 is extracted for irrigation, industrial and domestic uses while about 450 km^3 is regenerated into rivers. The remaining 90 km^3 is accounted for by evapo-transpiration and raising of the water table. According to present estimates, the ultimate potential of utilisable groundwater resources will be about 350 km^3. These estimates, however, should be taken as indicative rather than definite till detailed information becomes available from water balance studies of groundwater basins.

Some suggestions

For a precise appraisal of water resources, we have to consider making an inventory of Himalayan snow masses and glaciers which feed our northern rivers and devise means to continuously record river discharges accurately. There is also need to conduct regional water balance studies and to establish inter-relationships between atmospheric moisture and surface water, precipitation and run-offs and surface water to groundwater systems under different agro-climatic conditions. To achieve the above objectives, the latest technology, e.g., remote sensing, isotopic techniques and systems approach to water resourecs evaluation and exploitation has to be harnessed fully. Adoption of well coordinated inter-disciplinary approach is the only answer for an accurate appraisal of water resources.

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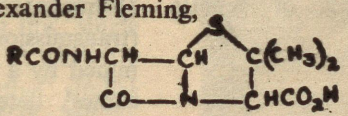
Corrigenda

1. Ref: *S.R.*, April 1978. p. 274, Sir Alexander Fleming, *Read* structure of penicillin as and not as printed.



2. Ref: *S.R.*, April 1978, p. 276 (Fun with mathematics), column 3 *Read* second equation as:

$$1+2+3+4+5+6+5+4+3+2+1=36=6^2$$

and *also read* eqn. $1+2+3+4+5+6+7+6+5+4+3+2+1=49=7^2$ *before* the equation ending with 8^2.

on p. 277, col. 3, *read* $629=37\times17$ *for* $629=37\times26$

3. Ref: *S.R.*, October 1977, p. 616, in reply to letter on Eucalyptus (column 2, 4th line from bottom) *Read* 500 *for* 3000.

CAN BIRTH DEFECTS BE PREVENTED ?

S. M. TULI

Human material can be improved by providing good environment for the developing embryo

IN the wake of developments in genetics in early twentieth century, it was presumed that a majority of birth defects were genetic or hereditary. But now it is believed that aberrations of genetic material are responsible for not more than 30 per cent of all birth defects. The rest 70 per cent of the defects are attributable to the environment of developing embryo. Chances of prevention of congenital malformations are more likely in environmentally determined defects rather than in abnormalities of genetic origin.

Genetic causes

Genetic material in the chromosomes of the ovum and the sperm carries specific information for the developing embryo. A defect in the genetic material may manifest as an abnormality in the embryo. The malformation may be caused by aberration of a chromosome or due to mutation of genes situated on the chromosomes. The chromosomal defects usually lead to severe defects of sex organs, abnormal body development, intellectual impairment and general inability of procreation.

A large number of birth defects are caused by subtle changes (mutation) of genes. These defects may be transmitted by defective genes carried on autosomes (non-sex chromosomes) or on X-chromosomes (chromosomes that determine sex) following Mendel's Law of inheritance. Dominant autosomal inheritance (transmission of a character determined by a dominant gene on autosomes) determines transmission of conditions like achondroplasic dwarfs (a witty dwarf commonly employed in circuses), polydactyly (more than five fingers), etc. In such situations one of the parents exhibits and transmits the same defect. Recessive autosomal inheritance determines diseases like phenylketonuria (faulty metabolism of phenylalanine), albinism, deaf mutism (deaf and dumb), etc. In these cases both parents must carry the defective genes. That is, each parent may carry either both the recessive genes for an abnormal trait (homozygous) or one dominant gene for the normal character and one recessive (heterozygous) for the abnormal trait. The offspring which receives the defective genes from both father and the mother, may exhibit the defect and become a carrier of the defective gene. The offspring which receives the defective gene only from one parent is a carrier but does not himself suffer from the defect due to the presence of a dominant gene for normal character.

Some rare recessive birth defects are caused by defective genes carried on X-chromosomes, e.g., pseudohypertrophic muscular dystrophy, colour blindness, haemophilia, etc. In these conditions, the defective gene is carried on the X-chromosomes of the mother, but the defect manifests in males only. The sex determining chromosomes are

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Fig. 1. Multiple deformities of upper and lower limbs in a child

XX in females and XY in males. If the defective gene is carried on one X-chromosome it can be compensated for by the presence of a normal X-chromosome in males. There are, however, many genetically determined defects which do not exhibit any distinct dominant or recessive pattern of inheritance.

The theoretically calculated risks in birth defects of genetic origin are fairly reliable. An individual with dominant anomaly will have a 50 per cent risk for each child. The parents with a recessive anomaly will have a 25 per cent risk for each additional child. The mother with recessive X-linked anomaly will have a 25 per cent risk in each new pregnancy for a boy, and similar risk for a girl who looks normal but is in a carrier-state like her mother.

Environmental factors

Many congenital anomalies have been attributed to a viral or other infections occurring to the mother during pregnancy. The commonest defects produced are eye defects (especially congenital cataract), heart defects, deafness, microcephaly (abnormally small head), mental retardation, cleft-lip, cleft-palate, intestinal constriction, spina bifida (failure of closure of vertebral canal) and mongolian idiocy (now called Down's syndrome). These children have mongolian features with slanted eyes, a broad nose, a protruding tongue and a lower IQ. Incidence of birth defects is the highest if the mother gets the infection during the first trimester. Depending upon the time of maternal infection the incidence of anomalous baby varies between 70% to 80%. The most clear aetiologic relationship has been established for rubella (German measels) and for human cytomegalovirus (HCMV). The credit for the discovery that maternal rubella causes birth defects goes to the Australian eye specialist, Normal Gregg (1941).

HCMV infection of the mother during early part of pregnancy may lead to defects such as jaundice, enlargement of liver and spleen, haemorrhagic spots, pneumonia, and defects in nervous system.

Thalidomide and other drugs

Thalidomide was first marketed in Germany in 1956 as a harmless and popular tranquilliser. Very soon its use spread to other European countries, Australia, and Canada. In December 1959, a single case report of a girl born with a upper and lower limbs missing appeared in German literature. But this single case drew little attention. It was only in 1962 that retrospective studies conclusively proved that the 'harmless' drug was responsible for untold sorrow and suffering to thousands of families. In West Germany alone, the number of defective babies related to a definite history of thalidomide consumption by expectant mothers during the critical phase of pregnancy was 4500. Between 1962-1965, more reports appeared of this tragedy. Soon the use of thalidomide was banned in all countries. Today, no new drug is marketed without teratological screening in laboratories.

Among the large varieties of malformations associated with thalidomide are absence of whole or part of upper or lower limbs, defects of finger, eyes, heart, atresia or congenital closure of various parts of digestive system, and haemangiomas (a benign tumour made up of blood vessels) of face. The overall incidence of malformed babies born to mothers who had taken thalidomide during the sensitive period is about 20 per cent.

In the wake of the reports of 'thalidomide tragedy,' many therapeutic drugs were suspected to lead to malformations. But only a few have been incriminated on careful scientific observations. At present it is advisible to avoid the following drugs during the first trimester of pregnancy except for life threatening indications: hormones, especially cortisone; compounds of lead and mercury; hypoglycaemic doses of insulin; anticancer chemotherapeutic drugs; and anticoagulants, especially Warfarin.

Radiation hazards

As man himself is responsible

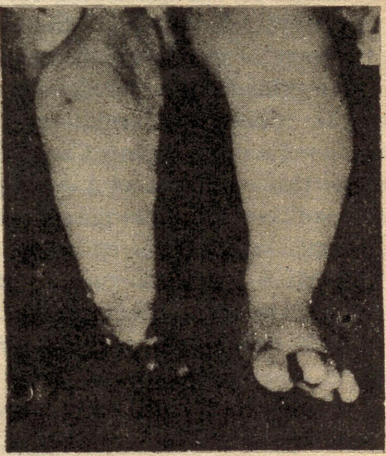

Fig. 2. Absence of foot since birth

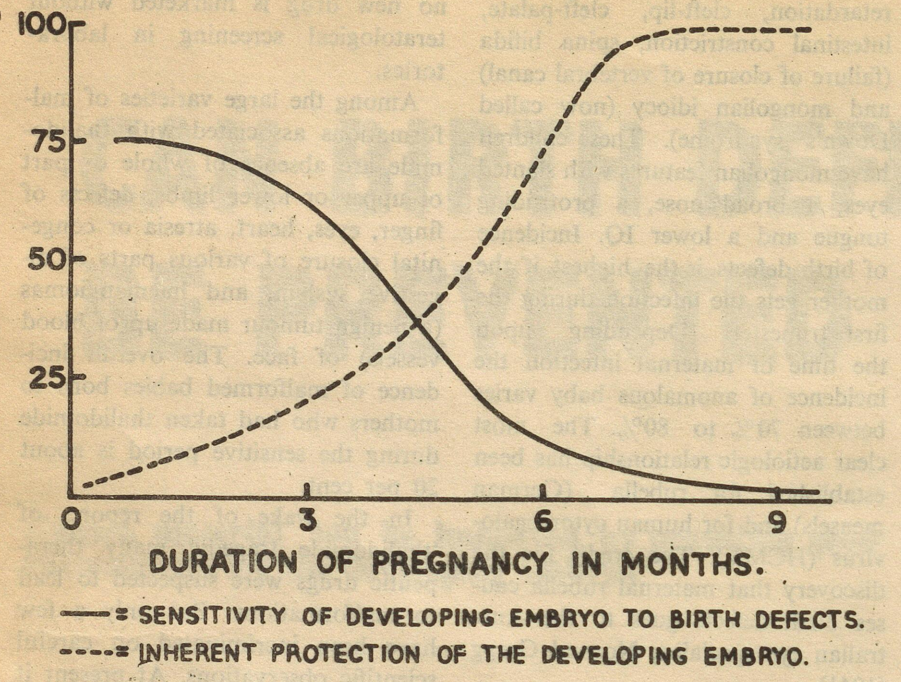

Fig. 3. Sensitivity of the developing embryo to teratogenic agents and the protection of tissues with further development of the embryo

creating most sources of radiation, whether in the form of X-rays or atomic fall-out or radioisotopes, it has become a subject of intensive study. In human beings, most congenital malformations due to irradiation are caused by (i) mutation or aberration of genetic material of germ cells when ovaries or testes are exposed to radiation before procreation, and (ii) direct effects of radiation on the developing embryo (especially during first trimester). Exposure of more than 10 roentgens is considered unsafe for the sensitive organs during the critical period.

Abnormalities reported as a result of *in vivo* irradiation of a developing human embryo are microcephaly, mental retardation, hydrocephalus (dilatation of brain due to excessive fluid), spina bifida, spinal cord defects, cleft-palate, clubfoot, eye defects, and mongolism.

There are many reports about a higher incidence of malformations among offsprings of diabetic mothers than of normal mothers. The overall frequency of a birth defect is about three times as high as in the general population. The two most important causes appear to be poor control of diabetes and vascular complications associated with it. Important types of deformities noted under this group are vascular and heart anomalies, spina bifida, meningocoele (hermiation or protrusion of brain or cord through an opening in skull or spinal column) and malformations of renal excretory system.

There is some evidence that unsuccessful attempts to induce abortion by various chemical agents like amniopterin and quinine may be one of the causes of congenital defects in human beings. Failure to induce abortions by mechanical means by amateur experimentalists might also lead to malformations due to disturbances of the foetus and its blood supply.

Maternal and foetal immune reactions due to rare Rh incompatibility may be responsible for a condition called erythroblastosis fetalis (characterised by anemia, jaundice, enlargement of liver and spleen, and generalised oedema). Carbon monoxide poisoning, toxaemic pregnancies and advanced maternal age (more than 45 years) are considered to increase slightly the risk of a congenital defect.

Prevention of birth defects

The seeming multiplicity of causes, lack of possibility of experimentation in human beings, and ignorance about the underlying fundamental mechanisms of birth defects make their prevention difficult. However, based upon extensive scientific observations some suggestions can be made to decrease the risk of such abnormalities.

Girls should be immunised against all infections for which lifelong or prolonged immunity can be provided. This may be achieved by vaccination (e.g., small pox, poliomyelitis, tetanus, etc.) or by deliberate exposure to those infections for which reliable vaccinations are not yet available (e.g., measels, chicken pox, rubella, etc.)

Heart defects leading to poor oxygenation of blood (cyanosis), maldevelopment or underdevelopment of uterus and pelvis, defects of endocrine glands (e.g., diabetes, hypothyroidism, hyperthyroidism, etc.) should be corrected before marriage.

Socially it is difficult to forbid a marriage between men and women carrying unhealthy genes. Avoidance of consanguineous (between blood relatives) marriages may lower the risk of defects of recessive inheritance. It would be wise for an Rh-negative female not to marry an Rh-positive man. Diabetic and other endocrinal disturbances should be kept appropriately controlled. Incidence of malformations has been reported to be the lowest in mothers of 25 to 29 years of age.

The most critical period of the developing embryo is the first trimester of pregnancy. Diagnosis of preg-

(*Continued on page 357*)

AUXIN: A Plant Growth Hormone

R. RAJ BHANSALI

RAVI BHUSHAN

Flowering and fruit setting in plants can be conveniently controlled by the use of growth regulators

THE phenomenon of development, in both plants and animals, presents some of the most challenging unsolved problems of biology. 'Development' is applied in its broadest sense to the whole series of changes which an organism goes through during its life cycle, but it may equally be applied to individual organs, tissues or even to cells. Plant development involves both 'growth' and 'differentiation'. The term 'growth' is applied to irreversible quantitative changes in the size of a cell organ or a whole organism, while the term 'differentiation' is applied to qualitative differences between cells, tissues and organs.

The growth of a plant is a dynamic and complex process. The coordination of growth between different parts of the plant must clearly involve some control mechanism. As a result of intensive studies, it is now known that hormones play a vital role in the control of growth, not only within the plant as a whole, but also within individual organs.

The word "hormone" was first used by the British animal physiologists, W. M. Beyliss and E. Starling in 1904, to refer to a substance which is synthesized in a particular secretory gland and is carried by blood or lymph to another part of the body where extremely small amounts of it influence a specific physiological process. However, in plant hormones we cannot always differentiate so clearly between the site of hormone synthesis and its place of action. Unlike animal hormones, a plant hormone can elicit a wide range of responses depending upon the type of organ or tissue in which it is acting.

A plant growth hormone may be defined as any organic chemical which controls either by stimulation, inhibition or alteration, the growth, development and differentiation of the plant. The individual hormones rarely function alone in the isolated systems but do so by interacting with one another. Their physiological properties are often interrelated and may overlap. For reasons such as these, plant growth hormones have frequently been referred to by other names such as 'phytohormones', 'growth regulators' or 'growth substances'. There are today five major classes of growth hormones, viz., auxins, gibberellins, cytokinins, abscisic acid and ethylene. Each of these chemically different types of growth hormone has characteristic influences on the growth and differentiation of plant cells. The influence of growth hormones extends to all phases of germination, dormancy, organogenesis, flowering, senescence and growth movements.

Auxins

Auxins were the first plant growth hormones to be discovered. The basis

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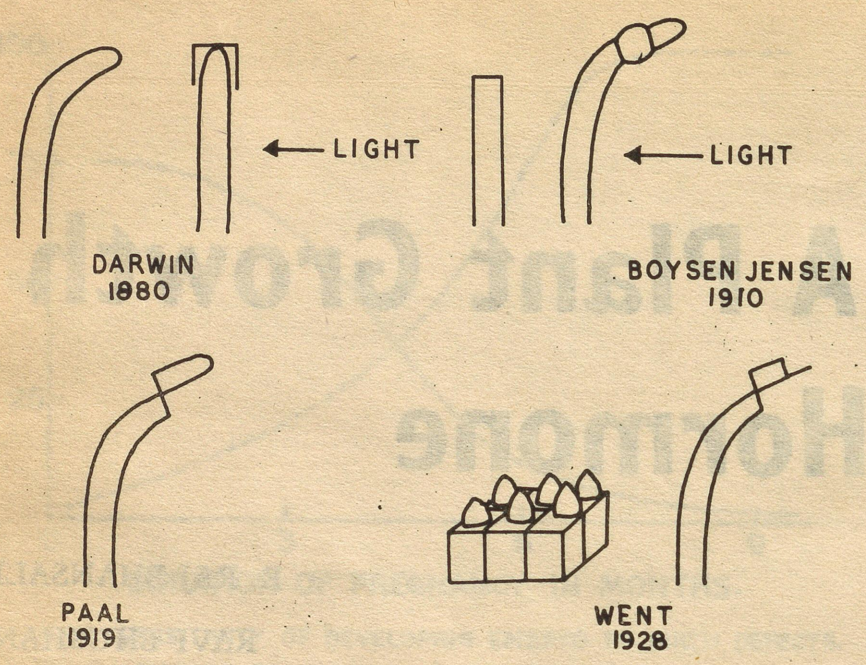

Fig. 1. Diagrammatic summary of the major steps in the discovery of auxins

of modern knowledge of auxins lies in the work of Charles Darwin, published in 1880 in a book entitled *The Power of Movement in Plants.* Darwin investigated the phenomenon of "Phototropism" with the seedlings of canary grass (*Phalaris canariensis*). His experiments made Darwin to realize that the tip of coleoptile 'perceives' the unilateral light stimulus but that the curvature response occurs lower down (Fig. 1). Darwin concluded that "when seedlings are freely exposed to a lateral light, some influence is transmitted from the upper to the lower part, causing the latter to bend".

Boysen Jensen and A. Paul of Germany, demonstrated (1910-1920) that the growth promoting influence transmitted from a coleoptile tip was of a purely chemical nature. In 1928, F. W. Went at Utrecht, Holland measured the growth substance in coleoptiles. He proposed a theory of "Ohne wuchstoff, kein wachstum" (without auxin, no growth). He also measured the growth substance. In 1934, F. Kogl and his group from Utrecht, Holland found that human urine is an abundant source of auxin. They obtained a crystalline substance from urine, which was found to cause a marked growth curvature. This chemical is now known as 3-indole acetic acid (often abbreviated as IAA).

Auxin is a generic name (from the Greek *auxein*—to grow) given to the growth hormone produced by the tip of a coleoptile. It is now believed that IAA occurs in most plant species and is the principal auxin in higher plants. The elucidation of the true nature of endogenous auxin in plants involves chemical and physical techniques as well as biological methods (bioassay). During the isolation and chemical identification of IAA, it was established that there are other substances in plants which also possess auxin activity. For example, the compound, indole-3-acetonitrile (IAN) is known to be present in a number of plant species. Other auxin-like compounds such as alfa and beta naphthalene acetic acid, 2, 4-dichlorophenoxy acetic acid; 2, 4, 5-trichlorophenoxy acetic acid and 2-methyl 1-4-chlorophenoxy acetic acid have been developed synthetically. These compounds are generally acids with unsaturated cyclic nucleus or derivatives of such acids.

In 1938 it was discovered that for a molecule to behave as auxin it must possess: (i) a ring system with at least one double bond, (ii) a side chain containing a carboxyl group (or a group easily converted into a carboxyl group), (iii) at least one carbon atom between the ring and carboxyl group in the side chain, and (iv) a particular spatial relationship between the ring system and the carboxyl group. Another requirement, suggested later, was the ability to form a covalent bond at a position on the ring system 'ortho' to the side chain which terminates in a carboxyl group.

Several other theories such as "two point attachment theory", "three point" and "multipoint" attachment theories, have been put forward since then, but neither of them is accepted as valid by all plant physiologists.

Auxin translocation

The rate of growth and pattern of development of a plant depends upon both its genetic constitution and on environmental factors. Both genetic and environmental control of growth and differentiation are achieved by means which include the participation of growth hormones. It may, therefore, be assumed that the distribution and concentration of auxins are vital factors in the control of growth and differentiation. The pattern of distribution of growth hormones in the plant with regard to space, time and concentration, is itself controlled by interactions

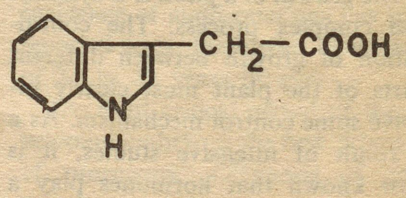

Fig. 2. Indole acetic acid (IAA)

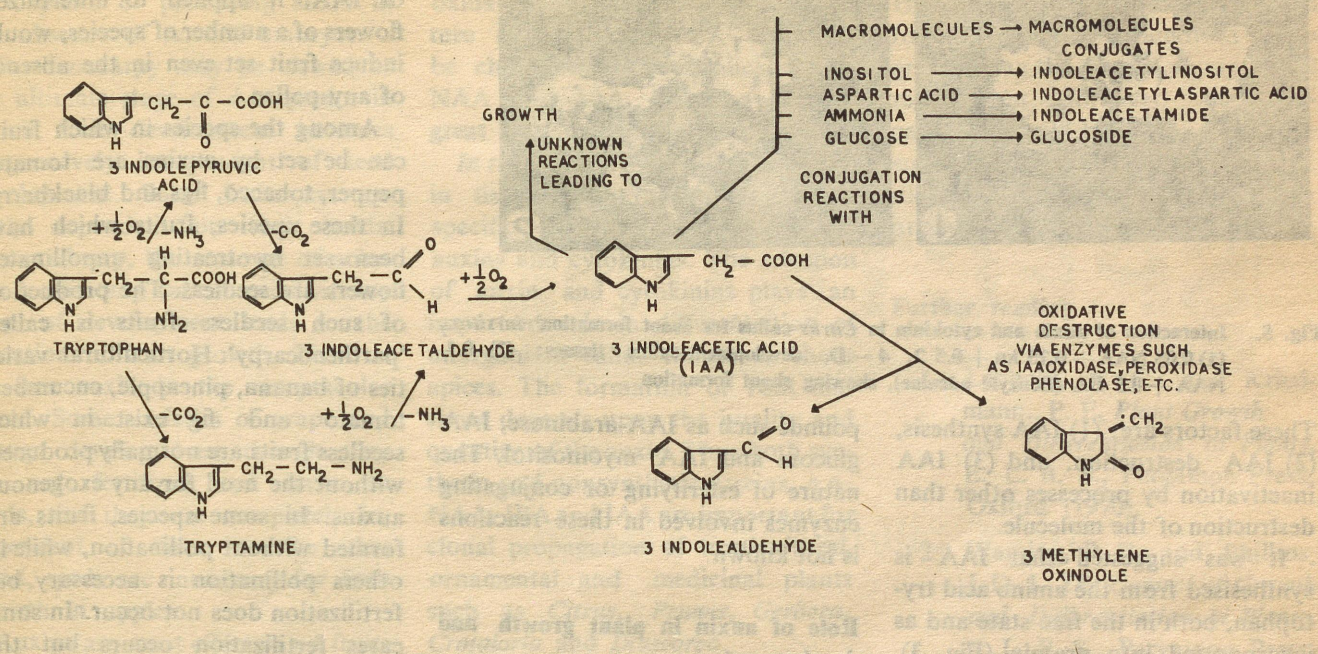

Fig. 3. Formation and metabolism of indole acetic acid

between the environment and the genetic make up of the plant. The growth hormones serve merely as agents in the overall integration and coordination of growth and differentiation. Two very important factors in the coordination of growth in the whole plant are : (1) the localization of the sites of hormone biosynthesis, and (2) the pattern of hormone movement and distribution from these sites. The auxin appears to be synthesised mainly in the meristematic tissues such as those of stem apex, young developing leaves, flowers and fruits. There is still doubt as to whether auxin is synthesised in roots. It appears that auxin is transported from the centres of production in the shoot in a predominantly basipetal (downward) direction, but in roots the movement is preferentially acropetal (upward). Transportation usually takes place through phloem and parenchyma tissues. But the mechanism of this 'polar' transport process is still not understood.

Auxin metabolism

The belief that IAA is the principal auxin and attempts to understand normal plant growth regulatory mechanisms have led scientists to investigate the metabolism of endogenous auxin. Since it is known that the 'concentration' of auxin available to tissues has a determining effect on growth and differentiation, the factors which limit the concentration of IAA in plant tissues have received most attention.

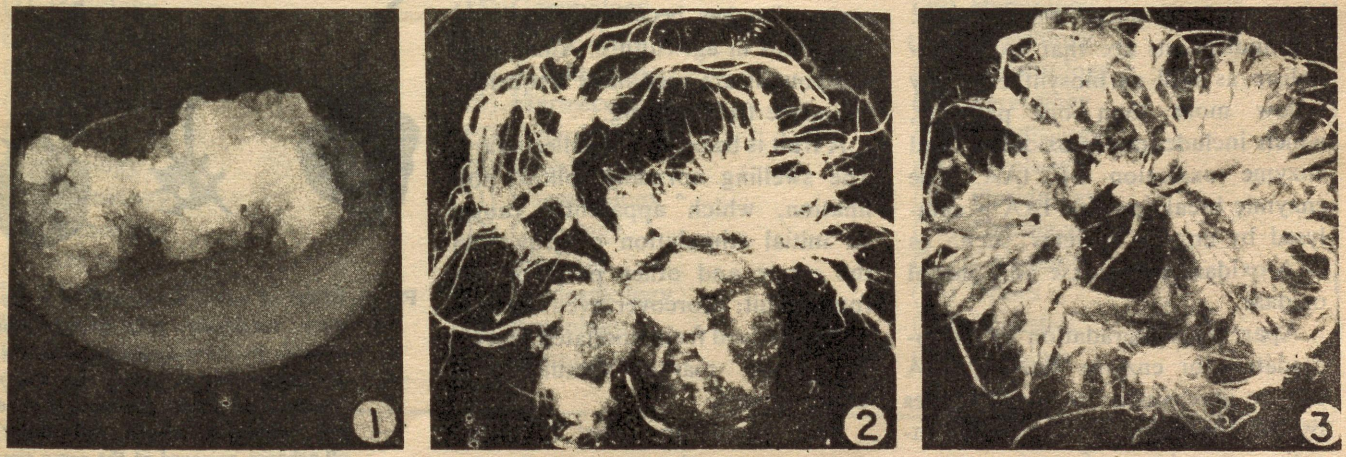

Fig. 4. Effect of auxin on *Crotalaria* tissues for rooting *in vitro*., (1) 0.25 NAA + 0.05 mg kn formation of undifferentiated callus mass., (2) 2.5 NAA + 0.05 kn, rooting in callus; (3) 5.0 NAA + 0.05 kn formation of abundant roots from cotyledon (all concentrations in mg/litre)

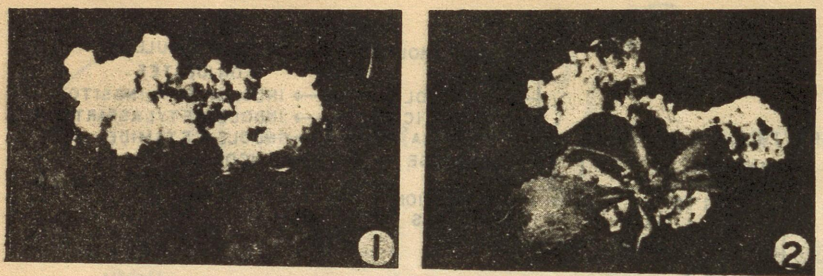

Fig. 5. **Interaction of auxin and cytokinin in** *Citrus* **callus for shoot formation** *in vitro*., **(1) 0.05 NAA + 0.25 kn + 0.5 2, 4 — D, development-callus tissues; (2) 0.1 NAA + 0.5 BA (Benzyle adenine), showing shoot formation**

These factors are: (1) IAA synthesis, (2) IAA destruction, and (3) IAA inactivation by processes other than destruction of the molecule.

It was suggested that IAA is synthesised from the amino acid tryptophan, both in the free state and as incorporated into protein (Fig. 3). There are two possible pathways : (1) through the formation of indole-3-pyruvic acid, which is decarboxylated to form 3-indole acetaldehyde and then oxidised to give IAA, (2) through formation of tryptamine by decarboxylation of the tryptophan and its oxidative deamination to 3-indole-acetaldehyde, which on oxidation forms IAA. In some species indole-3-acetonitrile (IAN) can also serve as a precursor of IAA but the pathway of synthesis of IAA itself is still unknown.

It is well established that IAA is in one way or another fairly readily inactivated by most plant tissues. The indications are that IAA catabolism as well as biosynthesis may follow more than one pathway, which include photo-oxidation and enzyme oxidation of IAA. The enzymic breakdown of IAA is catalysed by enzyme systems such as IAA-oxidase peroxidase and phenol oxidase.

Apart from degradation by photo-oxidation or enzyme activity, IAA can be inactivated in plant tissues by the formation of hormonally inactive complexes of various types. IAA can conjugate various sugars and sugar alcohols yielding compounds such as IAA-arabinose, IAA glucose and IAA myoinositol. The nature of esterifying or conjugating enzymes involved in these reactions is not known.

Role of auxin in plant growth and development

Processes such as root initiation, onset and termination of dormancy flowering, fruit set and development, abscission, senescence, and rate of growth in plants are under hormonal control. In many agricultural plants, these processes can often be altered to man's benefit by proper application of plant growth substances, and it is quite possible that in due course all physiological processes in plants will be controlled by application of growth substances.

Fruit growth. Use of growth substance to control fruit set, size and maturation has become increasingly important in agriculture. Auxin-type compounds are used most frequently to induce fruit setting.

A fruit is basically a swollen ovary. The swelling normally follows pollination, which apparently causes an initial stimulation of growth in the ovary and other parts of the future fruit. Moreover, even 'foreign' pollen derived from unrelated species, may cause marked stimulation of ovary growth.

The stimulatory effect of pollen on ovary growth appears to be due to the auxin which it contains. It was shown that a purer peparation of IAA, if applied to unfertilized flowers of a number of species, would induce fruit set even in the absence of any pollen.

Among the species in which fruits can be set by auxins are tomato, pepper, tobacco, figs and blackberry. In these species, fruits which have been set by treating unpollinated flowers are seedless. The production of such seedless fruits is called 'parthenocarpy'. Horticultural varieties of banana, pineapple, cucumber, tomato and fig exist in which seedless fruits are normally produced without the need for any exogenous auxins. In some species, fruits are formed without pollination, while in others pollination is necessary but fertilization does not occur. In some cases fertilization occurs but the embryos abort before the fruit matures. It is not known how the growth of these seedless fruits is controlled, but it seems possible that in some cases the maternal tissues, such as the placenta, may

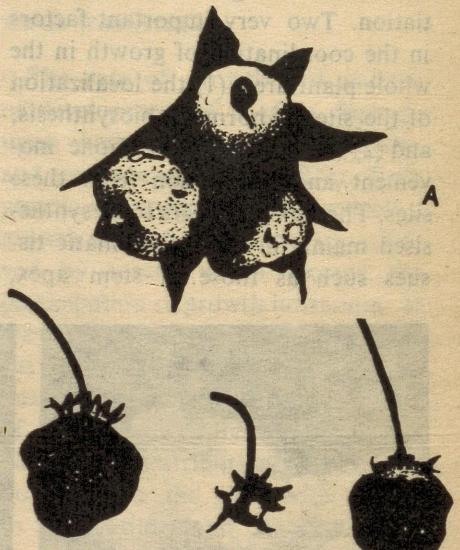

Fig. 6. Effect of auxin on growth of strawberry receptacle; (A) growth was induced by three fertilized achenes; (B) Strawberry of same ages (*left*), control (*Centre*) all achenes removed and replaced by lanolin, and (*right*) all achenes removed at the same time but replaced by a lanonlin paste containing 100.0 beta-naphthoxyacetic acid (natural size)

be capable of producing auxin in the absence of normal embryos.

Parthenocarpy may be viewed as the ultimate stage of a sequence in which fruit development becomes progressively independent of seed development. Some fruits are entirely dependent on their seeds. In strawberry, the removal of achenes (commonly called seeds) at any stage of development leads to the cessation of fruit growth. There is no free auxin in the receptacular tissue. Some varieties of grape and orange develop even though they are not fertilized and have no seeds, and they are completely independent of them. On the other hand, seeds are necessary for fruit growth in apples.

Auxins are most effective on fruits with many ovules such as fig, strawberry, tomato and tobacco, while they are ineffective on peach, plum, cherry and other stone fruits. Many synthetic auxins set fruit in plants, best set is usually obtained with 4-CPA (4-chlorophenoxyacetic acid) or BNOA (B-napthoxyacetic acid). IAA is usually ineffective, probably because it is unstable in light and is rapidly destroyed in the plant by oxidative processes. Falling of immature fruits from plants can also be checked by the application of NAA and IAA. This may be of great help to fruit growers.

In tissue culture. Plantlet formation in tissue culture depends on a specific equilibrium between the auxins and cytokinins. The selection of auxin and cytokinins plays an important role in differentiation of unorganised callus tissues or shoot apices. The formation of root and shoot depends upon the quality and quantity of the auxin. Thus both synthetic and nonsynthetic auxins, e.g., NAA, IBA and IAA are important for clonal propagation of horticultural, ornamental and medicinal plants such as *Citrus*, *Prunns*, *Gerbera*, *Crotalaria* and *Dioscorea*.

Hormonal weed killers

The possibility of using plant growth regulators as weed killers first came to light during World War II in an attempt to increase fruit production. Among the most effective compounds are 2,4-D (2, 4-dichlorophenoxyacetic acid) and MCPA (2-methyl-4-chlorophenoxyacetic acid). However, the concentration required for weed killing is hundreds times greater than the normal physiological requirement. Moreover, special precautions should be taken when these substances are used as herbicide for dicotyledonous crops because both are susceptible.

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Answers to Name the science

(1) Heliology
(2) Selenology
(3) Nephology
(4) Anemology
(5) Astronomy
(6) Orology
(7) Limnology
(8) Balneology
(9) Aerology
(10) Oceanography
(11) Seismology
(12) Volcanology
(13) Petrology
(14) Crystallography
(15) Gemmology
(16) Conchology
(17) Arachnology
(18) Myrmecology
(19) Ophiology
(20) Graphology
(21) Haematology
(22) Osteology
(23) Myology
(24) Syndesmology
(25) Angiology
(26) Odontology
(27) Genetics
(28) Psychology
(29) Hypnology
(30) Oneirology
(31) Gerontology
(32) Teratology
(33) Dendrology
(34) Bryology
(35) Pteridology
(36) Pharmacology
(37) Cryogenics
(38) Optics
(39) Acoustics
(40) Horology

SCIENCE SPECTRUM

Dehra Dun satellite earth station

COMMUNICATION via satellite is the modern mode of telecommunication. Most communication satellites are geosynchronous, i.e., they go round the earth with the same angular velocity as the earth's rotation and so appear stationary to a viewer on earth. Such a satellite orbits our planet at an altitude of 36,000 km above the equator with a velocity of 10,600 km an hour. The large distance between earth and such a satellite greatly weakens the signals to and from it and for properly utilising the facilities offered by it, a highly sophisticated set-up is required. The set-up should be able to generate high power beam at frequencies of the order of 6,000,000,000 cycles per second (6 Ghz) and transmit it to the satellite. It should also be able to receive signals of the order of 4,000,000,000 cps (4 Ghz) beamed by the satellite and process them for extracting the information they contain. Such a set-up is called an earth sation.

Requirements

The site for an earth station should be free from "electrical noise" caused by internal communications, man-made interference, etc. This can be achieved to a remarkable degree by choosing the site in a "bowl" of hills away from cities. It should be free from seismic belt, have a temperate climate, be preferably free from dust storms, snow storms and hurricanes. The radiation of high power beam should not pose health hazards. As communication is the second line of defence, the place should have a natural protection from enemies. Most important of all, the satellite to which it is to be linked should be "visible" from it.

Arvi to Dehra Dun

India's first earth station for satellite communications was set up at Arvi, 80 km north of Pune. It went into operation in February 1971. It has direct access to 21 countries for international telephone, telex, telegraph, radiophoto and leased channel services via the Indian Ocean geosynchronous satellite *Intelsat-IVA*.

One earth station cannot meet the needs of a large country like India. Traffic from the remotest parts of the country has to be routed to Arvi via Bombay. This involves long transit routes. The high efficiency of satellite communications (more than 99.9%) is thus affected by the comparatively low efficiency of the terrestrial network.

In 1977, for a more efficient utilisation of communication facilities, a

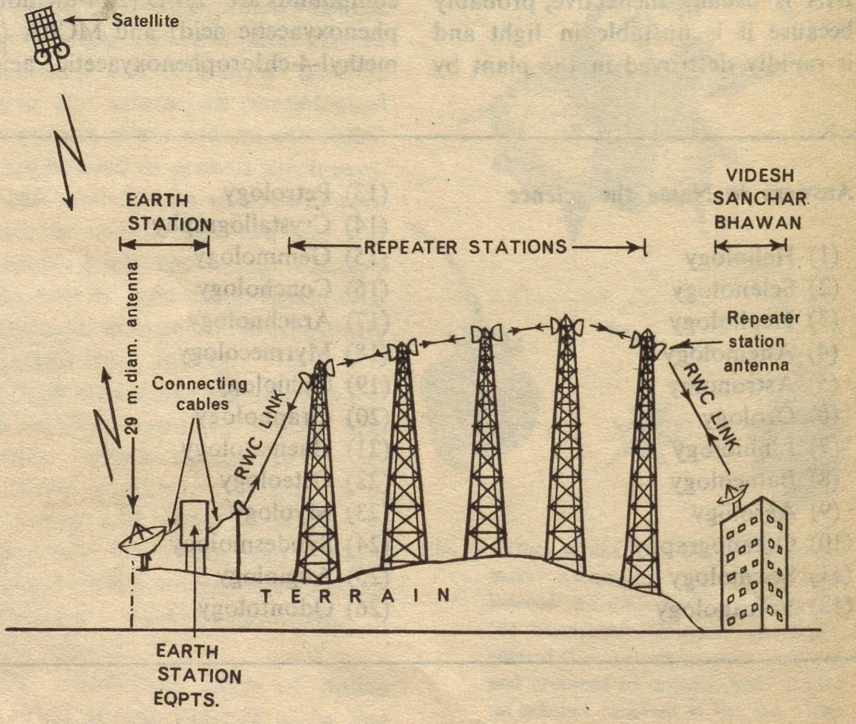

Fig. 1. A conceptual diagram (not to scale) showing the link between the exchange, repeater stations and the satellite

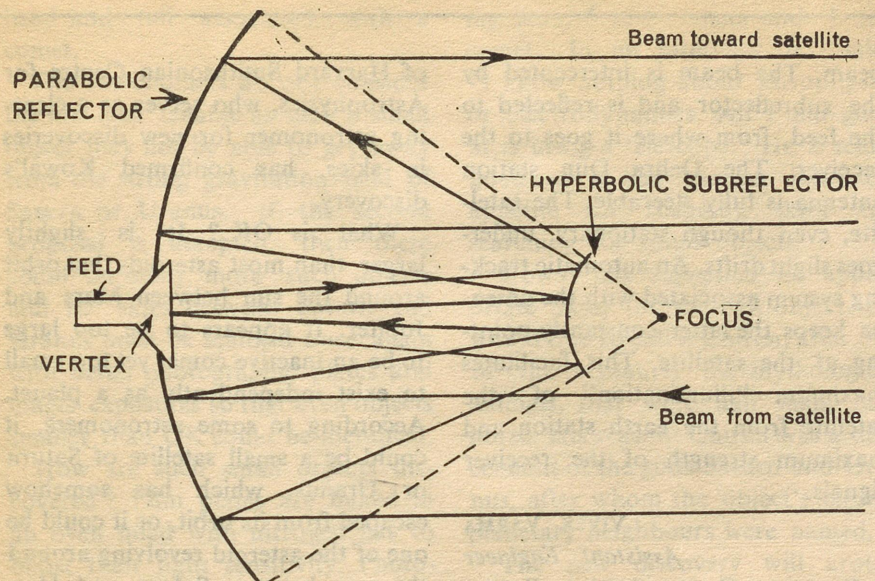

Fig. 2. Antenna using Cassegrainian principle

second earth station was commissioned by the Overseas Communication Service. This station, is situated in the Dehra Dun valley 20 km away from Dehra Dun and 470 metres above the mean-sea-level. It was built at a cost of Rs. 10.16 crores and is linked to the Indian Ocean satellite of the *Intelsat* organisation. A remarkable feature of the Dehra Dun earth station is its indigenisation. Indigenous content in this project is as high as 80% against 60% at Arvi. Many firms, both public and private, have provided the sophisticated equipments.

At present, the Dehra Dun earth station handles traffic of Delhi and Calcutta regions, whereas Bombay and Madras zones are covered by the Arvi station. In future, it will facilitate direct TV links between Delhi and many foreign countries. It can be a standby to the Arvi station and will handle the entire traffic in the country if the Arvi station fails. In the initial stage, Dehra Dun will establish direct links with France, Japan, Australia and the UK.

Repeater stations

As mentioned above, an earth station has to be far away from cities. A series of intermediate stations are therefore required to link the earth station with exchanges, which provide connections between the national and international networks. These stations are known as repeater stations. They receive signals from the exchange situated in city and transmit them to the earth station. They also receive signals from the earth station and transmit them to the exchange. The international telephone and telex exchanges of Delhi region are housed in the newly built Videsh Sanchar Bhawan at New Delhi. The Bhawan will also house programme transmission studios and an internatinoal television centre. The Dehra Dun station is linked to the Bhawan by unmanned repeater stations located at Mussorie, Roorkee, Muzaffarnagar, Meerut and Dasgarah. The terrestrial line-of-sight communication system between the Videsh Sanchar Bhawan in New Delhi and the earth station provided by the repeater stations constitute the Rear Ward Communication Link (RWC). This link can carry 960 simultaneous telephone channels or a colour TV programme.

Multiplexing

When a person makes a telephone call, his speech is converted into electrical signals by the microphone of his telephone. The path taken by these signals through various equipments of the telecommunication system constitutes one "channel." Twelve channels are combined in "channel translating equipment" to make a "group." Five groups are combined in "group translating equipment" to make a "supergroup." Sixteen supergroups are combined in supergroup translating equipment" to form a "baseband." A baseband has thus 960 channels.

The combining of channels into a baseband is called "multiplexing." It enables sending of several messages simultaneously over the same medium of transmission.

RWC and Multiplexing equipments comprise channel translating, group translating and supergroup translating equipments for assembling baseband to transmit to the satellite. They also demultiplex (i.e., break up the baseband into channels) basebands received from the satellite. Separate set of multiplex equipment is associated with the RWC link system.

The antenna and tracking system

The most important item of an earth station is the antenna. The same antenna transmits as well as receives signals to and from the satellite. Since the order of power transmitted by the satellite is as low as a few watts and the distance separating the satellite and the station is very large (36,000 km), a large antenna has to be used to collect signals of sufficient strength. The Dehra Dun station antenna, like the one at Arvi, has 29-metre diameter paraboloid dish.

It makes use of Cassegrainian principle (Fig. 2). In such an antenna, a hyperbolic subreflector is placed in front of the parabola between its vertex and the focus. At the vertex is a waveguide with an open end. Waveguides are hollow metallic tubes which carry energy at microwave frequencies from one point to another. This open-ended waveguide is the outlet to the antenna for transmitting signals and also the inlet to receive the incoming signals. It is called the feed.

When the antenna is used for transmission, the power from the feed is incident on the subreflector. The subreflector reflects the power back to the parabolic dish. The dish focusses this power into a conical beam and directs it towards the satellite. When used as a receiving antenna, the signals collected by the dish are reflected by the parabola towards focus as a convergent beam. The beam is intercepted by the subreflector and is reflected to the feed, from where it goes to the receiver. The Dehra Dun station antenna is fully steerable. The satellite, even though stationary, undergoes slight drifts. An automatic tracking system associated with the antenna keeps the latter constantly pointing at the satellite. This facilitates maximum "illumination" of the satellite from the earth station and maximum strength of the receiver signals.

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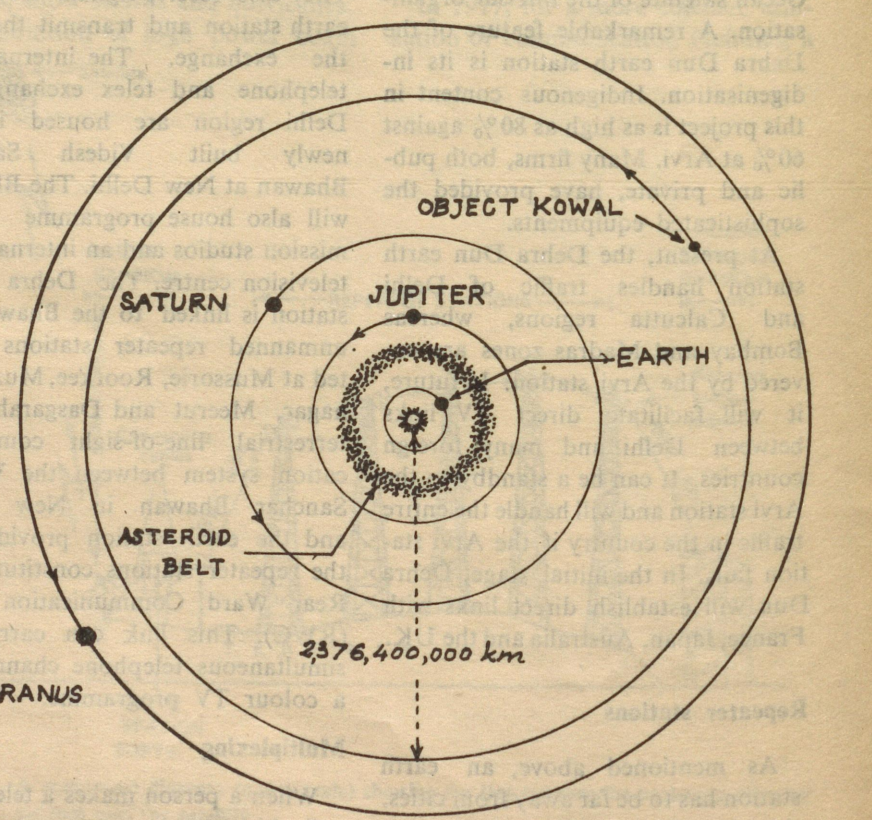
A new object in solar system

CHARLES T. Kowal of Hale Observatory on Mount Palomar, California, USA announced the discovery of a new object in the solar system in November 1977. It has not been officially named so far. It is known as Object Kowal, or OK in scientific circles. According to recent opinions OK is an asteroid. It is far smaller than Mercury, the smallest planet, its diameter being about 160 km. This has been estimated from the brightness of its image. It makes a complete revolution once in about 50 years, and while doing this it swings as close as 1.3 billion kilometers to the sun which brings it to a point just inside the orbit of Saturn. At its extreme limit it swings as far out as 2.8 billion kilometres close to the orbit of Uranus. Harvard astronomers have re-examined some old sky photographs taken as far back as 1895 and found this object in them. In fact Kowal had himself photographed it while surveying the sky in 1969 but had unfortunately missed it. The orbital period of OK was calculated with the help of these photographs. Brian Marsden of Harvard Smithsonian Centre for Astrophysics, who serves as a clearing astronomer for new discoveries in skies, has confirmed Kowal's discovery.

What is OK ? It is slightly larger than most asteroids that orbit around the sun between Mars and Jupiter. It appears to be too large to be an inactive comet yet too small to exist independently as a planet. According to some astronomers, it could be a small satellite of Saturn or Uranus, which has somehow escaped from its orbit, or it could be one of the asteroid revolving around the sun between Saturn and Uranus. According to some others, it is an object which has escaped from the asteroidal belt between Mars and Jupiter. Brian Marsden thinks that it is an inactive comet so far from the sun that the solar radiation it receives is not strong enough to vapourize its icy surface, and so it produces a characteristic



The orbit of Object Kowal and its position with respect to earth and some outer planets head and tail associated with a comet.

The astronomers do not consider the first idea tenable as such a small object may not be able to get away from the strong gravitation field of Saturn or Uranus. If the second proposal is accepted, then there could be many more such objects and the skies between Saturn and Uranus must be scanned once again with better photographic plates and longer exposures so that even objects smaller than OK could be identified.

How are such small objects discovered ? Film plates are baked in an oven filled with nitrogen gas to boost their light sensitivity. Photographs are taken with two hours or even more exposure, and then examined under a microscope.

Surprisingly, OK's discoverer is not even an M. Sc. or Ph.D., but he has published nearly 24 research papers, discovered two small moons of Jupiter, 80 supernovas or exploding stars, 5 lost comets and 1 new comet. In an interview he said, "I know nothing about astrophysics or electrodynamics. All I am good at is using a telescope." He is really good at it and has an insatiable appetite for scanning skies and searching for small objects.

Kowal has suggested an appropriate name for the new object. He would like to call it Chiron, after one of the centaurs, the mythological animals, that were half man, half horse. His reason: Chiron was a descendant of the gods Saturn and Uranus, after whom the object's closest planetary neighbours were named.

The new discovery will arouse further interest in the search for small objects. The skies are full of wonders for those who would look for them.

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Supernovas can cause catastrophe

THAT a supernova explosion (the explosive collapse of a star) in the neighbourhood of sun can cause drastic changes on the surface and atmosphere of earth has been suspected for quite some time. It was however not known what exactly those changes would be on the atmosphere of earth. According to a recent calculation of Garry E. Hunt, of University College London, U. K., (*Nature*, 2 February 78) a supernova would bring about favourable conditions for the coming of an Ice Age, besides jeopardising the existence of life on this planet.

The crux of the issue is the ozone layer in the atmosphere of the earth present at an altitude of 15 km to 20 km. Though ozone gas is present in traces all over the atmosphere, the layer plays a critical role in maintaining life on this planet. It absorbs ultraviolet radiations coming from sun which are otherwise harmful to living beings. These radiations damage the genetic material (DNA) of cells in smaller organisms and thus eventually kill them, while in higher organisms they damage skin. In humans, for instance, they produce the so-called sunburns, and even skin cancer. So the absence of this gas in traces or as a layer in the atmosphere can cause serious damage to life.

Besides, the layer has also another important function. Alongwith ultraviolet radiations, it also absorbs hot infrared and light radiations coming from sun. It passes the heat absorbed on to the upper layers of atmosphere and helps in maintenance of its circulation. The depletion of this gas can therefore change the prevailing climate.

A supernova is a stage in the life of a star when it becomes million times brighter than its original luminosity. It is a sort of an explosion in which a lot of matter and radiations are spewed out. Of interest in the present case are the X-rays and gamma rays a supernova emits. Assuming that the supernova occurs at a distance of 10 parsec (some 206, 2650 times the distance between the sun and the earth) about 10^6 erg/cm of the harmful radiations of interest would strike the earth. Compared to the average amount of such harmful radiation—20 erg/cm^2—coming to earth from sun, the above mentioned amount is indeed enormously high and so would instantly affect the atmosphere of earth.

This initial "flash" would doubtlessly prove to be an ionising dose which would consequently oxidize the excited free nitrogen in the atmosphere to oxides of nitrogen. These oxides would act as a catalyst in dissociating ozone into oxygen. The initial flash would therefore deplete ozone layer and so life on the surface of earth would be adversely affected. However it is claimed that this sudden depletion would be temporary. What would follow in its wake would produce slow but drastic consequences.

The radiations coming from the supernova after the initial flash would begin to show their effects. The intensity of cosmic rays would increase hundredfold, which would subsequently increase the background radiation on the earth by 30 per cent. Also, as cosmic rays produce

Fig. 1. Remnants of a supernova which occurred in 1054; because of its irregular Shape and crab-like appearance, it is called 'crab-nebula'

nitric oxide on interaction with the atmosphere of earth, its increase in intensity would affect the concentration of ozone. All these subsequent effects would last many hundreds of years—the time the supernova would take to cool down and shut the radiations it is emitting. The absence of ozone layer would lead to the cooling of stratosphere, troposphere and surface layers of earth and would thus lead to the stopping of the circulation process. This, according to Hunt, would bring the average temperature of earth down by 1 degree K, the condition required for the initiation of an Ice Age.

Could we now make out anything about life and climate of earth in the past or future? One possibility shows itself. The catastrophes wrought by a supernova may explain why some animals became extinct suddenly in the past. The supernova that caused the last Ice Age and other changes in life had occurred some 10 years ago. So if one wants to check on this theory, one has to look for the remnants of that supernova, which is not possible as by now they must have diminished beyond detection.

To predict anything about the future is also a difficult task. However some statistical probability technique can be made use of. According to D. H. Clark, W. H. McCrea and F. R. Stephenson (*Nature*, January 27, 77) a nearby supernova explosion occurs once during the passage of the sun through our galaxy's (the Milky Way) arms. In other words, drastic climatic and biological catastrophes occur on the earth once in 10^8 years. So we have to look at the position of sun with respect to the arms of our galaxy to predict anything about the future.

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Optical technique for measuring water purity

WITH the increasing pollution and poisoning of rivers and surface waters in general, the necessity of monitoring the quality of water is becoming increasingly important. The present practice is to subject water samples to conventional chemical, physical or biological analyses in the laboratory. However, depending upon how frequently measurements are carried out, such analysis of individual samples may prove highly expensive. In addition, properties of the samples can also vary as a result of unavoidable pressure and temperature changes occurring after the samples are taken. So, optical method of measuring water purity is becoming increasingly popular. This technique is based on the principle of light scattering by solid particles present in water.

An incident light ray impinging on a small particle in suspension in water loses part of its energy by absorption and scattering by that particle. For very small isotropic particles dispersed very thinly in a medium, the intensity of scattered light is given by the Rayleigh formula:

$$I_s(r, \theta) = \frac{I_0 8 N \pi^4 \alpha^2}{\lambda^2 r^2}(1+\mathrm{Cos}^2\theta)$$

where I_s = Intensity of scattered light,
I_o = Intensity of incident light,
N = Number of particles,
α = Polarizibility of particles,
θ = Angle of scattering,
r = Distance of the point of observation from the scattering particle, and
λ = Wavelength of light.

For larger particles whose dimensions are comparable with those of the wavelength of the incident light, the Rayleigh formula breaks down. The exact mathematical treatment becomes more rigorous and will not be dealt with here.

When the diameter of the particle is much smaller than the wavelength of light, intensity of the scattered light is proportional to incident light intensity I_0 and the sixth power of the particle diameter. It is also symmetrical with respect to the plane perpendicular to the direction of incidence; its value is the same

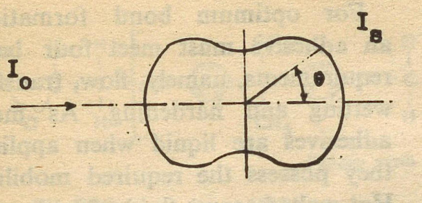

Fig. 1. Angular distribution of a Rayleigh scattering pattern for unpolarized incident light. I_o=Incident light intensity; I_s (θ)=Scattered light intensity in a direction at angle θ

in either forward or backward direction, i.e., $\theta = 0°$ or 180°. Scattered light intensity at 90° is half the forward or backward value.

The behaviour of scattered light differs increasingly from the above pattern as particle diameter exceeds the wavelength of light. Fig. 2 shows scattering angles for particle diameters equivalent to about three times the wavelength. It can be seen from Fig. 2 that forward scattered predominates, with frequent maxima and minima at the larger angles.

In a fluid containing a number of particles in suspension, scattered light behaviour is proportional to solid matter concentration if there is no interaction between individual scattering centres. Suspended solid content of a fluid therefore can be determined by light scattering or attenuation measurement.

The principle of measurement is illustrated in Fig. 3. The diagram on the left shows a system in which the incident light impinges on a free water surface at a shallow angle. The detector at 90° to the free surface responds to the light scattered by particles in suspension in the fluid. Reflected and refracted light is eliminated by light traps.

The diagram on the right shows a system in which the light ray passes through a free falling liquid jet, and forward scattering from particles in suspension is determined by a detector. In both methods, lenses are never in contact with the test fluid, which ensures perfect cleanliness of all optical components in light path.

However, owing to the presence of a free surface both methods suffer from some serious disadvantages. For instance, neither system is suitable for installation in a pressure pipe; both can cause trouble with the escaping foul-smelling or poisonous gas. The low rates of flow required to ensure scattering from the surface are liable to block inlet and discharge ducting. In addition, dirt on fluid surface may cause measurement error. The instrumentation must operate under entirely vibration-free conditions to

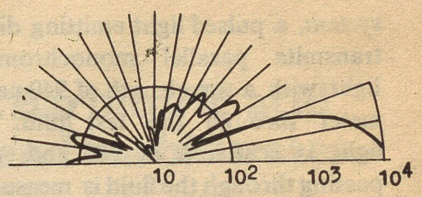

Fig. 2. Polar diagram of scattered light for particle diameters approximately three times the wavelength of light

ensure that reflected light is not picked up by the scattered light detector when there are waves on the free surface.

These problems are overcome in a system shown in Fig. 4. In this

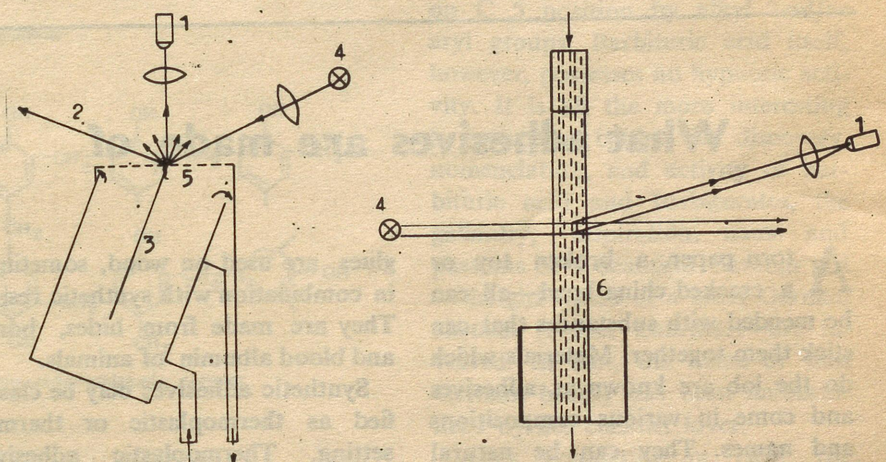

Fig. 3. Principle of scattered light measurement at a free surface and a free falling fluid jet; 1. Detector; 2. Reflected light ray; 3. Refracted ligtht ray; 4. Light source; 5. Free surface; 6. Free-falling fluid jet

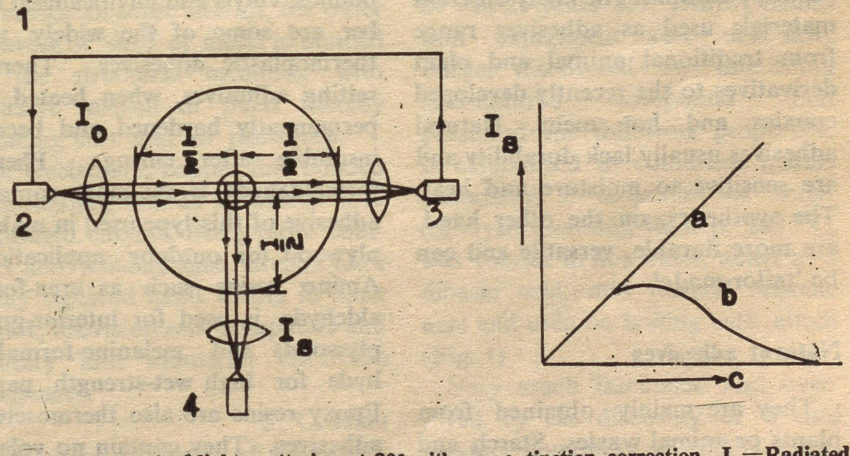

Fig. 4. Measurement of light scattering at 90° with an extinction correction. I_o=Radiated light intensity, I_{ref} Reference light intensity; I_s=Scattered light intensity; 1. Regulation system; 2. Light source; 3. Reference detector; 4. Scattered light detector; (a) Regulating system, (b) Regulating system not operating, (c) Particles per cm^3

system, a pulsed light emitting diode transmits parallel monochromatic light with a wavelength of 940 nanometer through the test fluid. The light is scattered at 90° and that passing through the fluid is measured. With a light source of constant intensity, scattered light intensity increases proportionally with the number of light scattering particles at first, but then falls off exponentially to zero (curve *b* in Fig. 4). As a result an ambiguous, nonlinear result is obtained, which is also affected by variations in the light source intensity and absorbent matter in the measurement medium. These problems can be solved by providing a regulating circuit between the reference detector light source. If the light source intensity is adjusted to give a constant intensity at the reference detector, the scattered light intensity will be proportional to the number of light scattering particle (curve *a* in Fig. 4), with the result that fluctuating light source intensity and absorbent-matter no longer affect the measuremnt data.

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What adhesives are made of

A torn paper, a broken toy or a cracked china bowl—all can be mended with substances that can stick them together. Materials which do the job are known as adhesives and come in various compositions and names. They can be natural such as glues, starches, casein or even natural rubber, or they can be synthetic, which have come in the market in recent years for specialized applications. The many different materials used as adhesives range from traditional animal and plant derivatives to the recently developed epoxies and hot melts. Natural adhesives usually lack durability and are sensitive to moisture and heat. The synthetics, on the other hand, are more durable, versatile and can be 'tailor-made'.

Natural adhesives

They are mainly obtained from plants or animal wastes. Starch and dextrins are derived from corn, tapioca or potato and are used on paper and paper products. Protein glues are used on wood, sometimes in combination with synthetic resins. They are made from hides, bones and blood albumin of animals.

Synthetic adhesives may be classified as thermoplastic or thermosetting. Thermoplastic adhesives soften when heated and harden when cooled. They can be dissolved in water or organic solvents. Waxes and asphalt, various cellulose compounds, vinyls and unvulcanised rubber are some of the widely used thermoplastic adhesives. Thermosetting adhesives, when heated, get permanently hardened and become insoluble after curing. Phenol-formaldehyde is the most common adhesive of this type used in making plywood for outdoor applications. Amino resins such as urea-formaldehyde is used for interior-grade plywoods and melanine-formaldehyde for high wet-strength paper. Epoxy resins are also thermosetting adhesives. They contain no volatile solvent and show outstanding adhesion to metals, glass, ceramics and thermoset plastics.

For optimum bond formation, an adhesive must meet four basic requirements, namely, flow, transfer, wetting and hardening. As most adhesives are liquid when applied, they possess the required mobility. Hot melts become fluid when heated above their melting point. Other adhesives such as polyvinyl acetate and white glue are suspended in water for mobility.

In most applications, the adhesive is applied to only one of the surfaces to be bonded. Pressure and contact transfer it to the second surface. The attractive force between the substrate surface and the applied film of adhesive is known as wetting. An adhesive must have good wetting properties for sufficient flow and transfer.

The final step in bonding is solidification or hardening of the adhesive between the bonded surfaces. The formation of a solid continuous layer between the two substrates is also known as curing or gelation. Adhesives harden by either physical or chemical reactions or by a combination of both. Hardening by cooling and solvent evaporation are physical reactions. Starch, polyvinyl acetate emulsions, white glue—all harden by evaporation of the solvent, water. Hot melt bonds are another example of physical hardening. Here the adhesive is applied on the substrate in molten state which solidifies on cooling. Bonds formed by physical hardening are, however, not so durable as chemically cured bonds.

Many adhesives solidify because of chemical reaction between the component polymers. This gives an extremely large and complex polymer which is resistant to moderate heat and chemical attack. The epoxy resins are a common example of two component systems. Here the user mixes the adhesive polymer with a hardener at the time of use. Hardeners are generally polyfunctional amines or anhydrides which

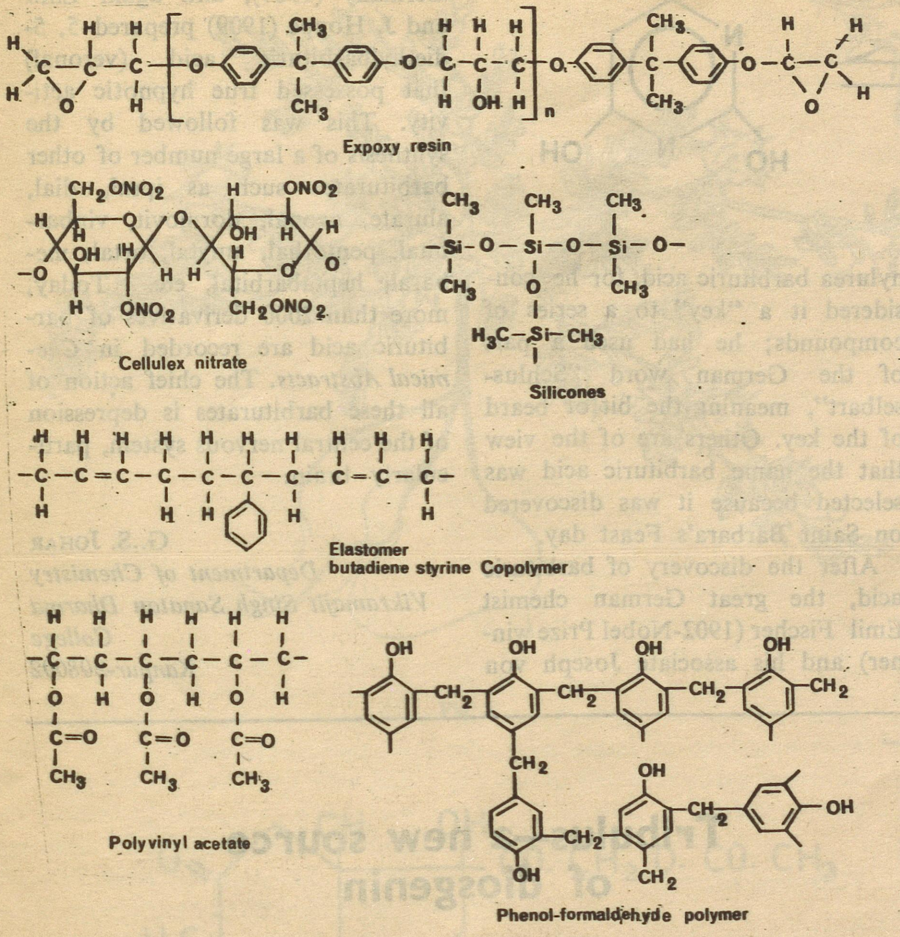

Fig. 1. Common adhesives

react with the epoxy polymer and solidify into a highly cross-linked structure.

There are many other adhesive systems that solidify by a combination of physical and chemical reactions. These adhesives are applied in a solvent medium which must evaporate before the chemical reaction between the component polymers can occur.

Adhesives today find wide use both at home and in industry. Many industrial manufacturing processes are based on adhesive bonding. Grinding wheels, abrasive papers, leather goods, fibreglass products, plywood, and wooden furniture—all depend on adhesives in one form or another. In the manufacture of boats, and trailers, honeycomb cores of paper, fibre, wood or metal are bonded by adhesives to surface coverings. In some aircraft, the outer covering or 'skin' of metal is bonded to the structural members with adhesive instead of rivets thereby reducing cost and air resistance.

In electronics, copper foil bonded to insulating boards is widely used in printed circuits. Being more compact and reliable, such circuits have today replaced hand wiring in most radios, television sets, computers and military and industrial electronic equipment.

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Barbituric acid and barbiturates

A number of chemical agents are known which induce sleep or wakefulness in man and animals by appropriately affecting the central nervous system. Substances that facilitate sleep are called hypnotics, somnifacients, or soporifics. To this class belong the barbiturates, derived from barbituric acid (Fig. 1) by replacement of the hydrogen atom on C 5 position by alkyl and/or aryl groups. Barbituric acid itself, however, possesses no hypnotic activity. It is all the more interesting to learn that behind the discovery, nomenclature, and activity of barbituric acid and barbiturates, the gallantry, inspiration, name and passions of a beautiful German girl—the girl friend of a great German chemist (Nobel Laureate)—are involved. In fact, the name of that German beauty has been immortalized by her chemist lover.

After graduating in 1858, the Berlin-born and self-taught German chemist Johann Friedrich Wilhelm Adolf von Baeyer started research work on uric acid in 1860—when he was 25-years old. During oxidation experiment s on uric acid, Baeyer discovered an interesting acid-natured compound that possessed the following properties. It crystallized in colourless prisms containing 2 molecules of water (of crystallization), its m.p. 253 °C, was soluble in hot water, acted as a dibasic acid, and formed malonic acid and urea on boiling with alkali (Fig. 1).

Very much fascinated and overjoyed by the discovery of a new product possessing unusually interesting structure and properties, Baeyer, however, found him self

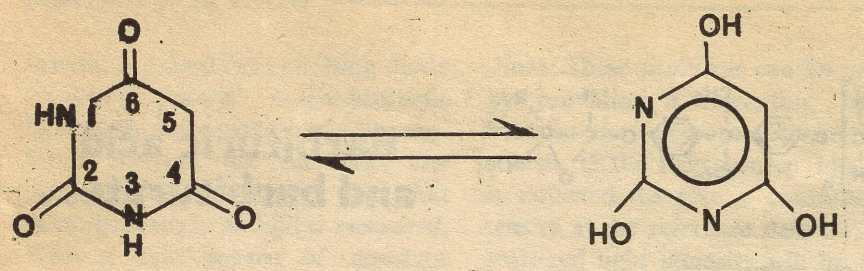

Fig. 1

at a fix because of his failure to assign a befitting name to this acid. He was so confused because of this problem that neither he could sleep properly at night nor take his meals, nor could he remember to see his girl friend. Perplexed, the girl suddenly visited Baeyer's laboratory where she found him sitting dazed and depressed. Only after a prolonged persuasion and affectionate conversation could she know what the reason was behind her lover's anxiety. H. Stadlinger (1949) writes in his paper in a German journal that in an attempt to soothe Baeyer's anxiety, his girl friend asked him jokingly, "Why don't you name your acid after me?" This sudden idea proved so appealing that Baeyer immediately named the new acid as "barbituric acid" (or "Barbara's acid") and sent his research paper for publication. Miss Barbara was the name of Baeyer's beloved girl. Baeyer was later awarded Nobel Prize in chemistry in 1905.

Barbituric acid was later synthesized by another German chemist Grimaux (1879) by condensing malonic acid with urea in presence of phosphoryl chloride, and was named malonylurea. Two other German chemists Conrad and Max A. G. Gutzeit (1882) prepared it by condensing ethyl malonate with urea in ethanolic solution in the presence of sodium ethoxide. Two pharmacology professors of United States, John C. Krantz Jr. and C. Jelleff Carr (at the School of Medicine, University of Maryland), on the other hand, write in their book on pharmacology that Baeyer named malonylurea barbituric acid, for he considered it a "key" to a series of compounds; he had used a part of the German word "Schlusselbart", meaning the bit or beard of the key. Others are of the view that the name barbituric acid was selected because it was discovered on Saint Barbara's Feast day.

After the discovery of barbituric acid, the great German chemist Emil Fischer (1902-Nobel Prize winner) and his associate Joseph von Mering (1904), W. Pokotilo, also of Germany (1907), and again Emil and J. Hoppe (1909) prepared 5, 5-diethylbarbituric acid (veronal) that possessed true hypnotic activity. This was followed by the synthesis of a large number of other barbiturates such as ipral, dial, alurate, neonal, dormovit, vinbarbital, pentothal, amytal, ortal, mebaral, heptabarbital, etc. Today, more than 2000 derivatives of barbituric acid are recorded in *Chemical Abstracts*. The chief action of all these barbiturates is depression of the central nervous system, particularly brain.

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Tribulus—a new source of diosgenin

THERE is a growing need for steroid drugs in India. The high cost of their synthesis in the laboratory as well as obtaining them from animal sources makes it imperative to search plant sources for this drug. A simple method for the isolation of diosgenin (an intermediate compound required for the preparation of steroid hormones) from *Gokhur* (*Tribulus terrestris*, L., Fig. 1) has been developed recently at the Indian Institute of Experimental Medicine, Calcutta.

Diosgenin is the best starting material for preparation of cortisone (Fig. 2) and other steroid hormones. Cortisone, a recently discovered steroid hormone, has proved to be of immense value in the treatment of a variety of diseases, particularly rheumatism, allergy, blood diseases and endocrine disorders.

The principal effect of cortisone and its allied substances or derivatives is on protein and carbohydrate metabolism. It converts amino acids into sugars instead of protein and may be regarded as an anti-anabolic agent.

Gokhur belongs to the family Zygophyllaceae, a prostrate herb, with opposite leaves bearing yellow flowers on short peduncles. Fruits are spinous with two sharp rigid spines and two shorter ones.

This drug-yielding plant attained recognition many years ago for its medicinal values and was used by Indian physicians. The fruits are used specially in stone formation, impotence, painful passage of urine and other genito-urinary disorders.

Besides diosgenin content, che-

Fig. 1

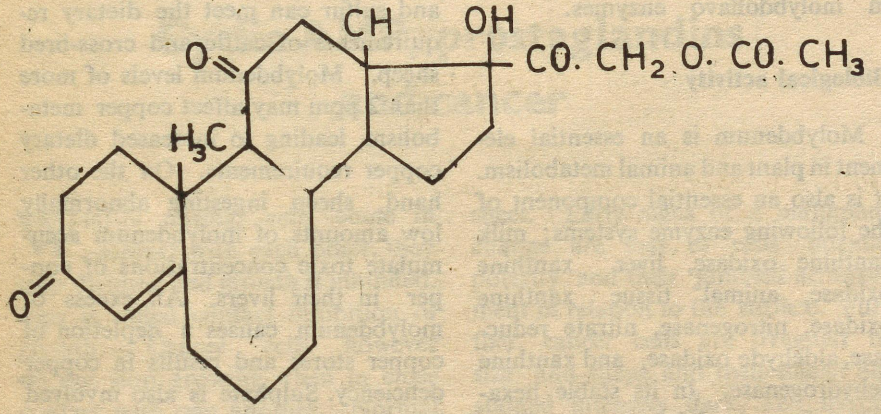

Fig. 2

mical investigation of the plant indicates that its fruit contains alkaloids in traces (0.001%), oil (3.5%), an essential oil in small quantity, resins and a fair amount of nitrates. Stems are rich in starch, fructose and glucose. Sucrose content is more than glucose and fructose. The fructose content is 5-10 times higher than glucose.

Although alternative sources of diosgenin like *Dioscorea* sps., *Trigonella foenumgraicum*, fruits of *Solanum khasianum*, *Costus speciosus*, *Balanites* sps. and *Kallstroemia* sps. have been identified, the wide distribution of *Tribulus terrestris* and its easy availability makes it an additional source of diosgenin.

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Molybdenum in plant and animal life

THE silver-grey metal, molybdenum, derived its name from the Greek *molybdos* meaning "lead-like", but the only physical similarity between the two metals is in their density (molybdenum=10.22; lead =11.4). Molybdenum is present in earth's crust in very small amounts (10^{-4} per cent). It was discovered by K.W. Scheele in 1778 in molybdenite, MoS, the chief ore of the metal. The metal was first isolated in 1782. During the 19th century, molybdenum was largely a laboratory curiosity and no appreciable use was made of the metal until World War I. At that time, reports came to Allied Intelligence that the Germans were using "moly steel" in their Big Bertha gun barrels, and the United States moved fast to develop sources and do research on effect of molybdenum on iron and steel. The reports were later found to be untrue, but the impetus had been provided.

Metallic molybdenum became commercially important by about 1910 when C. Coolidge and C. Fink first prepared the metal in ductile form. Production of by-product molybdenum from copper sulfide ores started in 1939. A resurgence of interest in molybdenum as an engineering material started after World War II.

The grey, heavy, hard, refractory (melting point $2622 \pm 10°C$) metal is used principally in the targets of x-ray tubes and in high vacuum tubes for electronic purposes because of the metal's ability to form tight seals with glass. It also finds many uses outside the electric and electronic fields under conditions where its high hot strength, stiffness and corrosion resistance is an advantage. World production of molybdenum in 1968 totalled 66,000,000 kg of which 47,000,000 kg came from the United States.

Of late, there has been an increasing interest in the organic constituents of living organisms and a new field of chemistry of biological systems is developing. One of the most important aspects of bio-inorganic chemistry is the study of metallo-enzymes and enzymes whose action depends on metal ions. Much work on molybdenum compounds was accomplished in the nineteenth century and the early part of the twentieth; much of this has not been repeated and confirmed by modern methods. In recent years, important investigations have been done related to bio-inorganic chemistry of molybdenum. They include synthesis of molybdenum (V) complexes of ligands of biological interest, e.g., sulfur containing ligands dialkyldithio-carbamates, alkyl xanthates, cysteine and cysteine esters. In complexes of these substances there are apparently Mo—S bonds as is possibly the case in molybdoenzymes. In several enzymes, histidine residues are involved in binding metals and it is of particular interest that histidine forms complexes with Mo(V) and Mo(VI).

Molybdenum in its various compounds possesses valence of 2^+, 3^+, 4^+, 5^+ and 6^+, and its co-ordination number may be 4 or 6. Molybdenum compounds of lower valences readily disproportionate to yield compounds of both higher and lower valences, so that pure chemical individuals are rare in the lower valence range. Ligand substitution reactions of the μ-dioxobis- [oxo oxalato-aquomolybdate (V)] ion have been studied and the results have biochemical significance because the oxalate complex may be taken as a model for the enzyme xanthine oxidase. Complexes containing MoO_4 with cysteine or glutathione ligands may help in determining the model of catalytic action of Mo (V) in molybdoflavo enzymes.

Biological activity

Molybdenum is an essential element in plant and animal metabolism. It is also an essential component of the following enzyme systems; milk xanthine oxidase, liver xanthine oxidase, animal tissue xanthine oxidase, nitrogenase, nitrate reductase, aldehyde oxidase, and xanthine dehydrogenase. In its stable hexavalent form, molybdenum combines with sugar and other organic compounds. Molybdenum compounds are highly sensitive to moisture and react readily with it through hydrolysis to oxy and hydroxy compounds or form co-ordinated hydrates. In this respect, molybdenum is of particular importance to agriculture. As a constituent of nitrate-reductase in plants and micro-organisms in trace amounts this metal is essential for proper plant growth, although the mechanism is not yet fully understood. It is also known that molybdenum is present in nitrogen-fixing bacteria and is involved in the function of nitrogen-fixing enzymes nitrogenase and hydrogenase of bacterial origin. The element is particularly important in nitrogen fixation and nitrate reduction.

Molybdenum is poisonous under certain circumstances. Cattle ingesting excessive amounts of molybdenum become ill with a disease ("tart") characterized by severe diarrhoea. The illness can however be treated successfully by use of copper sulphate in the diet. Copper deficiency in ruminants associated with high dietary molybdenum (molybdenosis) is known thoughout the world. The interaction of molybdenum with copper absorption is further complicated by dietary sulfur levels which may either antagonize or ameliorate the interaction. Pastures containing 4-6 ppm copper and with low levels of molybdenum and sulfur can meet the dietary requirements of cattle and cross-bred sheep. Molybdenum levels of more than 2 ppm may affect copper metabolism, leading to increased dietary copper requirements. On the other hand, sheep ingesting abnormally low amounts of molybdenum accumulate toxic concentrations of copper in their livers. An excess of molybdenum causes a depletion of copper stores and results in copper deficiency. Sulphate is also involved in the molybdenum-copper antagonism. The Cu-Mo-SO_4 metabolic interactions are complicated and the biological effects depend on the initial copper status of the animal. According to one theory, molybdenum interacts with copper in the rumen or in tissues to form a Cu-MoO_4 complex in which the copper is not biologically available. This complex is possibly excreted in the urine. Sulphate is believed to interact with copper absorption through microbial reduction of sulphate to sulphide and subsequent formation of insoluble copper sulfide. The clinical signs of molybdenum-induced copper deficiency are variable and appear to depend on species, age, duration of dietary exposure, and initial copper status. More commonly reported clinical signs in cattle are diarrhoea, poor growth, and alopecia, as well as improper bone mineralization leading to lameness and spontaneous fractures. Anemia has also been reported to be associated with molybdenosis.

In view of the reciprocal effects of molybdenum and copper in cattle, there is a question whether a similar antagonism exists in man, and specifically whether molybdenum may be involved in "Wilson's disease". This is a hereditary disease characterized by pathological changes of the liver, kidneys, and central nervous system reflecting excessive absorption of copper from the intestine, increased excretion of copper in the urine and low levels of plasma copper combined with the protein ceruloplasmin. It has been shown that urinary excretion of molybdenum is diminished in patients of "Wilson's dissease". Elimination of molybdenum is roughly proportional to that of copper in these and normal individuals, but the rates are entirely different; it is far greater with the "Wilson's disease" patients. Recently knee joint deformities similar to those in cattle have been observed in young men in India. This human disorder is thought to be associated with a molybdenum induced copper deficiency.

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Cyclic AMP, prostaglandins and cancer

WHEN normal cells come in contact with each other, they stop dividing and growth is inhibited. This is called contact inhibition of growth. Cancer cells however do not stop growing when in close contact with one another. Normal cells tend to reproduce the structure from which they grow and resemble each other in size and shape. But cancer cells fail to do so. Besides, cancer cells acquire the property of anaplasia (inability to differentiate) and so resemble embryonic cells. Anaplasia is directly related to malignancy of a cancer; the more anaplastic a tumor, the more malignant it would be. Normal epithelial cells that are arranged in sheets show a regular polarity, which means they are arranged with their long axis perpendicular to the surface of the sheet. Early signs of a malignant change are loss of cells' normal polarity and their jumbled arrangement in relation to the surface. Further, cancer cells are irregular in size and shape and their nuclei are stained intensely dark, i.e., hyperchromatic due to increased amounts of DNA (deoxyribonucleic acid). Recent investigations have shown that cyclic AMP (3′ 5′ adenylic acid) and prostaglandins have regulatory roles in the contact inhibition of growth and in the maintenance of normal polarity of cells, in addition to their actions on immune response of the body.

Cyclic AMP

Cyclic AMP (Fig. 1) is formed by conversion of ATP (adenosine triphosphate) by the enzyme system, adenyl cyclase, in the presence of Mg^{++}ions (Fig. 2). It appears that the enzyme adenyl cyclase and cyclic AMP are located on cell membrane, and therefore any stimulus (chemical, physical or hormonal) acting on the cell membrane can alter the intracellular content of the cyclic AMP. The cyclic AMP so formed is degraded by the specific enzyme phosphodiesterase to AMP (Fig. 2).

Various hormones bring about changes by altering the intracellular cyclic AMP content of the target cells. Besides, cyclic AMP also acts in a wide variety of ways. For example, cyclic AMP has been shown to be involved in the regulation of cell cycle, growth rate, morphology, adhesion to the substratum and synthesis of mucopolysaccharides and collagen. A striking correlation between growth rate and cyclic AMP levels has been observed. A cell line that grows rapidly like cancer cells has a very low level of cyclic AMP and *vice-versa*. In addition, various transformed cells have lower levels of cyclic AMP than normal cells. The characteristics of cancer cells like rapid growth rate, decreased adhesiveness amd abnormal cellular morphology are closely linked to their low cyclic AMP content. It is therefore believed that many properties of the cancer cells may be due to their low levels of cyclic AMP. Recently, it was shown that low levels of cyclic AMP in cancer cells are due to an increased activity of the phosphodiesterase enzyme which breaks down cyclic AMP to AMP (*Nature*, Vol. 259, 321, Pp., 1976). Changes in cyclic AMP levels were found both in virally and chemically induced cell transformations giving further evidence to support this concept. It was suggested that the carcinogens alter cell membrane which may in turn depress adenyl cyclase activity or increase phosphodiesterase activity leading to a fall of intracellular cyclic AMP

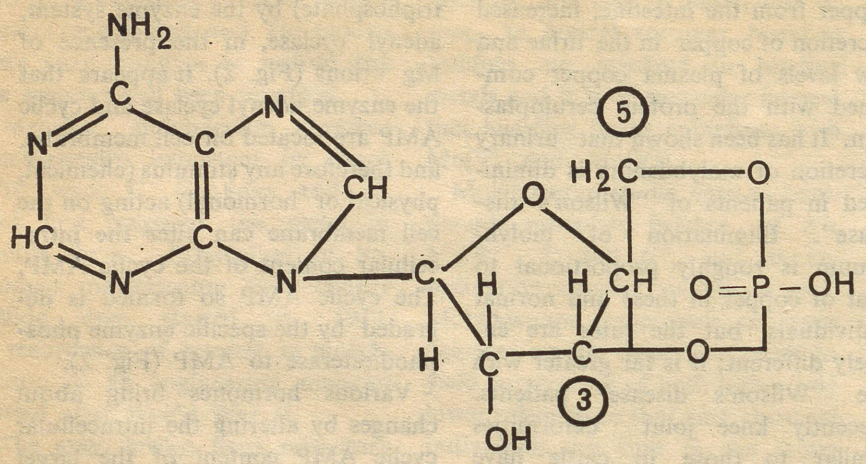

Fig. 1. 3'. 5' Adenylic acid (cyclic AMP)

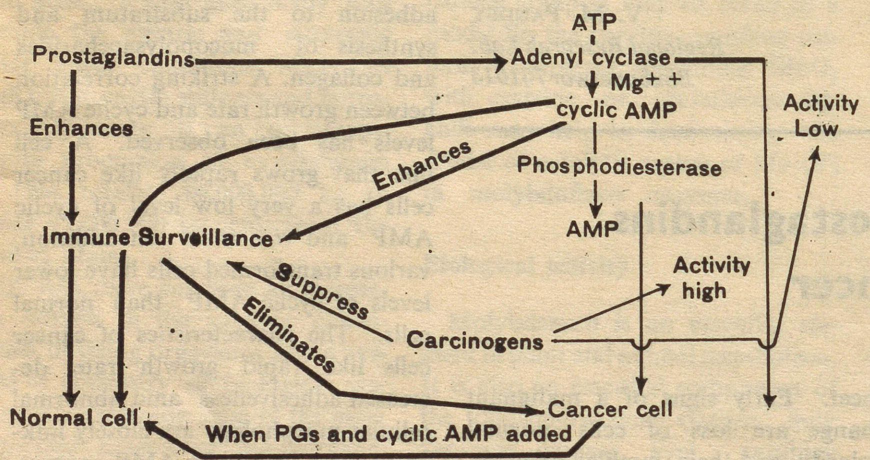

Fig. 2. **Scheme showing the role of cyclic AMP and prostaglandins in cancer. Thick arrows indicate the normal regulatory role of cyclic AMP and prostaglandins**

concentration.. Its evident that virus particles need not be incorporated in the cell genome to produce malignancy in a normal cell.

Prostaglandins

Prostaglandins are derivatives of unsaturated fatty acids and are ubiquitous in nature (see *S.R.*, July 1977). Many prostaglandins can activate adenylcyclase in a variety of tissues and enhance their cyclic AMP level. Recently it has been shown that besides their other actions, body prostaglandins also act directly on cancer cells. *In vitro* experiments demonstrate that prostaglandin E, like cyclic AMP, can change cancer cells to normal-looking cells. In addition, it has also been observed that prior treatment of experimental animals with PGE can successfully block occurrence of cancer when they received known carcinogens (*Nature*, Vol. 263, Pp. 777, 1976). The beneficial effect of PGE on cancer may be due to its ability to enhance intracellular cyclic AMP concentration, though other mechanisms of action cannot be ruled out. Since prostaglandins are present in several tissues of the body and as they can enhance cyclic AMP content of cells, it is now suggested that PGE deficiency might be responsible for the development of cancer. There is evidence that prostaglandins are involved in synthesis and release of several hormones in body. Also, certain tumors like carcinoma of breast, prostate, uterus, etc., are known to be hormone dependent. It is likely that PGE may be having a role in the development and growth of these cancers.

PGEs can directly act on cancer cells to enhance their cyclic AMP content and convert them to normal cells, and at the same time act systemically to gear up the immune system of the body (see Fig. 2), which may prove to be of immense value in the management of cancer.

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Electrolyte balance in the body

NORMAL tissue function depends upon the maintenance of the composition of the body fluid. Body fluid consists of fluid within cells (intracellular fluid), fluid within the vascular system (blood) and fluid in the tissue spaces between the cells (interstitial fluid). Blood and interstitial fluid together constitute the extracellular fluid. This extracellular (outside the cells—blood plasma) fluid constitutes an internal environment. Development of the higher forms of animal life depends upon a high degree of control of the internal environment.

The extracellular fluid consists primarily of sodium, chloride and bicarbonate ions. The blood plasma component, in addition, has an appreciable amount of protein, the plasma proteins. The small portion representing nonelectrolytes is mainly glucose, urea, etc. The major cations (positively charged ions) of the cellular fluid are potassium and magnesium with only small amounts of sodium. These cellular cations are balanced by organic phosphates, proteinates, sulphates, and a small amount of bicarbonates. Nearly all of the osmoconcentration of the extracellular fluid is due to sodium, chloride, and bicarbonate ions, while that of intracellular (within the cell) fluid is mostly due to potassium, magnesium and organic substances. The osmotic activity of all body fluids is nearly equal except for the small difference between plasma and interstitial (within interstices) fluid. The plasma proteins create this osmotic pressure difference across the capillary wall. Although it is smaller than the total osmotic pressure of the extracellular fluids, it is important for maintenance of blood volume and pressure.

Sodium is the major cation of the extracellular fluid and an important component of skeleton (bones). About 45% of the body store of sodium is found in extracellular fluid, and 45% in bone, and the remainder within the cells. Half of it in bone does not exchange with sodium ions in the fluid compartments. The non-exchangeable sodium is absorbed on the surfaces of the hydroxyapatite crystals deep in long bones. None of the bone sodium is osmotically active, although part of it may become available to ameliorate the osmotic effects of the extracellular fluid dilution. A relatively constant Na^+ concentratoin of the extracellular fluid is attained by regulation of both intake and excretion of sodium, to maintain a 'salt balance'. Many sodium deficient animals have a strong behavioural drive to ingest salt. These animals show a remarkable ability to control ingestion of sodium chloride or sodium solutions so that they just replace the body deficiency of sodium. When more than minimal amounts of salt are ingested with the diet, as is usually done, salt hunger will not be evident. The excess salt is excreted.

Probably sodium appetite is controlled by a neuromuscular system similar to that of thirst. Excretion of sodium by the kidney involves first the filtration at the glomerular part (kidney part) of the plasma sodium, and then reabsorption from the tubule (kidney part) of most of the filtered sodium. The difference between the amount of sodium filtered and that reabsorbed is the amount excreted in urine.

Changes in sodium excretion can be effected in two ways. Firstly, if plasma sodium concentration or glomerular filtration rate suddenly increases, the amount of sodium filtered per unit time into the tubule will also increase. However, sodium reabsorption from the tubule will not increase proportionately in such a short period of time. Therefore, the difference between sodium filtered and sodium reabsorbed will be greater, and more sodium will be in urine. Conversely, if plasma sodium concentration or glomerular filtration rate decreases, less sodium will be excreted. Secondly, a rise of plasma sodium concentration will cause decreased secretion of aldosterone (hormone) by the adrenal cortex (endocrine gland). The primary action of aldosterone is to increase sodium reabsorption from the renal (kidney) tubule. Decreased amounts of aldosterone will result in less reabsorption of sodium, and consequently more sodium will escape reabsorption and thus appear in the urine. On the other hand, a fall in plasma sodium concentration will cause an increase of aldosterone secretion and increased reabsorption of sodium from the tubule.

In severe sodium deficiency virtually all filtered sodium will be reabsorbed and a sodium-free urine will be excreted. Both mechanisms act to control sodium excretion so as to maintain normal sodium concentration of extracellular fluids. However, aldosterone mechanism is more important where the disturbance of sodium concentration is prolonged. Aldosterone secretion is also stimulated when extracellular fluid volume falls, especially when arterial blood pressure is depressed. The volume and osmoconcentration of extracellular fluid are regulated together by thirst ADH (antidiuretic hormone) and salt appetite-aldosterone systems. Little is known about these, and volume regulation is poorly understood. The body content of sodium determines to a great extent the volume of extracellular fluid, while osmoconcentration is controlled primarily by variations of water intake and excretion. If an organism is deprived of sodium for several days, its extracellular fluid volume will decrease by a few per cent. Conversely, extracellular fluid volume will rise if a large amount of salt is ingested daily for some days.

If an animal ingests a large amount of water, urine excretion rate increases, and the excess is removed within a few hours. In such a situation the increased water excretion can be explained as the action of diluted body fluids on hypothalamic osmoreceptors causing reduction in ADH release. However, if a large volume of isotonic saline is injected, it will not be excreted. Here body fluid osmo-concentration is normal and stimulation of hypothalamic osmoreceptors could not occur. Volume receptors are located probably in various parts of the blood vascular system and the sensory inflow to the CNS (central nervous system) causes appropriate variations in the release of ADH and aldosterone. It has been shown that an angiotensin also directly stimulates secretion of aldosterone from adrenal cortex and hence causes sodium retention.

Potassium

It is the major cation of the intracellular fluid, and 89% of the total body content of potassium is located within cells. Nearly all of the intracellular potassium is readily exchangeable with potassium in the extracellular fluid. Potassium concentration in extracellular fluid is well regulated, but details are not completely known. Dietary intake is usually in excess of need because most food stuffs contain considerable potassium. Kidneys appear better able to excrete the excess potassium than to conserve potassium. Renal handling of potassium involves exchange of potassium ions with sodium or hydrogen ions between tubular fluid and plasma. These exchanges are influenced by sodium and hydrogen concentrations of exracellular fluid. Aldosterone causes increased excretion of potassium ions. Secretion of aldosterone can be stimulated by high potassium concentration and low sodium concentration. In addition to passing out excess potassium, the regulatory mechanisms tend to maintain a constant sodium / potassium concentration ratio in extracellular fluid.

Potassium maintains acid-base balance, regulating osmotic pressure, and developing cellular membrane potentials. When extracellular potassium is low, transmission of nerve impulses becomes impaired and muscular paralysis develops. Potassium influences the capacity of smooth, skeletal, and cardiac muscle to contract. It also works on muscular irritability which, like that of sodium, tends to antagonise the effect of calcium ion. However, under conditions of salt restriction, calcium appears highly important in helping to maintain potassium content of tissue.

Chloride and bicarbonate

Sodium ions of extracellular fluid are balanced electrically for the most part by chloride ions and bicarbonate ions. Osmotically, the effect of these ions equals that of sodium ions. However, vaiations of osmoconcentration are usually a consequence of changes in cation concentration (or water content) rather than that of anions. The chloride concentration tends to be regulated secondarily to regulation of sodium and bicarbonate concentration. If excess sodium is excreted by kidney chloride usually accompanies it. If due to an alkalotic condition, the plasma level of bicarbonate ion rises, an equivalent amount of chloride ion is excreted in order that electroneutrality be maintained in the extracellular fluid. The bicarbonate ion is unique in that it can be maintained in the extracellular fluid; it can be formed or removed in the body with great rapidity. It is formed in solution form from its anhydride:

$$CO_2+H_2O\rightleftharpoons H_2CO_3\rightleftharpoons H^++H_3CO^-_3$$

There is a ready supply of carbon dioxide from cellular metabolism and a rapid means for its removal by the repiratory tract.

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Nucleotide sequence of a viral gene tells more

A group of British molecular biologists led by Dr. F. Sanger (who won the Nobel Prize for determining the sequence of amino acids in an insulin molecule) of the Laboratory of Molecular Biology at Cambridge, England, have reported that for the first time they have determined the complete genetic structure of a living organism and discovered that a gene, controlling agent for all inherited characteristics, is more complicated than was known (*Nature*, Feb. 24, 1977). They determined the sequence of the 5,375 nucleotide subunits of genes that carry all the genetic information needed for the reproduction of a virus called Phi-X174. These researchers said that the most important aspect of the study was to overthrow one of the fundamental principles of modern genetics that each gene carries the code for reproduction of only one type of protein molecule. They found that the same sequence of nucleotides could be chemically "read" as producing either of two protein molecules from material available with the virus. The researchers further indicated that there may be a great amount of genetic information compressed into an extremely small amount of DNA. The small DNA of the Phi-X174 virus possesses an unexpectedly high information content and seems to exploit every structural possibility to control gene expression, the report suggested.

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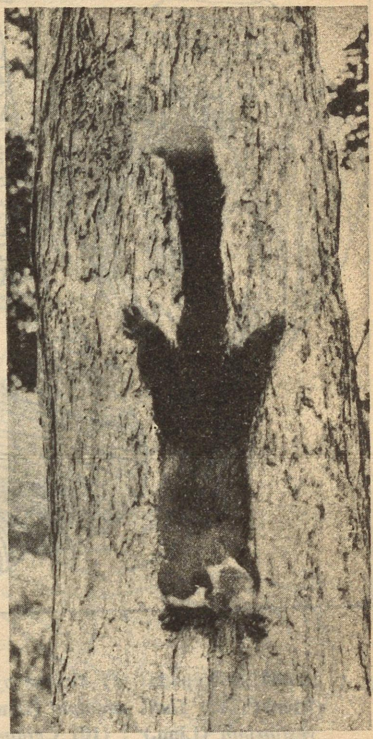
A toddler among giants

HAVE you seen the Indian Giant Squirrel, leaping about among the dizzy heights of the sunlit treetops of evergreen, moist and deciduous forests of India? With a burly body and head, about 50 cm long and a streaming bushy tail equally long, it is a giant among squirrels.

Of the world's mammals, it is among the few most brilliantly coloured. It is handsome and eye catching in its shining furry coat, which combines a superb design of delicate shades of crimson, black, brown and buff. It is one of the few animals which can recognise some colours. It is a widely spread mammal of the Oriental zoogeographical region. There are seven geographical races, distinguished by variations in the above colour scheme, the paler coloured occurring in the northern part of their distributions while the darkest dwelling down south in the Malabar coast. The animal is widely known as Malabar squirrel though it is not endemic to Malabar region. Its call is sharp, metallic, far reaching and startles one in the jungle. Its face is most inquisitive, with its flesh coloured nose, beady brown eyes and tufted ears. The mobile bushy tail acts as the essential balancer in its agile arboreal life.

Its food consists of buds, foliage, flowers and fruits of trees, abundantly available all the year in the multi-canopied forests. Nectar filled flowers of Erithrina, Butea, and orchids and bamboo seeds are eaten with great relish. The chisel tipped teeth helps them to feed on hard nuts. Generally it is a solitary feeder: the mating pairs race about in hot pursuit. With twigs and leaves, they build enormous globose nests on slender ends of branchlets for sleeping and separately for nursing the young. The pale yellow nests appear like balloons stuck up amidst trees. Predacious birds like forest owls and hawk eagles are its chief enemies. To escape from them, it freezes flattening its body against the trees. Though timid by nature, it is aggressive inter-specifically during breeding season. Its habitat is shared by lion-tailed macaque, Nilgiri langur, and racket-tailed Drongo. When roads and powerlines are formed making forests into isolated pockets, the habitats become useless for them. Being absolutely arboreal, it requires contiguous pathways among canopies. The species has been massacred for its fur, flesh and most excruciatingly for fun by sportsmen. It gets fondly familiar with people and learns to pick peanuts from the stranger's hands. As it makes an easy and engaging pet, it is kept sometimes in large wirenet cages and fed on vegetables and fruits. But this creature belongs to the slender summits of sky-high trees, and seeing them jumping about in this environment will be a thrilling aesthetic experience,



Giant squirrel

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Molluscs as food

AMONGST marine products, molluscs are an edible group next to fish and crustaceans. In America, Europe, Japan and other countries, molluscs are recognized as nutritive seafoods rich in glycogen, vitamins and several minerals. However, a majority of Indians avoid molluscs due to ignorance of theirfood value. In India most edible molluscs are eaten by the poor in the coastal area. Major species of edible molluscs are distributed in three groups, viz.,

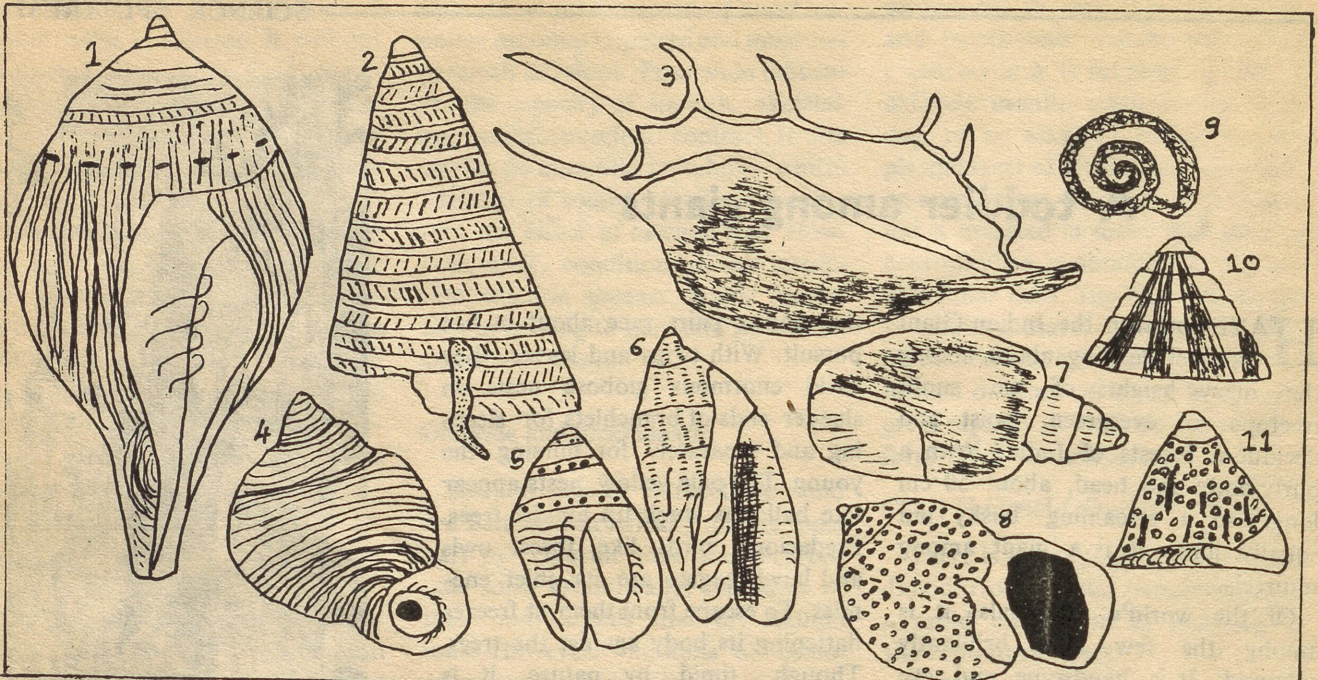

Fig. 1. Edible gastropoda: (1) *Xancus pyrum L.* ; (2) *Telescopium telescopium* L.; (3) *Lambis lambis* (Linn.) ; (4) *Turbo intercostalis* (Menke) ;(5) *Thais rudolphi* (Lamarck); (6) *Oliva gibosa* ; (7) *Babylonia spirata* L., (8) *Natica tigrina* (Roding); (9) *Umbonium vestiarium* (Linn.) ; (10) *Cellana radiata* (Born); (11) *Trochus radiatus* (Gmelin)

gastropoda, pelecypoda and cephalopoda.

Gastropoda

A large number of species of this class are found in shallow sea. Of them, only a few gastropods such as limpet (*Cellana* spp.). turban shell (*Turbo* spp.), botton shell (*Trochus* spp., *Umbonium vestiarium*), whelk (*Babylonia spirata*), sacred chunk and (*Xancus pyrum*), horn shell (*Telescopium telescopium*), olives (*Oliva* spp.), purples (*Thais* spp.), five fingered chank (*Lambis lambis*) and *Natica* spp. are utilized as food (Fig. 1). Most species of gastropods are boiled in water and their meat extracted with the help of a pointed iron rod. The viscera (internal organs of the body) and operculum are removed and the remaining muscular parts are only eaten. Gastropods are consumed as curry and soup. Chank and olives meat is also consumed by frying it in oil. Chank chips are rich in protein and minerals. Chank meat is used for curing diseases like rickets, jaundice, cough, phthisis (pulmonary tuberculosis), etc. Shell powder and meat are also considered effective against some types of skin diseases. The meat of *Lambis* is said to have narcotic effect. Gastropods meat is used as a fish bait.

Pelecypoda

Marine pelecypods include the largest number of edible species of the phylum mollusca such as oysters, mussels, clams and other bivalves (Fig. 2).

(*i*) *Edible oysters*. Edible oysters are a delicacy and claim a place on gourmand's table. Eleven edible species are available in the Indian coasts. Among them, four species, viz., Indian backwater oyster (*Crassostrea madrasensis*), giant oyster (*C. gryphoides*), rock oyster (*C. cucullata*) and disc oyster (*C. discoidea*) are commercially important. The edible oysters contain good quantities of glycogen, lipid, protein, vitamins (especially A, B and D) and several essential minerals. In India oysters are cooked in ghee or vegetable oil after adding condiments.

(*ii*) *Mussels*. Two species of edible mussels found in India are green mussel (*Mytilus viridis*) and brown mussel (*Mytilus* sp.). They are mostly eaten by poor people. Sea mussels are relished in western countries.

(*iii*) *Clams and other bivalves*. Besides mussels and edible oysters, a large number of clam species and other edible bivalves are found in appreciable quantities in creeks, estuaries and backwaters of Indian coasts. Various types such as clam (*Meretrix* spp.), inflated clam (*Katelysia* spp.), wedge clam (*Donax spp.*), black clam (*Villorita cyprinoides*), cockle clam (*Gafrarium* spp.), ark shell (*Arca* spp.), false clam (*Paphia* spp.), razor shell (*Solen*

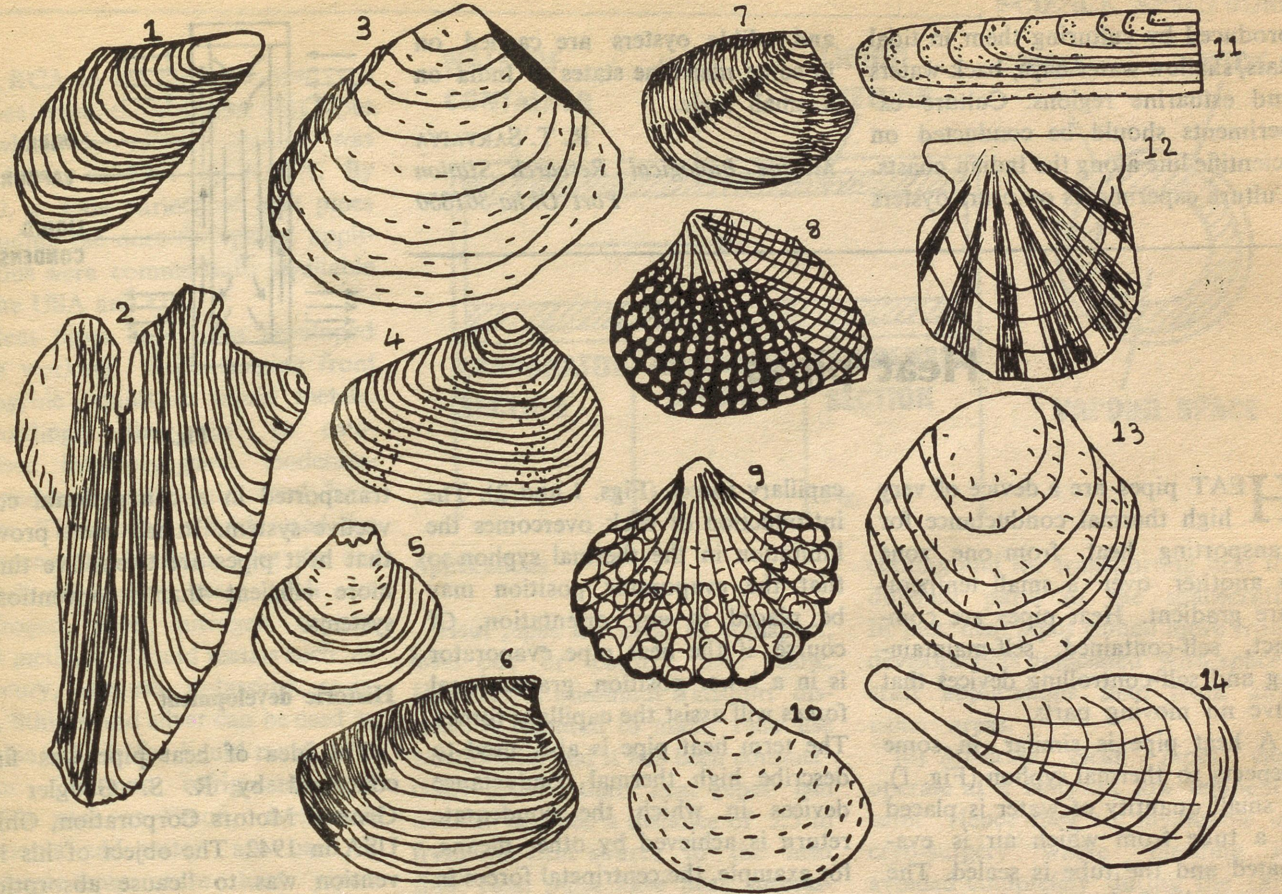

Fig. 2. Edible pelecypoda: (1) ***Mytilus viridis*** **(Linn.); (2)** ***Crassostrea gryphoides*** **(Nnewto and Smith); (3)** ***Meretrix meretrix*** **(Linn.); (4)** ***Donax cuneatus*** **(Linn.); (5)** ***Villorita cyprinoides*** **(Gray); (6)** ***Katelysia opima*** **(Gmelin); (7)** ***Tellina pingnis*** **(Hanley); (8)** ***Gafrarium tumidum*** **(Roding); (9)** ***Arca granosa*** **(Linn); (10)** ***Palphia malabarica*** **(Dil.), (11)** ***Solen kempi,*** **(Preston); (12)** ***Pinctada fucata*** **(Gould); (13)** ***Placenta placenta*** **(Linn.); (14)** ***Pinna bicolor*** **(Gmelin)**

spp.) are common forms of bivalves fished for food. Pearl oyster (*Pinctada fucata*), window pane oyster (*Placenta placenta*) and fan shell (*Pinna* spp.), though edible, are not eaten as food in India. *Pinna* spp. are utilized as food in Japan and in the Indo-Pacific region. The Japanese pearl oyster *Pinctada martensii* is used for the favourite 'tempura' dish.

Cephalopoda

Squids, cuttlefish and octopuses (Fig. 3) are common groups of this class. People in Japan, Korea, Malaysia, Taiwan, Indonesia and Philippines eat these nutritious items but their use in India is limited to coastal people only. The edible parts of these animals are as much as 80% (mantle 50%-55% and arms, head, etc., 25-30%) in squids, 70% (mantle 40%-45% and arms, head, etc., 25-30%) in cuttlefish and 85% in octopuses. The meat of cephalopods has a high protein content and is good in flavour. The meat is used for making curries, soup, cutlet, frie, etc. In India, squids are consumed more than cuttlefish and octopus. In Gujarat, except for a little local consumption of squids and cuttlefish, most of the catch is utilized for preparing fish meal. Cephalopods are also used as fish bait. After 1972, India started exporting frozen meat of squids and cuttlefish to Japan, Australia, France, Spain, Italy, etc.

Cultivable molluscs

Edible oysters, pearl oysters, mussels, clams and chank could also be

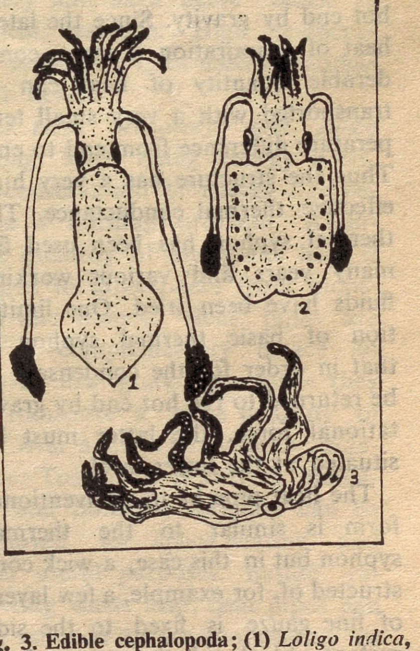

Fig. 3. Edible cephalopoda; (1) ***Loligo indica,*** **(Pfeffer), (2)** ***Sapiella inermis*** **(F. et d' orb); (3)** ***Octopus sp.***

produced by culturing them in tidal flats, shallow water bays, back waters and estuarine regions. Culture experiments should be conducted on scientific line along the Indian coasts. Culture experiments on pearl oysters and edible oysters are carried on in some maritime states of India on a small scale.

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Heat pipes

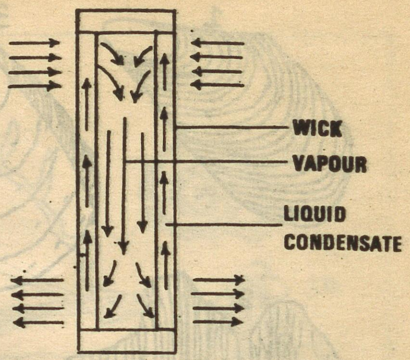

Fig. 1

HEAT pipes are a device of very high thermal conductance for transporting heat from one zone to another over a small temperature gradient. Heat pipes are compact, self-contained, self-maintaining and self-controlling devices that have no moving parts.

A heat pipe is similar in some respects to thermal syphon (Fig. 1). A small quantity of water is placed in a tube from which air is evacuated and the tube is sealed. The lower end of the tube is heated causing the liquid to vaporise and the vapour to move to the cold end of the tube where it is condensed. The condensate is returned to the hot end by gravity. Since the latent heat of evaporation is large, considerable quantity of heat can be transported with a very small temperature difference from end to end. Thus the structure has a very high effective thermal conductance. The thermal syphon has been used for many years and various working fluids have been tried. One limitation of basic thermal syphon is that in order for the condensate to be returned to the hot end by gravitational force, the latter must be situated at the lower level.

The heat pipe in its conventional form is similar to the thermal syphon but in this case, a wick constructed of, for example, a few layers of fine gauze is fixed to the side surface, which aids the return of the condensate to the evaporator by capillary forces (Figs. 1 and 2). The introduction of wick overcomes the limitation in the thermal syphon so that the evaporator position may be placed in any orientation. Of course, if the heat pipe evaporator is in a lower position, gravitational forces will assist the capillary forces. The term heat pipe is also used to describe high thermal conductance devices in which the condensate return is achieved by other means, for example, the centripetal forces in wickless rotating heat pipe.

The heat pipe is a closed chamber or tube of any cross-section—circular, elliptical, square or rectangular. The wick-lined inside surface is saturated with the liquid phase of a working medium and the remaining volume of the pipe contains vapour. Heat applied at the evaporator section by a heat source vapourises the working fluid in that section. The resulting difference in pressure drives the vapour from evaporator to condenser, where it condenses by releasing the latent heat of vaporisation to a heat sink. Capillary forces pump the condensate through the wick to the evaporator section for re-evaporation. Thus the heat pipe can continuously transport heat from one end to another and without drying out the wick. With a small unit size the heat pipe can transport a large quantity of heat since the latent heat of vaporisation is usually several times greater than that which can be transported in a conventional convective system. It has been proved that heat pipes are twentifive times more efficient than conventional systems.

Historic development

The idea of heat pipe was first conceived by R. S. Gaugler of General Motors Corporation, Ohio, USA in 1942. The object of his invention was to "cause absorption of heat, or in other words, the evaporation of a liquid to a point above the place where the condensation or giving off of heat takes place without expending upon the liquid any additional work to lift the liquid to an elevation above the point at which condensation takes place." A capillary structure was proposed as the means of returning the liquid from condenser to evaporator and Gaugler suggested a sintered iron wick.

G. M. Grover's patent, filed on behalf of the United States Atomic Energy Commission in 1963, uses the term "heat pipes" to describe devices essentially identical to that in the Gaugler patent. An extensive programme was conducted on heat pipes at Los Alamos Laboratory, New Mexico.

Subsequent heat pipe developments were made by a number of research organisations in different countries. The first commercial organisation to work on heat pipe was RCA in the USA. A new type of heat pipe, the rotating heat pipes in which the wick is omitted was developed in 1964 by NASA. By 1970, a wide variety of heat pipes including the ones for special applications were commercially available in the USA and UK.

Heat pipes have been developed with working fluids ranging from cryogenic liquids to liquid metals. Accordingly they can be categorised into cryogenic, moderate-temperature and liquid-metal heat pipes. The working fluids used for cryogenic applications are the so-called permanent gases such as hydrogen, neon, nitrogen, oxygen and methane. Liquid metals such as mercury, caesium, potassium, sodium, lithium and silver can be used as working fluids for liquid metal heat pipes. Common refrigerants and liquids such as Freon, methanol, ammonia and water are used in moderate-temperature heat pipes.

An effective wick structure requires small surface pores for large capillary pressure, large internal pores in the direction normal to the liquid flow for minimal flow resistance and an uninterrupted and highly conductive heat flow path across the wick thickness for a small temperature drop. Many types of wicks have been developed which are classified as homogenous wicks and composite wicks. Mesh screen, fibreglass, sintered porous metal, glass wool, woven cloth, felt, and narrow slots cut in the inner surface of the container wall have been used as wick materials. The containers of the heat pipe should be very thin in order to reduce the radial temperature gradient. At the same time it must withstand the pressure difference between inside and outside of the heat pipe. Stainless steel, nickel, copper, glass can be used as materials for the container. Substantial work has been done in the design, materials of construction and control of heat pipes to make them suitable for numerous applications.

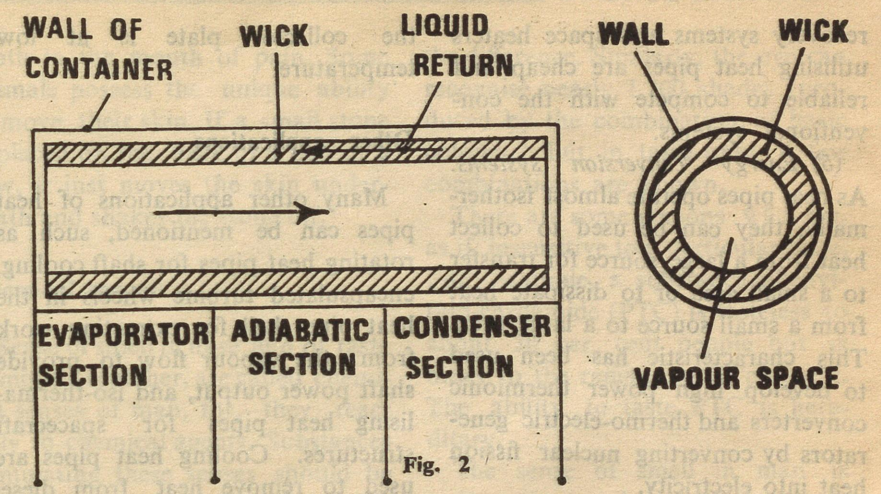

Fig. 2

Applications

Heat pipes are used to transport, level out or control heat flow. However, a minimum transport distance is required to make their use worthwhile, and it has been commercially proved that heat pipes can operate between a distance of 3.5 m from the heat source to the heat sink. Heat pipes have been successfully adopted to solve difficult problems in a variety of fields. The list of applications is quite long and growing at a rapid rate. Only a few selected applications are discussed here.

(*1*) *Electronic and electrical equipment*. At present possibly the largest application of heat pipes in terms of quantity is in the cooling of electronic components such as transistors, integrated circuit packages and other semi-conductor devices. The light weight, compactness and efficiency of heat pipes render them ideal for heat sinking in electronic components. It has been proved that heat pipes are the best devices to spread out hot spots, level temperature and for remote heat sink operations. Dielectric heat pipes are used to cool high voltage components.

(*2*) *Spacecraft*. Since heat pipes are light-weight and gravity-insensitive, they are well adapted for use in outer space for spacecraft temperature equalisation, component cooling and for transporting heat to different parts in the spacecraft. In fact, heat pipes gained more from developments associated with spacecraft applications than from any other areas.

(*3*) *Medicine*. Heat pipes can operate at a constant low temperature. Hence they are invaluable in cryo-surgery where bleeding is avoided completely during the surgery. Heat pipes are being used to freeze harmful skin tumours to produce tissue death. It is used as a constant-temperature probe in brain surgery and as a nerve block in medical research. High temperature units have been used in mechanical hearts.

(*4*) *Heat recovery and space heating*. With rising energy costs, the conservation of energy has become a burning problem. Abundant quantity of low grade heat is let out to atmosphere from industries and homes. Heat pipes are also a complementary device to recover low grade heat since they can transport a large quantity of heat over a small temperature difference. The waste heat from industrial and domestic furnaces can be employed for space heating and other useful purposes. Beside recovering waste heat, heat pipes can also be used to pre-cool supply air by rejecting heat into a cold exhaust duct, for example, in an airconditioning operation. Heat recovery systems and space heaters utilising heat pipes are cheap and reliable to compete with the conventional systems.

(5) *Energy conversion systems.* As heat pipes operate almost isothermally, they can be used to collect heat from a large source for transfer to a small area or to dissipate heat from a small source to a large area. This characteristic has been used to develop high power thermionic converters and thermo-electric generators by converting nuclear fission heat into electricity.

(6) *Solar collector.* Use of solar energy for electric power generation and the heating or cooling of buildings are currently under active study. Heat pipes can be used to collect solar energy from a large flat plate and transmit it to a small area where a storage liquid is heated. Also they can be operated as diodes to cut off loss of heat from the storage liquid to atmosphere when the collector plate is at low temperature.

Other applications

Many other applications of heat pipes can be mentioned, such as rotating heat pipes for shaft cooling, encapsulated turbine wheels in the heat pipe shell for extracting work from the vapour flow to provide shaft power output, and iso-thermalising heat pipes for spacecraft structures. Cooling heat pipes are used to remove heat from diesel engines, arc jets, batteries, brakes, bus-bars and cutting tools. Heat pipes are used in nuclear field for moderator cooling, removal of heat from the reactor and elimination of troublesome thermal gradients.

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Senses—do they always make sense?

WE are taught to believe that whatever we see is always correct, whatever we hear at first hand is always true, and whatever we feel is real. We believe that our senses provide us with cent per cent correct information of the world around us. However, this is not always true. Senses have their shortcomings and often suffer from distortion or wrong judgement. Normally this is not noticed, as the sense organs of the two sides of the body work in unison and the defects of one side are completely shielded by the other. We have five senses: vision, hearing, smell, taste and the general sensation of the skin. Scientists have discovered a number of defects related to each of them.

Vision

Vision is the most important of all the senses and also the most developed one. It depends on proper functioning of the eyes. Visual narration of an incident in the court is considered as an evidence of the first order. It is a common belief that when cyes are open, we see everything that is in our sight. This, however, is not true. There is, in the range of our vision, a small area called blind spot, at which we cannot see at all.

The blind spot is situated a little to the outer side of the centre of the eye and is best demonstrated with one eye closed. Hold Fig. 1 about 15 cm in front of the right eye and look steadily at the cross. Move the magazine slowly upwords towards the eye till the circle on the right disappears. Now, the image of the circle is within the range of the

Fig. 1

blind spot. The circle reappears if the magazine is moved further up. To observe the blind spot in the left eye, turn the magazine up-sidedown, close the right eye and hold the figure in front of the left eye. Gaze steadily at the cross and raise the magazine up towards the eye.

The blind spot is only two milimetres wide, but, its angle widens steadily as we focus our attention on objects that are situated farther away. For example, an ordinary postal stamp disappears at a distance of 25 cm, a cricket ball at a meter length and a horse would be blind spotted at a distance of 25 metres.

Another handicap of the vision is the sluggish response of the eyes, because it takes 80 milliseconds to transmit the image of an object to the brain, interpret it and realise the meaning. That is why a pistol fired bullet remains invisible, and the quick transfer of objects in the hand of a deft magician goes undetected.

When an object is viewed and then removed out of the sight, the image of the object formed in the eye is not immediately wiped out. It lingers for about a fifteenth of a second. This peculiar phenomenon is made use of in producing the cinema effect. Pictures of moving bodies, when shot in quick succession and projected serially at a rate of 16 frames per second, produce the illusion of the actual movement. The persistance of an image in the eye after the object has moved out of sight, otherwise a shortcoming of vision, is thus put to great advantage and serves as a means of mass entertainment.

Hearing

The capacity of humans to hear is less efficient than that of some animals. Human hearing is restricted to a narrow band of sound in the range of 20 to 20,000 cycles per second. Sounds of higher frequency, called the supersonic, are well appreciated by dogs, cats and other animals. The bat, not able to see in bright light, is known to find its way throngh a maze of obstacle with the help of supersonic waves it produces with its mouth during the flight. These waves strike obstructions and are reflected back to the bat's ears, warning it of the dangers ahead.

Special 'Dog whistles' are available to day for training dogs. They produce supersonic sounds which only dogs hear. Police use these whistles to train and guide dogs to pursue and catch a thief

The external ear does not take actual part in the mechanism of hearing, but helps collect sound waves and guide them to the opening of the ear Many animals are able to voluntarily move their ears and point them in the direction of the sound, but man is devoid of this ability.

General sensations

General sensations are percepted through the skin. The sensations include touch, heat, cold and pain. They are comparatively less developed than the sensations of vision and hearing. They are also not uniformly acute over various parts of the body. Lips, face and hands are very sensitive, whereas back and legs are dull. Skin on the back of the neck cannot even detect points a centimetre apart separately, i.e., they are felt as one point. On the other hand, lips and finger tips can make out distance of even a few millimetres. Also, distribution of some senses is irregular. For example, skin on the back of the outer ear is devoid of sensation of cold, the tip of the penis of heat, and an area adjacent to the second molar tooth in the mouth of pain. Some animals possess the unique ability to move their skin. If a small stone is placed on the back of a bull or a cow, it just moves the skin underneath and shakes the stone off.

Chemical senses

Sense of smell in nose and of taste in mouth, together, are called chemical senses of man, for, they react only to chemical agents. Substances stimulating these senses should be in solution. That is why the inside of mouth and the nose is always moist.

In man, taste sensation is located only on the tongue, but aquatic animals have organs of taste on their body surface. Insects possess them on pads of their legs so that they know the taste as soon as they land on a substance.

Modern medicine recognises four basic taste sensations, namely, sweet, sour, saltish and bitter. They are unevenly distributed over the surface of the tongue. Sweet sensation is in the front, bitter in the hind part, sour on the sides and salt sensation spread all over the top. Other tastes which we experience are the blends of two or more of the four basic ones. For example, lemonade taste is aroused by the combination of sour and sweet tastes.

Some tastes that we experience are no tastes at all. They are flavours smelt through nose and are lost if smelling mechanism is put out of order. That is why during an attack of cold, when the nose is blocked, food does not taste natural.

Taste and smell sensations, in relation to vision and hearing, are rather crude. The eye can detect only one per cent change in illumination, and the ear 10 per cent change in sound intensity. But, taste and smell require an alteration of 30 per cent in the intensity of their stimulus before one can detect the difference. Similarly, the eye can recognise nearly 1,200 shades produced by the combination of basic colours, but in taste only a few combinations are known.

There are some persons who are, as if, insensitive to a particular taste. For example, a substance phenyl-thio-carbamide (PTC) is tasteless to about 30 per cent people but is bitter to the remaining 70 per cent. The ability to taste PTC is hereditary.

The sense of smell in man is rudimentary and is restricted to a small portion of the brain. Though one can smell nearly 3,000 different odours, their classification into basic groups is not possible. Sense of smell is, however, much superior in dogs because a large area in their brain, nearly one third, is related to it. Hence dogs can recognise their master or trace a thief by smelling things left behind by him at the site of robbery.

The sixth sense

Some animals possess special receptor mechanisms for physical agents other than those covered by the traditional five senses. For example, snakes have receptors on their head for infrared rays. With this aid they sense the rays emitted by the warm body of a mouse and prey on it even in darkness. Bees are sensitive to magnetic fields. They get confused and stop work when such an influence is induced around them. Also, migratory birds are believed to be endowed with a special sense of direction and recognition of geomagnetic field; otherwise they would not be able to travel accurately over long distances.

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Ringworm—a fungal infection

RINGWORM is one of the most common skin infections in man and animals. It accounts for 6% to 10% of all the skin diseases in India. Clinically, it is known as tinea or dermatomycoses. The term 'tinea' is of Roman origin and is used to denote moth that destroys keratin in wollen garments. Keratins are the most stable proteins found in nature and chiefly occur in skin, hair, fur, nail, feather, horn, hoof, etc. Probably, the Anglo-Saxons coined the name tinea for the ringworm lesion keeping in mind the circular hole made by *Tinea* species (moths) on garments.

Ringworm is classified according to the sites of infection. Tinea corporis, ringworm of the hairless skin, is characterised by a circular lesion which increases radially at the periphery. The border of lesion is slightly raised. It causes severe itching and dry scaling of skin. Tinea cruris is an acute or chronic dermatomycoses of the groin and perianal areas. Both the types are widespread in India ; males are more susceptible to tinea cruris. Tinea pedis (ringworm of the foot) and tinea unguium (ringworm of the nail) are also quite common. In the former, lesion involves webs and subdigital and interdigital surfaces of the toes. The webs are covered with dead, white and ruptured epidermis. In the latter, infected nails develop a whitish, wrinkled surface which often appears pitted or striated. People wearing shoes and dirty socks continuously are more likely to develop tinea pedis. Tinea capitis, ringworm of the scalp, is seen largely in children. It exhibits dry scaly lesion of the scalp and stimulates alopecia (baldness) with the hair breaking off below the scalp surface. It is reported to be common among Anglo Indians and Kashmiris and is rare in Eastern India because of the use of vegetable oils for hair-dressing. *In vitro* hair penetration experiments by G. H. Hajini, K. C. Kandhari, L. N. Mohapatra, and L. K. Bhutani, in 1970, at the All India Institute of Medical Sciences, New Delhi, revealed that hairs smeared with mustard oil were not perforated by ringworm fungi.

Incidence of ringworm in humans is prevalent during May to September in India. High humidity and temperature during these months result in profuse sweating which constitutes an important predisposing factor for the disease. All age groups are vulnerable to the disease, though it is more common in youths of 16 to 25 years. The incidence is lesser in females.

Ringworm is caused by a specialised group of fungi which nourish themselves on the skin (keratinized) tissues of man and animals. They are grouped as dermatophytes. In 1837, Robert Remak, a Polish physician from the medical faculty of Berlin University was the first to observe fungal filaments (hyphae) in the crust of scalp infection. In 1841, the fungal origin of ringworm was independently confirmed by David Gruby, a Hungarian physician. In India, ringworm was first reported in 1900 from Assam. Establishment of the School of Tropical Medicine in Calcutta in 1927 brought fresh impetus to research in this field. Today 24 species of gundi classified among 3 genera are considered valid dermatophytes. Among these, *Epidermophyton* is monotypic, genus *Microsporum* includes eight species and *Trichophyton* has fifteen species.

Dermatophytes have marked host preferences. Some are strictly anthropophilic (man-infesting), some zoophilic (animal-infesting) and a few geophilic (soil inhabiting). *Trichophyton rubrum* is the most prevalent anthropophilic dermatophyte in India, while *Epidermophyton floccosum* is the second most common. *Tripchophyton verrucosum* has been isolated from animals such as cows and sheep. Members of the *Microsporum* group are also known to cause ringworm occasionally in India. The geophilic species, *Microsporum gypseum* and *Trichophyton ajelloi*, which usually exist in the soil, are, however, rare parasites of man and animals.

Dermatophytes differ from each other in their tissue choice too. For example, *Epidermophyton floccosum* is not known to invade hair though it is capable of invading skin and nail. *Microsporum* is usually responsible for scalp infection including hair. Sometimes they produce skin lesion and infrequently invade nails. *Trichophyton rubrum* produces chronic skin lesion.

The main mode of transmission of the ringworm infection is through personal contact. Also, tools and other accessories in public places like barber's shop, theatre hall, etc., contaminated with bits of infected skin, nail and hair filaments are some of the important sources of transmission of the disease.

Proper hygienic practices, like boiling of undergarments, socks, gloves, etc., cleaning of body and keeping it dry with powders containing propionic acid or salicylamide; use of vegetable oils for hair, body massage, and exposure of the infected parts to direct sunlight are some prophylactic (control) measures against dermatomycoses.

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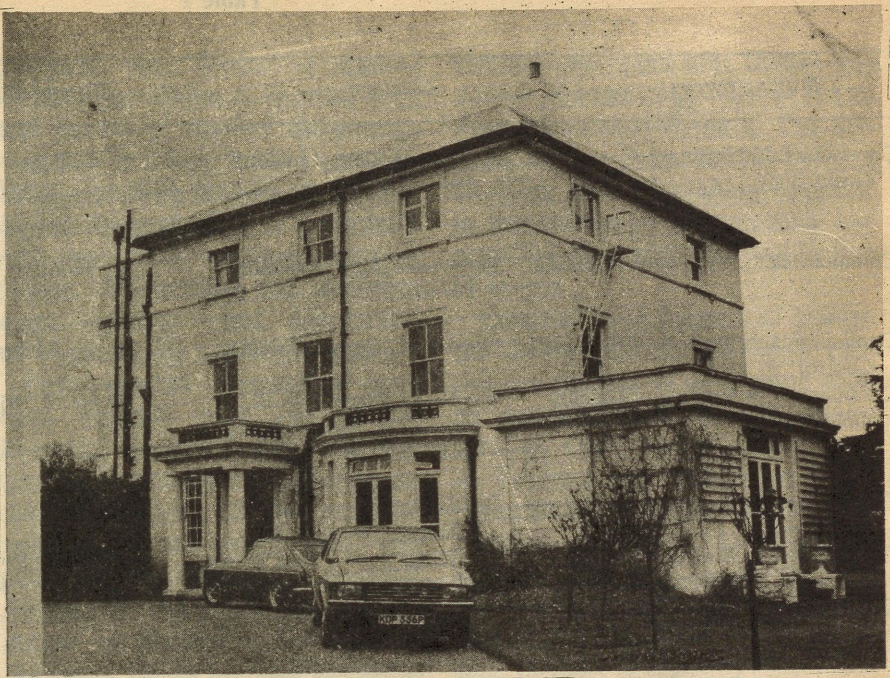
NEWS & NOTES

Commonwealth Agricultural Bureaux—an organisation in service of agriculture



Headquarters of CAB

THE developing countries of the world are keenly engaged today in thrashing out problems related to agricultural production and public health. The population explosion has added to their miseries and a substantial progress in food production only can save them from the unavoidable. For meeting out such challenge, an international organisation with experts carefully commissioned from concerned countries might prove a boon. It would not only study the problems prevalent in these regions but would also help them guide in finding out solutions and make available to them latest information on agricultural sciences.

One such organisation engaged in providing identification (of plant and animal pests responsible for crop damage and plant and animal diseases) and information (biological control) services to its 27 member countries and 10 dependent territories is the Commonwealth Agricultural Bureaux (CAB) with its secretariat office located at Farnham House, Farnham Royal, Slough, England. Initially starting with a few institutes at the beginning of this century, the CAB today is a large organisation enfolding within itself 10 Bureaux, 3 Institutes and one Commonwealth Institute of Biological Control at Curepe, Trinidad. The Commonwealth member countries whose governments are contributing to the common fund of CAB include Australia, Bahamas, Bangladesh, Belize, Botswana, Canada, Cyrpus, Fiji, Ghana, Guyana, India, Jamaica, Kenya, Malawi, Malaysia, Mauritius, New Zealand, Nigeria, Sierra Leone, Sri Lanka, St. Vincent, Tanzania, The Gambia, Trinidad and Tobago, Uganda (not operative at present), United Kingdom and Zambia. The dependent territories are Brunei, Gibraltar, Gilbert Island, Hongkong, St. Helena, Solomon Islands, Tuvalu Island, Bermuda, Virgin Island and Monserrat.

The apex body of the CAB, the Executive Council, comprises of the members appointed by various member governments from among their officers resident in London. The members elect one of their own number as Chairman. The Council does not address the governments direct but corresponds through the members or at times through their High Commissions. An Executive Director reports to the Executive Council which meets monthly and has day to day responsibility for running CAB. The present Chairman is Mrs. J. George from Trinidad and Tobago and Acting Executive Director is Mr. N. G. Jones from U. K. The usual administrative and accounting functions are centred at the CAB Head Office, together with the central sales deptt., a printing unit and the computing control centre known as the "Systems group."

Each Bureau or Institute has a director who is both an administrative head and a research guide. The Institutes help in taxonomic research,i.e., identification of plant and animal species received from overseas countries and also abstract international science literature in their specific fields and publish it for the benefit of contributors. The bureaux are mainly concerned with compilation and publishing of such literature. CAB as a whole now

Table 1

Institute/Bureau	*Location*	*Director*	*Publications*
Commonwealth Institute of Entomology	56, Queens Gate, London SW-7 5JR	N. C. Pant	Review of Applied Entomology—Series A, Review of Applied Entomology—Series B, Bulletin of Entomological Research
Commonwealth Mycological Institute	Ferry Lane, Kew, Richmond TW 93AF	A. Jhonston	Review of Plant Pathology Review of Medical and Veterinary Mycology
Commonwealth Institute of Biological Control	Gorden St., Curepe, Trinidad	F. D. Bennett	
Commonwealth Institute of Helminthology	The White House, 103, St. Peter's, St. Albans, Herts, ALI3EW	Sheila M. Willmott	Helminthological Abstracts Series A Helminthological Abstracts Series B
Commonwealth Bureau of Agricultural Economics	Darlington House, Little Clarendon St., Oxford	J. O. Jones	World Agricultural Economics Rural Sociology Abstracts
Commonwealth Bureau of Animal Breeding and Genetics	The Kings Builds, West Mains, Road, Edinburgh, EH93, JX	J. D. Turton	Animal Breeding Abstracts
Commonwealth Bureau of Animal Health	Central Veterinary Laboratory, New Haw, Waybridge, Surrey, KT 153 NB	R. Mack	Veterinary Bulletin Index Index Veterinarins
Commonwealth Bureau of Dairy Science and Technology	Lane End House, Shinfield, Reading, RG2 9AT	E. J. Mann	Dairy Science Abstracts
Commonwealth Forestry Bureau	South Park Road, Oxford OX1 3AD	W. Finlayson	Forestry Abstracts
Commonwealth Bureau of Horticulture and Plant Crops	East Malling Research Station, Maidstone, Kent ME 19 6 BJ	D. J. O'd Bourke	Horticultural Abstracts Ornamental Horticulture
Commonwealth Bureau of Nutrition	Rowlett Research Institute, Bucksburn, Aberdeen AB 2 9 SB	D. L. Duncan	Nutrition Abstracts & Reviews
Commonwealth Bureau of Pastures and Field Crops	Hurley, Maindenhead, Berks, SL6 5LR	P. J. Boyle	Herbage Abstracts Field Crop Abstracts
Commonwealth Bureau of Plant Breeding & Genetics	Dept. of Applied Biology, Pembroke, St. Cambridge CB2 3DX	R. H. Richens	Plant Breeding Abstracts
Commonwealth Bureau of Soils	Rothamsted Experimental Station, Harpenden AL5 2JQ	B. Butlers	Soils & Fertilizers

employs over 400 people of which about 150 are of professional standing.

The origin of the Commonwealth Agriculture Bureau and Institutes lies in a memorandum issued in 1909 by the British Colonial Office to a few selected scientists for their views upon entomological research on the West Coast of Africa. In 1910, the Entomological Research Committee (Tropical Africa) was formed and two field entomologists were employed to survey incidence of insect pests (mainly of medical importance) and a Scientific Secretary to identify and collate information about the material collected by the field staff. In 1913, its area of operation was extended to other continents and the name was changed to Imperial Bureau of Entomology. It was renamed as Imperial Institute of Entomology in 1929 and later Commonwealth Institute of Entomology in 1948. The Commonwealth Mycological Institute at Kew was founded in 1920 under the name of Imperial Bureau of Mycology on the same lines. The Imperial Agricultural Research Conference, attended by a large number of overseas delegates in 1927, recommended establishment of centres on interchange of information on soil science, animal health, animal nutrition, plant genetics, pastures and forage crops, horticulture and animal parasitology. Table 1 shows the present position of CAB Bureaux and Institutes.

CAB Institutes

A prompt and accurate identification is the key to insect control. Insects today are the biggest enemy of man depriving him of a large part of his agricultural produce (several million tonnes per year both bydirectly sfeeding on the crops or by transmitting viral diseases in plants. In India alone, over 25 million tonnes of food grown are destroyed by insects in fields and storage.

N.G. Jones

Commonwealth Institute of Entomology (CIE). It is one of the oldest Institutes of CAB and is engaged in the identification of insect samples submitted by agricultural, veterinary, medical and other scientists, and by government departments, research institutes and universities all over the world.

The taxonomists of the CIE, several of them world authorities, examine and identify between 40,000-50,000 specimens each year. Their site of work is the entomology section of the British Museum (Natural History) which has a vast collection of insects from all parts of the world. Out of the 8-10 million species of the insects, the scientists have so far identified and described about 800,000 species. When the specimens have been identified, they may be incorporated into the National Collection, but most named specimens are returned to the senders for their own reference collection. In all cases the sender receives a list of the species together with relevant information.

The documentation staff of CIE scans about 10,500 articles annually published in about 900 journals, reports and proceedings throughout the world in different languages. Two monthly abstract journals, viz., *Review of Applied Entomology*—Series A (Agricultural) and *Review of Applied Entomology*—Series B (Med. & Vet.) are published alongwith *Bulletin of Entomological Research* which is a quarterly and deals with original research papers. The Institute also publishes maps showing world distribution of economically important insects.

Commonwealth Mycological Institute. Situated near the Royal Botanical Garden at Kew, the Institute collects current information on diseases of plants for the benefit of pathologists the world over and publishes two abstracting journals *Review of Plant Pathology* and *Review of Medical and Veterinary Mycology*. Books are also published from time to time. The Institute identifies about 9000 specimens annually received from various countries. All specimens are numbered and indexed under both host and fungus names. A herbarium containing over 200,000 specimens, mostly of microfungi, is being maintained for quick reference. The culture collection maintains a large number of strains which are made available to educational and research establishments on request. Domestic and destructive moulds which damage food and organic material are also identified.

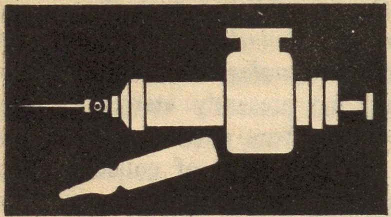
Commonwealth Institute of Helminthology. Of all the pests of animals and plants, helminths are the commonest cause of loss of agricultural products and animal diseases. They include three major groups of parasitic worms; Nematodes, Trematodes and Cestodes. The Institute identified 8,689 samples from January 1971 to December 1975, out of which 6391 were from contributing countries and 2298 from non-contributing countries. The staff summarizes information as abstracts from 6000 or so papers on helminthology that are published each year in various journals of the world. At present, there exists an index of over 300,000 entries. The two abstracts published are: *Human and Animal Helminthology*—Series A and *Plant Nematology*-Series-B. The Institute has presently started training scientists from developing countries in the techniques of collecting and preparing specimens for identification of worms.

Commonwealth Institute of Biological Control (CIBC). Biological control is a method of controlling pests by exposing them to their natural enemies. CIBC has its headquarters in Trinidad and stations in India (Bangalore), Uganda, Switzerland, Pakistan, Malaysia, Argentia and Ghana. Its services are available to all countries and range from the supply of publications and information, through to planning supervision and supply of full scale control projects anywhere in the world. Whereas biological control by natural enemy of pests is economical, pollution free and requires virtually no labour, it has its own limitations in that the degree of control achieved by it varies in different circumstances and has to be supplemented by chemical pesticides. The Institute publishes parasite catalogues and reviews of biological control in different areas of the world.

The Bureaux

The ten Bureaux of the CAB are mainly concerned with collection, collation and dissemination of information in their own branches of agricultural science. The information, compiled from world literature, is published in abstract forms which have a monthly circulation of over 30,000 in 158 countries. From 1973 the journals are being produced through Lockheed's DIALOG system. The consolidated data base now contains over 500,000 records. The data base is being updated by staff in Bureaux/Institutes by scanning over 8,500 scientific journals in 37 languages of the world. The total

(*Continued on page 344*)



MEDICAL NOTES

Colon-rectum cancer most curable

CANCER of the colon and rectum is prevalent more than any other cancer except skin cancer. It occurs equally both in men and women. The colon and rectum, which make up the lower end of the digestive tract, are responsible for extracting liquids from the remains of digested food and holding the solid waste matter until it is ready to be expelled from the body.

Sometimes, for some unknown reason, the cells that make up the tissue in this area begin to divide uncontrollably forming a tumor. Fortunately most of these tumors are not cancerous and are not usually dangerous because they do not invade or spread to other tissues in the body. But, some of these tumors are cancerous and can grow, invading surrounding tissues and spreading through the blood system, to other parts of the body. Most rectum cancers occur within the last segment of the bowel and can be seen easily through the proctoscope. Colon tumors may be detected by a new technique of colonoscopy which is a direct visualization of the colon with a lighted instrument. The symptoms of colon and rectum cancer are constipation (or perhaps diarrhoea), gas pains and rectal bleeding. Of course, some of these symptoms may be caused by many minor problems too, such as haemorrhoids. While haemorrhoids are not extremely dangerous, they are so common that they may occur in some people who also have cancer. Thus, rectal bleeding must always be investigated even in people who are known to have haemorrhoids.

Cancer of the colon and rectum is one of the most curable cancers of all. Yet, over 52,000 people die every year of this disease. Why? The reason is due to two significant factors: (1) Cancer of the colon and rectum is often called "the cancer nobody talks about". Thus, there is widespread lack of information about the disease and a tendency to avoid diagnosis and treatment of it; and (2) Not enough people have regular checkups which include a proctoscopic examination and/or hemocult slide test. By such examinations the doctor may detect early cancers when they are most curable. The proctoscopic examination is done with a lighted tube passed into the rectum and lower colon by which the physician can inspect the wall visually. This examination should be done regularly in persons over 40.

Another detection technique which helps find colon-rectum cancer early is testing for occult or hidden blood in the stool.

75% of the cases of cancer of the colon and rectum are curable when found early and treated promptly and properly.

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Dietary fibre and diseases

DIETARY fibre is that part of whole grains, vegetables, fruits and nuts that resists digestion in the gastro-intestinal tract. It consists of carbodydrates, viz., cellulose, hemicellulose and pectins and a non-carbohydrate lignin. Refined foods lack fibre because most of it is removed from grains by milling; some fibre is also removed from fruits and vegetables by peeling. The fibre content of foods is expressed in terms of crude fibre residue left after treatment with acid and alkali. It is estimated that crude fibre values obtained after extraction reflect only 16%-20% of the nutritionally undigestible dietary fibre. The crude fibre of wheat is about 2% but its dietary fibre (cellulose, hemicellulose and lignin) is 11%. Crude fibre consists of lignin and in part cellulose, but it does not take into account hemicellulose or pentosans not hydrolyzable by the small bowel enzymes.

There is now an increased consumption of fat and protein. There is also a major change in the quality of carbohydrate foods eaten. Fibre-depleted foods, in particular, white flour, polished rice and sugar replace traditionally eaten lightly processed plant foods. The amount of dietary fibre consumed from plant foods by affluent societies in urban areas is far less than the people living in the rural areas where they depend largely on foods of natural composition.

Man-made diseases

Dietary fibre has long been neglected as an important factor in human nutrition because it is a negligible source of energy and that no specific deficiency symptoms develop

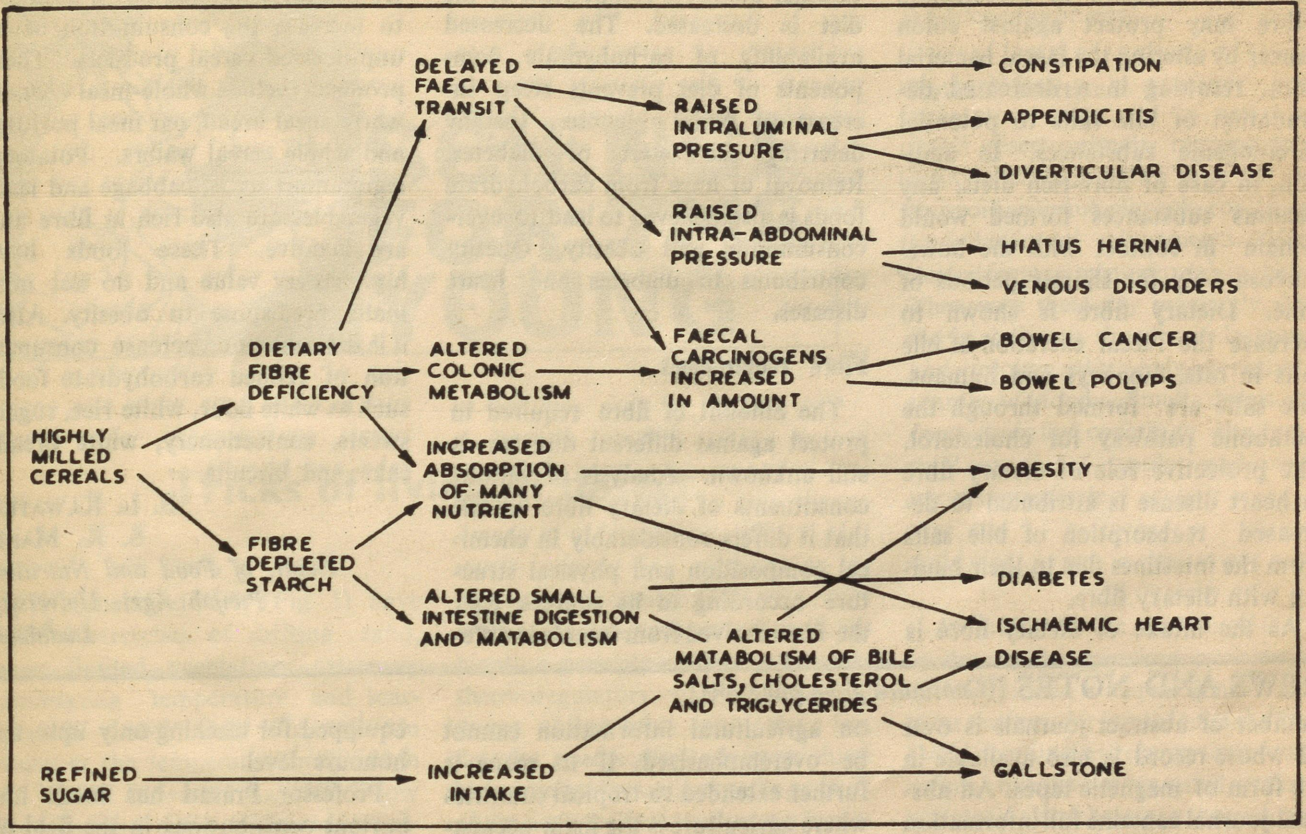

Fig. 1

in its absence. Recently epidemiological observations and the increasing knowledge of physiological role of dietary fibre in intestines have led to a hypothesis linking a variety of diseases prevalent in western countries to the relative deficiency of dietary fibre.

Many non-infectious, degenerative diseases, viz., ischaemic heart disease, diabetes, obesity, appendicitis, diverticular disease, haemorrhoids or piles, cancer of colon and rectum, hiatus hernia, varicose veins, and gall-stones are widespread in western or affluent societies, but are not so common in less-developed countries. The main factor responsible for the prevalence of these diseases is the reduced intake of dietary fibre in comparison with underdeveloped areas of the world. Fibre-deficient diets may cause a disease directly due to a decrease in the bulk, consistency, passage of stool through the intestine. Changes in fibre intake may also alter the metabolism of intestinal contents, the amount of calories consumed and their rate of absorption. The mechanism of various diseases due to lack of dietary fibre is represented in Fig. 1.

It has been suggested that dietary fibre can influence incidence of diverticular disease, appendicitis and constipation by increasing the bulk of the food and decreasing the transit time required for the food to pass through the gut. These functions are accomplished by the water-absorbing properties of fibre, especially cellulose. In fibre deficient foods, the difficulty encountered by the large intestine in propelling unnaturally viscid faeces along the colon leads to raised pressure within the lumen. This can force out pouches of the mucosa lining at a weak spot in the covering muscle, in the same way as a portion of the inner tube of a bicycle wheel protrudes through a defect in the covering tire. These intestinal blowouts are referred to as diverticula.

In appendicitis, it is believed that the trouble starts with the blockage of the outlet of the appendix. This is often caused by a small lump of hard faeces or excessive contraction of the muscle coat. The increased pressure behind the blockage interrupts the blood supply of the appendix lining, and once it is damaged in this way, infection supervenes. In the presence of soft faeces, associated with high roughage diets, the appendix empties more freely.

Dietary fibre is believed to prevent venous disorders such as varicose veins, haemorrhoids or piles, and venous thrombosis by decreasing the effort required in defaecation. Fibre may protect against colon cancer by altering the faecal bacterial flora, resulting in a decreased degradation of bile salts to potential carcinogenic substances. In addition, in case of fibre-rich diets, any noxious substances formed would remain in contact with the bowel mucosa only for shorter periods of time. Dietary fibre is shown to increase the faecal excretion of bile salts in rats, monkeys and humans. Bile salts are formed through the metabolic pathway for cholesterol. The protective role of dietary fibre in heart disease is attributed to decreased reabsorption of bile salts from the intestines due to their binding with dietary fibre.

As the intake of dietary fibre is increased, the apparent availability of other utilizable components of the diet is decreased. The decreased availability of carbohydrate components of diet prevents steep increase of blood glucose thereby deterring the onset of diabetes. Removal of fibre from carbohydrate foods is also believed to lead to over-consumption and obesity. Obesity contributes to diabetes and heart diseases.

Fibre requirement

The amount of fibre required to protect against different diseases is still unknown. Analysis of various constituents of dietary fibre reveals that it differs considerably in chemical composition and physical structure according to its sources, e.g., the fibre derived from cereals is different in many respects from that of fruits and vegetables. It is desirable to increase the consumption of all unprocessed cereal products. These products include whole-meal *chapati*, whole meal bread, oat meal porridge and whole cereal wafers. Potatoes, leguminous seeds, cabbage and leafy vegetables are also rich in fibre and are laxative. These foods have high satiety value and do not normally predispose to obesity. Also, it is desirable to decrease consumption of refined carbohydrate foods such as white flour, white rice, sugar, sweets, confectionery, white bread, cake and biscuits.

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NEWS AND NOTES (*Continued from page* 341)

number of abstract journals is over 22 whose record is also available in the form of magnetic tapes. An abstract journal contains full information regarding authors, title in original language, translated titles, names of the journal, year of publication, volume, issue, pagination, references etc., regarding all abstracts.

The CAB's role as a clearing house on agricultural information cannot be overemphasized. If its scope is further extended to tropical countries where agriculture is the main occupation of the masses by way of establishing local experimental and information centres, it would be more effective in fulfilling its objects it is dedicated to.

C. B. SHARMA

Prof. B. P. Prasad felicitated

ON the occasion of the 110th Commemoration Day, January 22, 1978, Ravenshaw College felicitated Professor Balbhadra Prasad, D. Sc. (London), F. N. A. in recognition of his achievement as a teacher, research scholar and educationsit, and in grateful appreciation of his contribution to the growth of higher education in Orissa.

Professor Prasad was born on January 31, 1905. After graduating from London University, he joined Ravenshaw College, Cuttack, as Assistant Professor of Chemistry in 1929. He was promoted to the post of Professor and Head of the Department of Chemistry in 1936. Prof. Prasad obtained D. Sc. degree of the London University in 1943, by doing research independently in the chemistry laboratory of Ravenshaw College, which was equipped for teaching only upto the honours level.

Professor Prasad has made important contributions in the field of viscosity of liquids and electrochemistry. He not merely initiated a tradition of research and scholarship in the chemistry department of Ravenshaw College, but also inspired many young teachers and research workers.

Professor Prasad is a generous man. During his stay in Ravenshaw College, he had rendered financial help to many poor students. He is a close friend of Lok Nayak Jayaprakash Narayan and is associated with a number of social and humanitarian activities.

Now 73, Prof. Prasad is passing his years lightly and is still actively pursuing research. Ravenshaw College will always be proud of this noble man.

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SCIENCE FOR THE YOUNG

Tricks of living in desert

IN general, deserts (Fig. 1) have vast stretches of drifting sand, very limited vegetation, extremely fluctuating temperature, and scarcity of water and humidity. In summer the temperature may reach 55 °C and in winter may fall below the freezing point. The most adverse conditions for desert life consist of a combination of aridity and high temperature. The combination presents an unusually acute thermoregulatory challenge to all desert inhabitants. In the last decade, spectacular advances have been made in understanding morphological, behavioural and physiological tricks employed by desert creatures to cope with their ever hostile environment.

Habitat selection

All desert animals, ranging from a tiny snail to a bulky mammal, try to avoid extreme climatic conditions by behavioural adjustments. Many desert forms are nocturnal in habit. They pass their day inactively, hiding in shelter or sleeping in burrows, and become active only at night in search of food. Small desert rodents usually constitute the main food source of reptiles and carnivorous mammals.

Water need

As aridity is the dominant factor in desert, the principal problem of desert animals is acquisition of sufficient water for their metabolism. Desert carnivores receive their water supply by devouring small, warm-blooded vertebrates, particularly rodents. Birds and reptiles fulfil

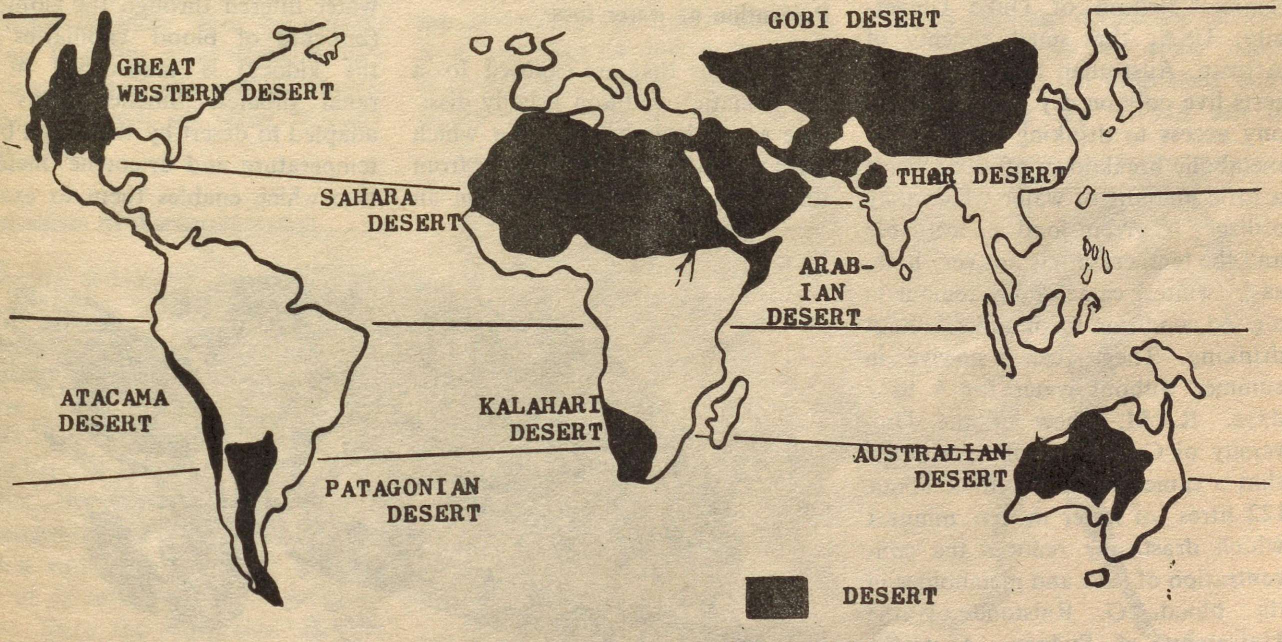

Fig. 1.

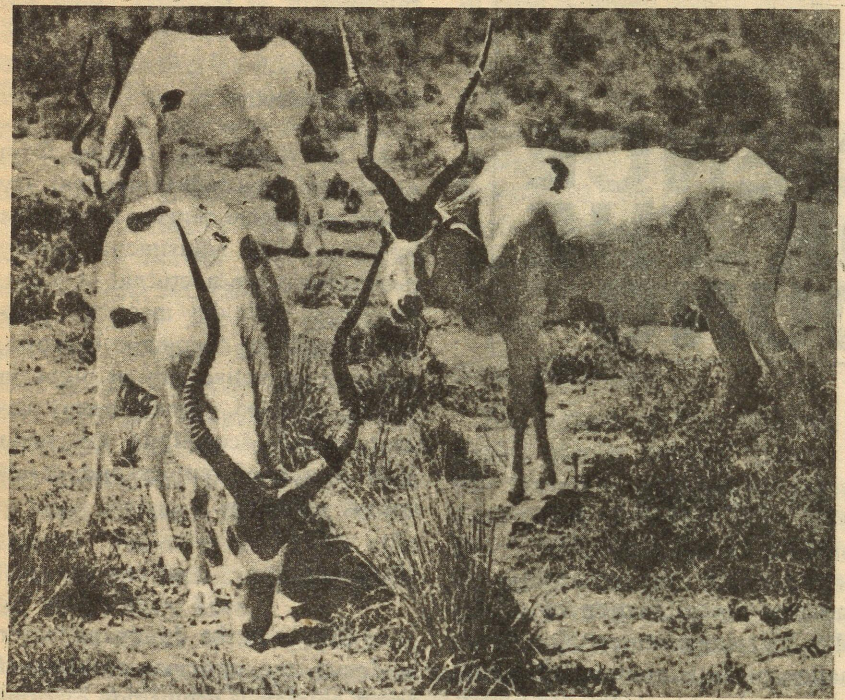

Fig. 2

their water needs by eating insects. It is now known that many desert herbivores, like antelopes (*Oryx* sp., *Addax* sp. etc.) (Fig 2.) and gazelles, never drink. It was reported by K. Schmidt-Neilson of Duke University, USA, that small rodents of African, Australian and Asian deserts live only on dry grains without any access to drinking water. The metabolic breakdown of seeds yields a little amount of water which they utilize. If green food is available and the temperature is not very high, as in winter, camels may remain in a good condition for months without drinking. They can survive in summer without water for 6 to 7 days. R. M. Chew of the University of California, USA, reported that a camel is able to drink about 122 litres of water in ten minutes which drastically reduces the concentration of salts and metabolites in its blood. G. Ralstone of the University of Sydney, Australia, in 1975 suggested that , unlike other mammals, the red blood cells of camel are made up of a special type of protein to withstand a sudden drop in salt concentration soon after drinking.

Prevention of water loss

Mammals that are exposed to a hot climatic condition usually dissipate excess heat by sweating which involves rapid loss of water from the body. When camels have an adequate water supply, they regulate their body temperature within normal limits by usual sweating. But during scarcity of water they avoid undue water loss through sweating, allowing the body temperature to vary over a greater range. K. Schmidt-Neilson and his research associates recorded that camels may have a body temperature of 33.9°C in the morning, and 40.7 °C in the afternoon. Sweating does not take place until the body temperature reaches 40.7 °C and a considerable amount of water is conserved by the body. Camel is also adapted to tolerate a loss of about 40% of its total body water without any ill-effect. Another large endotherm well adapted to desert conditions is ostrich. Like camels, ostriches are also extremely mobile and can withstand a water loss equivalent to 25 per cent of their own body weight.

All desert forms conserve considerable amount of water by producing extremely dry faeces and by excreting highly concentrated urine. G. M. Maloiy (1970) of USA demonstrated that in a dehydrated camel about 99.8 per cent of the water filtered through the glomeruli (bunches of blood capillaries in the kidney) is reabsorbed in the renal tubules. Smaller birds are adapted to desert by their high body temperature and uricotelic metabolism which enables them to excrete

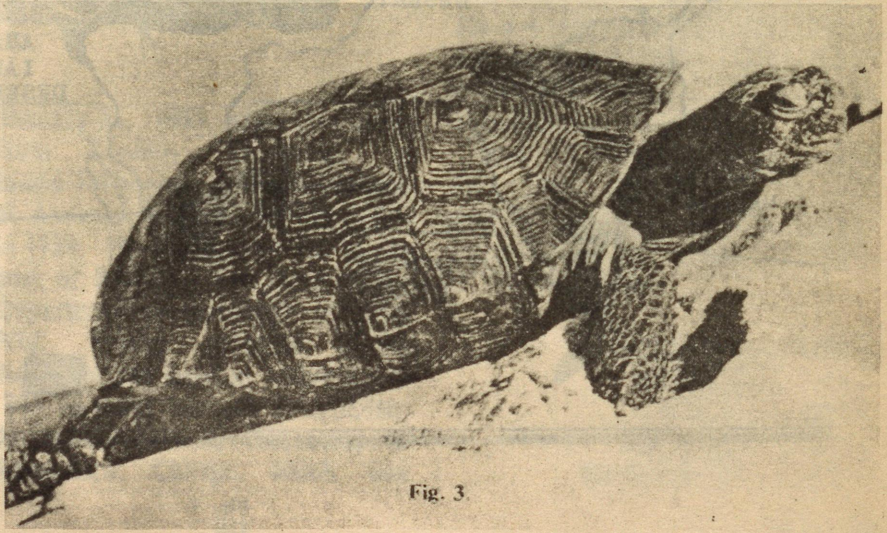

Fig. 3

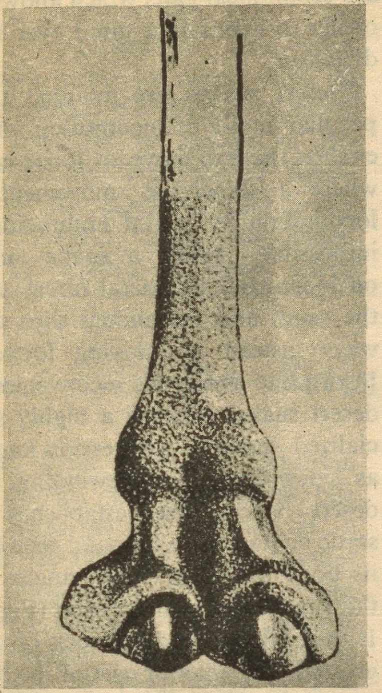

Fig. 4 (b)

Fig. 4 (a)

an extremely concentrated urine containing uric acid crystals (instead of soluble urea as found in mammals). In reptiles, a relatively water impermeable skin prevents unnecessary water loss by evaporation. However, some desert reptiles (*Uromastix* sp.) are able to absorb a large amount of water through their skin.

Mechanism of thermoregulation

Desert forms, in general, are capable of a wide range of heat tolerance. By varying body temperature to a great extent, camel stores a considerable amount of heat which is dissipated when the atmosphere is cool at night. At a higher temperature, the thermal difference between the environment and a camel is reduced due to rise in camel's own body temperature. Since the movement of heat is proportional to the temperature difference, less heat is obtained by a camel and so less water is required to prevent further increase of body temperature. Similarly, gazelles are also able to raise their body temperature to 65 °C.

Since an irregular deposition of fat hampers proper heat radiation, it is restricted in desert mammals to only limited islands of the body so that most of the body surface can act as an effective heat radiator. In camel, the fat is deposited only in its hump and in desert sheep mainly in the tail.

Panting (dissipation of excess body heat by gasping) is another efficient method employed by some small desert mammals to keep their body cool. Panting has certain advan-

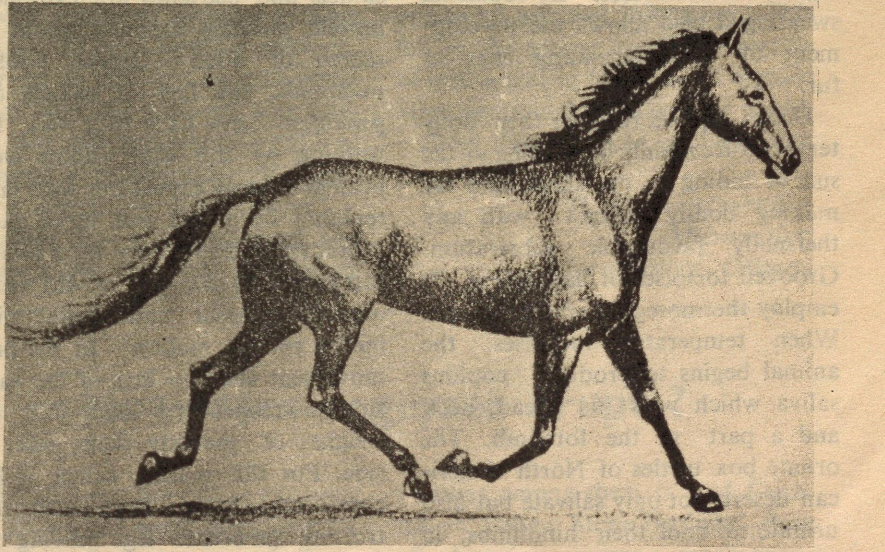

Fig. 5

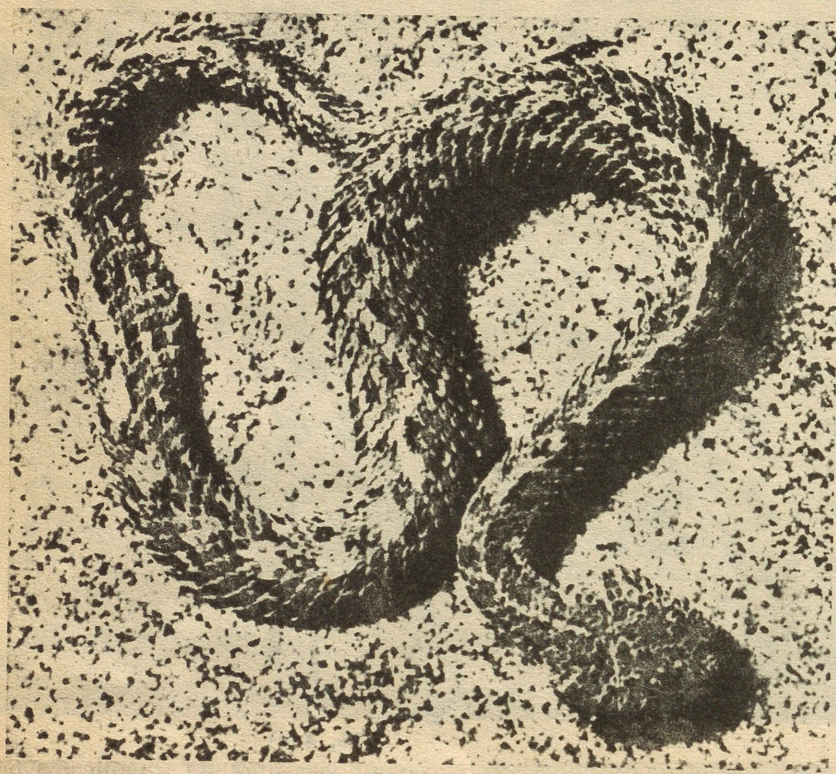

Fig. 6

tages over sweating in desert condition, because it does not increase the difference in temperature between the environment and the body surface and cools the body by avoiding undue water loss. By replacing sweating it also allows the development of thick insulating coat of fur.

Desert reptiles regulate their body temperature mainly by basking in the sun or hiding in the shade and by making bodily contact with any thermally favourable substratum. Grooved tortoises of Sahara(Fig. 3) employ thermoregulatory salivation. When temperature increases, the animal begins to produce copious saliva which wets its head, neck and a part of the forelimb. The ornate box turtles of North American deserts not only salivate but also urinate to cool their hindlimbs, in response to thermal stress.

Locomotion in desert

Fringed toes and long limbs are two important acquisitions for locomotion in desert. Both camels and ostriches are extremely mobile animals roaming about in search of food. Unlike hoofed mammals, the feet of camels are provided with pads (Fig. 4a) for walking on soft sand (hoofs were present in early camels but were later replaced by a nail and large pad). Moreover, camels move by a lateral gait known as pacing (Fig. 4b) which imparts peculiar and quite distinctive rolling motion. In the pace movement the two legs of the same side movetoget her and shift the weight of thebody from side to side. For this reason, camel is less comfortable to ride. Both pacing and trotting (alternate legs moving together as found in horses) (Fig. 5) are economical gaits which allow the owner to maintain a speed over long distances.

Desert snakes are adapted to a peculiar mode of locomotion which enables them to move on loose sands where a serpentine movement or locomotion by lateral undulation is impossible. When a snake moves on loose sand its lateral forces shift the sand, and the animal slips sideways instead of moving forward. In order to avoid this inconvenience, desert snakes practise a highly specialized mode of progression known as sidewinding. In sidewinding, the desert viper first establishes a static contact with the sand retaining its body almost at right angles to the direction of its movement (Fig. 6). It then lifts its head and neck off the ground. The anterior part of the body the ncurves in a wide loop which is immediately followed up by the extension of the front end until almost a quarter of the following trunk becomes free from the ground. Next, the neck bends and establishes a static contact with the ground, which is somewhat parallel to the preceding one, so that the rest of the body can be pulled forward abruptly. As sidewinding needs a minimum contact with the substratum, it seems to be an extremely helpful gait to snakes which are forced to move on a hot, sun-bathed sand.

Dormancy

During the period of extreme dryness, small desert animals become dormant after storing a good reserve of fat in the body. The dormant state reduces oxygen consumption and thereby cuts down the heat production in the body. Small mammals, particularly ground squirrels that aestivate during summer, show an extremely depressed metabolism during this period. Desert snails are active only during the short rainy season when suitable food is available (see *S.R.*, Feb. 1977). Considerable knowledge has been gained in recent years in understanding the various tricks of some creatures to survive in desert. But the accumulated knowledge in this particular field is still scant. Further work will, therefore, be needed to reveal many other unknown physiological mechanisms by which desert animals maintain an almost constant condition within the body in a fluctuating and ever hostile environment.

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Dr. Fritz Pregl

DR. Fritz Pregl, an Austrian doctor, was working on bile acids from the gall bladder of a rabbit. He obtained a small amount of degradation products but was not sufficient for the methods of chemical analysis known at that time. Dr. Pregl began to ponder over the matter. He had two alternatives, either to prepare the sample in a large quantity or to modify the existing methods of chemical analysis for much smaller sample size. He chose the latter. He modified the methods of Liebig and Dumas in such a manner that the analysis could be carried out with only a few milligrams of the sample and with great accuracy. Analysis of the contents of the elements, namely, C, H, O, N, S, etc., in an organic compound was now possible with just a pinch of the sample.

In the classical Liebig method of combustion analysis, the organic substance, contained in a porcelain boat, is heated in a slow oxygen stream until there is no residue. The oxidation of the carbonaceous matter is completed by passing hot gases over a column of red-hot copper oxide. Water is trapped and weighed in calcium chloride, and carbon dioxide is collected in strong caustic potash solution. Dumas' method of combusting a nitrogenous substance with copper oxide and collecting the resulting nitrogen gas over caustic potash is still the most reliable method.

The most essential piece of apparatus for Pregl's method is the balance. For ordinary analysis, that about 0.1 gm -0.5 gm of the sample is required; 20 mg-25 mg of the sample for semimicroanalysis and 3mg-5 mg of the sample for microanalysis. Hence for microanalysis a special type of analytical balance, called microbalance, is needed.

The exceptional achievements of W. H. Kuhlman of Hamburg in the construction of balances were already well-known to Dr. Pregl. On Pregl's repeated requests Kuhlman constructed a "Micro-balance" for him.

By 1912 Pregel was able to make measurements of carbon, hydrogen, nitrogen, sulphur and halogens using only 5mg-10mg of the starting material with results as accurate as those obtained by the existing methods. Later, he so modified his techniques that as little as 3 mg-5 mg were sufficient for measurements. In 1917 he published a monograph "*Die quantitative organische Mikroanalyse*".

Pregel's new work interested him so much that he never returned to medicine. He devoted the rest of his life to development and teaching of microanalysis. For his remarkable contribution to science, he won the Nobel Prize in chemistry in 1923.

Dr. Fritz Pregl was born at Laibach in Austria on September 3, 1869. He received his M.D. degree from the University of Graz in 1894 and was Lecturer in the Physiological Institute in Graz for several years. He went to Leipzig in 1904 where he studied the methods of physical chemistry with Dr. Wilhelm Ostwald. From there he went to Berlin to work with Dr. E. Abderhalden. He returned to Graz in 1904 as Professor of Physiological Chemistry in the Medico-Chemical Institute. Here he investigated the components of albuminous bodies and carried out the analysis of bile acids. From 1910 to 1913, he was a Professor at Innsbruck University. He returned to Graz in 1913 and became the Director of Medico-Chemical Institute.

Pregl was induced by academic chemists as well as industrial chemists to institute courses which were attended by eager chemists and biologists from all parts of the world. On their return home many of them followed his wish, of not only carrying out further work themselves but communicating his methods to others by personal instruction. This led to the setting up of new centres of instruction in quantitative organic microanalysis throughout the world.

Pregl died at Graz on December 13, 1930.

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Microanalyst
Bose Institute, Calcutta

How does a geyser erupt ?

GEYSER is a hot spring throwing up a jet of water intermittently. In nature, there are many geysers. Famous among them is 'Old Faithful' in Yellow Stone National Park of America, where spontaneous

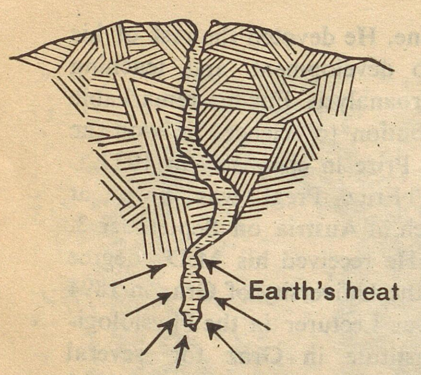

Fig. 1. A narrow fissure

eruptions occur almost every hour. In India, geysers at Manikaran and Puga are also well-known.

Dancing geysers are one of the magnificient wonders of nature that led people of ancient world to believe that there was a blazing fire below their feet to which sinners were sent after their death. This was however only a superstition. It vanished with the scientific revelation of the origin of natural geysers.

As we dig deep into earth, temperature increases. For every three hundred meters increase in depth, the temperature-rise is found to be about nine degrees Celsius. Also the average temperature on the surface of earth is about 20 degrees Celsius. Water boils at one hundred Celsius, so if a bottle containing it is lowered to a depth of about two kilometer into earth, it will start boiling. This shows the enormous amount of heat inside earth. Robinson deep is a gold mine in South Africa. It is the world's deepest gold mine and is hot like a furnace. To save miners from being roasted by earth's heat, an air conditioning plant had to be installed there.

In earth's crust, there are vertical narrow cracks and holes. Water from nearby streams seeps into these vertical fissures and is heated up gradually from below. The top of the water column formed in the crack is exposed to atmosphere. A pressure there equals to one atmosphere. Surface water can therefore boil at 100 degrees Celsius (water boils at 100 °C when pressure is one atmosphere). Far below the surface of earth, the pressure is equal to the atmospheric pressure plus the pressure due to water column above this point. Because boiling point increases with the increase in pressure, at this point water will boil at a temperature higher than 100 degrees Celsius. If the crack happens to be very narrow, convection currents are not present. Consequently, near the bottom, boiling occurs much earlier than it does at the top of the water column. At a sufficiently high temperature, vapour pressure near the bottom of the water column exceeds the pressure due to air and water column. This increased vapour pressure near the bottom pushes the water column up and eruption takes place (Fig. 1). This is how a geyser occurs.

At home, we can easily build working model of a geyser (Fig. 2). Take a long glass tube 30 cm to 300 cm in length, wider at the bottom and tapering towards the top end. This end should also have a trough to collect water on eruption. On heating from below, water erupts from the top like a natural geyser. Frequency of eruption depends on the length of the tube.

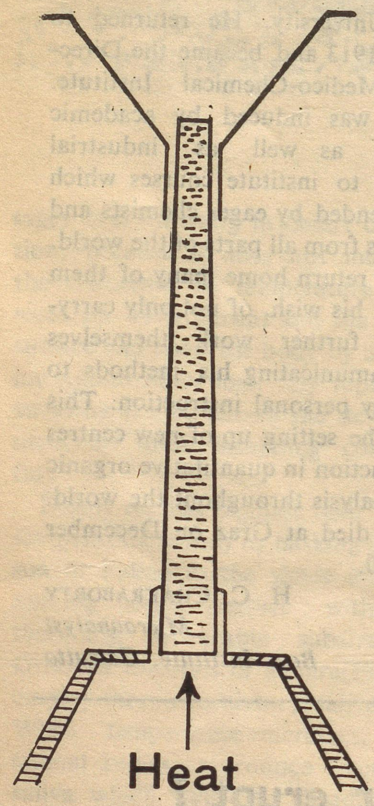

Fig. 2. A home-made geyser

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Chemical tricks

CHEMICAL tricks have always been popular. Here are some which can be demonstrated in science exhibitions.

Fire under water

Normally it is impossible for any substance to burn under water. But if white phosphorus with some potassium chlorate is kept in a large trough of water and concentrated sulphuric acid poured on it carefully using a funnel, the phosphorus burns violently under water.

The reactions are :

$KClO_3+H_2SO_4 \rightarrow KHSO_4+HClO_3$

$3HClO_3 \rightarrow HClO_4+2ClO_2+H_2O$

Chlorine dioxide (ClO_2) combines with phosphorus to make it burn.

Burning sugar by water

If some sugar mixed with sodium peroxide is kept on a sand tray and water is dropped on the mixture, the sugar burns violently. Heat is generated by decomposition of sodium peroxide by water which ignites sugar.

$Na_2O_2 + H_2O \rightarrow 2NaOH + H_2O_2 +$ heat

Cold flame

Usually a flame—of a candle or burner—is extremely hot. But the flame produced by the following experiment is cold and can be safely touched by finger. It will not ignite the head of a matchstick.

A few pieces of dry, white phosphorus are taken in a dry flask fitted with a cork carrying inlet and exit tubes for carbon dioxide. When the flask is put on a hot water bath and a stream of carbon dioxide passed through it, the phosphorus vapour carried by carbon dioxide gets oxidised in the air. If the room is darkened, a pale green flame is seen at the top of the exit tube. It is cold and does not harm the body.

Chemical garden

An experiment may be performed with solution of sodium silicate to form a beautiful silica garden. Sodium silicate is sold under the name water glass. It is soluble in water and the solution is alkaline.

To make silica garden, a dilute solution of water glass is taken in a large beaker over a layer of clean sand at the bottom. Tiny crystals of some coloured salts like cobalt sulphate, nickel chloride, copper sulphate, manganese sulphate, chrome alum, etc., are sprinkled over the sand. The beaker is placed undisturbed for a few days. Coloured shoots will be seen rising and growing through the solution like the trees and plants in a garden. If we siphon out the dirty liquid and refill the beaker with fresh water, the coloured shoots will be more distinct in the clear liquid.

The process of growth is probably as follows. Initially, a shell of the colloidal and semi-permeable silicate is formed around the crystal. Inside the shell is a strong solution of the salt and outside a weak solution of the silicate. Hence water passes into the shell and the osmotic pressure of the solution inside it rises and ultimately bursts it. The metal salt solution escapes. instantaneously, a fresh shell is formed and this process goes on until a tree-like formation results.

P. RAJALEKSHMI

Science Quiz

1. Transfer of heat by the flow of heated particles in a fluid is called

(a) convection
(b) thermodynamic expansion
(c) radiation

2. The velocity of light in air is of the order of

(a) 3×10^{20} cm/sec
(b) 4×10^{10} cm/sec
(c) 3×10^{10} cm/sec

3. Soldiers are not allowed to march while crossing a bridge because

(a) it is a law in army
(b) it produces sharp and unpleasant noise
(c) it might give way due to resonance

4. Helium was discovered from

(a) the mines
(b) the atmosphere
(c) the spectrum of sun

5. In an internal combustion engine, heat is produced

(a) in the petrol container
(b) inside the cylinder
(c) outside the cylinder

6. Gun metal is an alloy of

(a) tin and lead
(b) tin, zinc and copper
(c) antimony and copper

7. The lunar eclipse occurs when

(a) sun comes in between the earth and the moon
(b) the moon comes in between the sun and the earth
(c) earth comes in between the sun and the moon

8. Lamps used for street lighting are connected in

(a) parallel and series
(b) series
(c) parallel

9. The first synthesis of an organic compound was achieved by

(a) F. A. Kekule.
(b) F. Von Liebig.
(c) Friedrich Wohler.

10. In electrolysis, the reaction at anode is called

(a) ionisation
(b) oxidation
(c) reduction

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Jamshedpur-17 (Bihar)

Name the science

EVERYONE knows that the scientific study of animals is called "Zoology" and the study of fossils is known as "Palaentology". The science of plants is, of course, called "Botany" and the science that deals with nerves is "Neurology". Can you name the science that deals with the following?

(1) Sun
(2) Moon
(3) Clouds
(4) Wind
(5) Stars and planets
(6) Mountains
(7) Lakes
(8) Mineral springs
(9) Air
(10) Oceans
(11) Earthquakes
(12) Volcanoes
(13) Rocks
(14) Crystals
(15) Gems
(16) Shells
(17) Spiders
(18) Ants
(19) Snakes
(20) Handwriting
(21) Blood
(22) Bones
(23) Muscles
(24) Joints
(25) Blood vessels
(26) Teeth
(27) Heredity
(28) Mind and behaviour
(29) Sleep
(30) Dreams
(31) Ageing
(32) Tumours
(33) Trees
(34) Mosses
(35) Ferns
(36) Drugs
(37) Cold
(38) Light
(39) Sound
(40) Time measurement

R. SRIRAM

(*Answers on page .. 315*)

Answers to Science Quiz

1. (a)	5. (b)	9. (c)
2. (c)	6. (b)	10. (c)
3. (c)	7. (c)	
4. (c)	8. (a)	

Variable power supply for the hobbyist

INVARIABLY all electronic circuits require a d.c. power supply and each circuit has its own power requirement. Therefore, for a hobbyist there is definitely a need for variable power supply. This eliminates the efforts required to make a separate power supply unit suitable for a circuit. It enables a hobbyist to implement quickly various electronic ideas published from time to time.

In this article a rock-steady power supply circuit capable of producing a predetermined variable d.c. voltage in the range of 6 to 20 volts is given. This circuit is impervious to any voltage fluctuations in either the a.c. mains or the load current. The output is essentially the desired d.c. voltage as the residual ripple voltage is practically near zero. Furthermore, the circuit can take up a.c. mains variation from 175 to 275 volts. It also maintains the same voltage at no load and full load conditions. An important feature is the built-in current limiter to protect the entire system against over-loading.

The schematic circuit diagram of a regulated power supply is shown in Fig.1. It consists of two main blocks, namely, unregulated power supply and a regulator. The unregulated power block produces an unregulated voltage at the terminals BB′. The

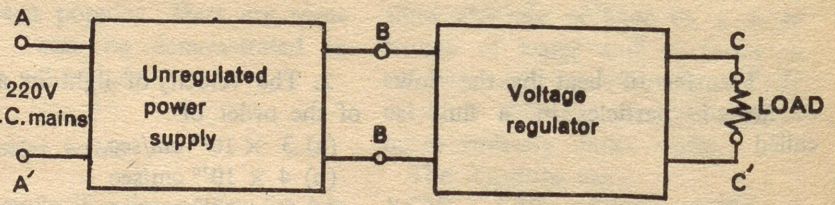


Fig. 1

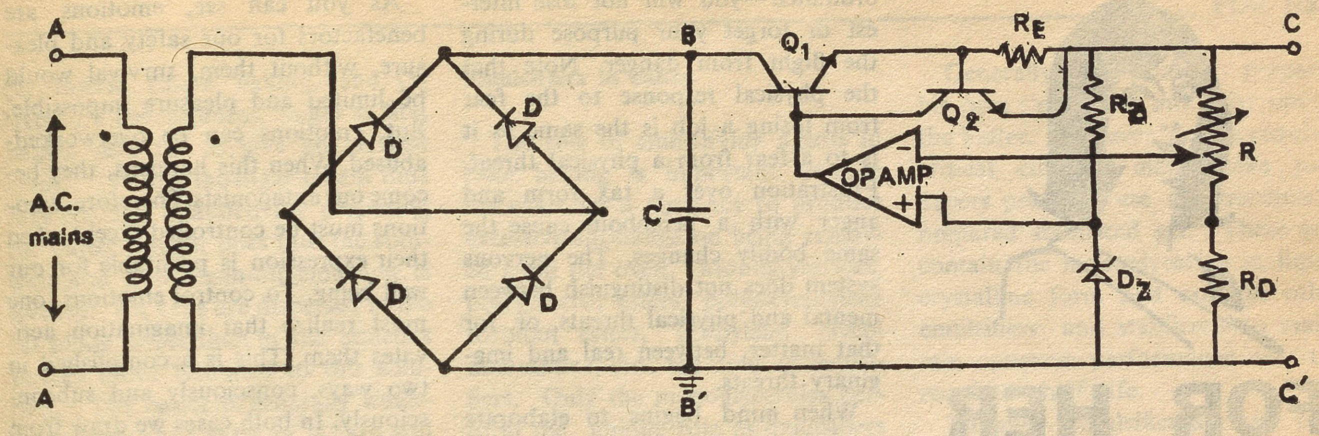


Fig 2

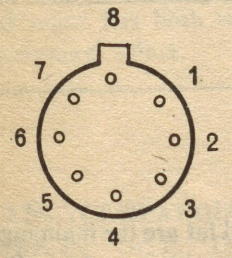
regulator smooths out the variations in the voltage. The complete circuit is shown in Fig. 2.

Components and interconnections

The heart of this circuit is an integrated circuit error-sensing device known as Operational Amplifier (OPAMP, SSD 741C). The bottom view of the OPAMP is shown in Fig. 3. The various pin connections are:

(a) Connect B to pin 7 and B' to pin 4;

(b) Connect pin 2 to the middle leg of the variable potentiometer R;



Pin	2	Inverting input
Pin	3	Non-inverting input
Pin	6	Output
Pin	4	Negative Supply
Pin	7	Positive Supply
Pins	1,5, and 8	are not connected

Fig. 3

(c) Connect pin 3 to the cathode of zener diode (D_Z);

(d) Connect pin 6 to the base of transistor Q_1, and

(e) Pins 1,5 and 8 are not connected.

Other components are:

1. Transformer..220V/24V, 1 ampere
2. Semiconduetor diode (D) BY 126
3. Electrolytic Capacitor (C) 500 microfarads
4. Power transistor(Q_1)..2N 3055 (NPN)
5. Transistor(Q_2)..SF104 (NPN)
6. Zener diode (D_Z)..SZ 211
7. Potentiometer (R)..10K ohms.
8. Resistances (R_D and R_Z) 1 K ohms.
9. Resistance (R_E)..1ohm., formed using a resistance wire

The readers are familiar with diodes and transistors, the circuit could be made in accordance with Fig. 2. After making the circuit, calibrate the output voltage with a multimeter and make marks for the potentiometer knob settings for different voltages.

Working

The load current passing through Q_1 produces output voltage at CC′. Part of this output voltage is fed to the inverting-terminal of the OP-AMP. A zener diode is connected to non-inverting input of the OPAMP to give a reference voltage equal to fixed zener breakdown voltage. The biasing of the zener diode is through resistance R_Z. The OPAMP derives its power from the input terminals BB′. The OPAMP compares the reference voltage V_R with a feedback voltage proportional to the output voltage. It senses the error between these two and amplifies the error signal greatly to apply an immediate correction at the base of transistor Q_1. Any surplus voltage over and above the desired value of the output is dropped across Q_1, from collector to emitter. Alternatively, this drop is reduced to increase the output voltage if for some reasons the output happens to show a tendency to fall below its required value.

The resistance R_E and the transistor Q_2 together constitute the current limiter. It provides protection to the power supply when the output is inadvertantly short circuited.

Now you have a variable voltage power supply using which you can confidently run almost any household electronic equipment, with the knowledge that it is drawing precisely the voltage which is safe for it.

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FOR HER

Happiness and health require emotional control

EMOTIONS are mediated through brain. They accompany internal bodily changes that enable an organism to carry out specific goals. These changes are essential, for they ready an individual to encounter danger, respond sexually, sleep, or react appropriately to any other situation. Three things happen in an emotional state—we evaluate something, changes take place within the body, and we feel those changes. For instance, if you lose your job, you would probably become upset or depressed. You would experience some fear, causing internal changes in the body. These changes wculd not only provide you with added strength to flee the cause of your fear and better suffer any physical harm you might experience in your escape, but they would also reinforce your fear. This reinforcement strengthens your will to carry out your objective. It enables you to be physically and mentally co-ordinated—you will not lose interest or forget your purpose during the flight from danger. Note that the physical response to the fear from losing a job is the same as it is to a fear from a physical threat. Frustration over a tax form and anger with a neighbour cause the same bodily changes. The nervous system does not distinguish between mental and physical threats, or, for that matter, between real and imaginary threats.

When mind begins to elaborate on pain or pleasure, the brain and automatic nervous system respond by mobilizing the body. The autonomic nervous system has no way of knowing if the source of stimulation is in the environment or in the imagination. Changes produced by emotion are really disturbances of the body's normal state, and therefore are themselves threatening. This is particularly true when no action is carried through. When muscle tension, excess energy, surplus hormones and other emergency factors are not utilized by action, they remain causing stress to the body. As you probably know, emotional stress has been discovered to be the cause, or major factor, in a growing list of diseases, including cancer and heart disorders.

As you can see, emotions are benefactors for our safety and pleasure, without them, survival would be limited and pleasure impossible. But, emotions can be overworked-abused. When this happens, they become our antagonists. Therefore, emotions must be controlled except when their expression is profitable for our well being. To control emotions, one must realize that imagination activates them. This is accomplished in two ways, consciously and subconsciously. In both cases we draw from memory, the seat of imagination. In the hypothetical case of your losing a job, you may remain objective, drawing from memory only raw data.

If you become subjective, however, you will draw from memory impressions imprinted during emotional states. These impressions are associated with the primary emotions: anger, fear and pleasure. Therefore, the images associated with losing a job will relate to anger and fear. Your nervous system will not only respond to conscious thoughts involving fear and anger, but also to key images, conditioned as threatening, through your subconscious.

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Cake emulsions

WE all like cakes, but not many of us know that it is nothing but an emulsion of oil-in-water. Theoretically, an emulsion is an intimate mixture of two immiscible liquids, one dispersed over the other in the form of fine droplets/or liquid crystals. A cake batter is a fat-in-water emulsion system. The aqueous phase contains dissolved sugar and suspended flour particles. Flour, sugar, egg and fat are the main ingredients used in making a cake. Each of them contributes to the structure and eating quality of the cake.

How cake is prepared

Making a cake is simple. The whole operation consists of three main stages, namely, (1) batter preparation and the initial baking,

(2) intermediate baking, and (3) structure development. Sugar is first beaten into fat to give an aerated cream. To the fat-sugar cream thus formed, egg is added for preparing the batter. Sugar goes into the solution and a water-in-oil emulsion is formed. Air cells are dispersed in the fat phase rather than in the aqueous phase. Flour is added to this solution. The batter is generally water-continuous, but parts of it are still water-in-oil emulsion type. The flour particles are suspended in the aqueous phase of the now complete batter.

The air bubbles dispersed in the fat phase are transferred to the aqueous phase at about 37°C-40 °C. By the intermediate stage of baking all the air is held in the aqueous phase foam, and the batter expands as the air cells expand. In the final stage of baking, structure of the cake becomes stable to heat as the egg protein coagulates, and wheat starch is partially gelatinized.

The finished baked cake is a heat set foam and has a light, aerated structure. The cake is strong enough to withstand mechanical handling but at the same time is friable and breaks down readily in the mouth. The fat provides a tenderizing effect, and sugar has both tenderizing and sweetening effect.

Emulsifiers in cakes

The role of emulsifying agents in cake baking is important because the cake has a tendency to produce excessive shrinkage on being removed from the oven. Monoglycerides, polyglycerol esters, polyoxyethylene sorbitan esters, propylene glycol monoesters, etc., are used as emulsifiers. Only the monoglycerides perform the unique role as emulsifiers improving the quality of the cake. They also impart resistance to shrinkage besides dispersing and stabilizing the fat.

Preparation of sponge cakes

For the preparation of sponge cakes, eggs are first aerated with sugar and flour is added carefully with other ingredients. The monoglycerides are used as an emulsifier. Emulsifiers aerate all the ingredients including flour in an 'all-in' process which makes a more stable batter. Quantity of the additive is an important factor. An insufficient addition of monoglyceride can give a lower batter and cake volume than none at all, and the optimum monoglyceride level increases as the amount of egg used in the formulation is increased over the normal usage level.

Generally, the baker prepares his own "emulsion mix" for use in the batter. However, as this requires critical control, many cake producers prefer to use a commercially prepared stabilized gel. These gels contain the monoglyceride in liquid crystalline form and contain other emulsifiers and stabilizers to maintain optimum performance over the required shelf life.

Though emulsification is considered more an art than a science, yet its importance is growing increasingly in recent years, especially in food emulsions. Properties in cake emulsions such as taste, flavour, softness, smoothness, appearance, and stability to aging, etc., are very important and depend on the basic properties of an emulsion. A top graded cake can be produced only when good physical and chemical properties of the emulsion have been ensured.

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Books Received

1. **ENCYCLOPAEDIA OF CHILD CARE** *by* Dr. P. Thirumala Rao, *Orient Paperbacks*, 36 C, Connaught Place, New Delhi-110001, Pp. 292, Rs. 10.00
2. **THE STRUGGLE AGAINST POLLUTION** (1) (UNESCO) *Federal Publications Pvt. Ltd.*, Singapore, Available with: *Affiliated East West Press Pvt. Ltd.*, 7, East Spur Tank Road, Madras. 600031., each title: Rs. 18.00
3. **WATER AND LIFE** (2) (address as above).
4. **SCIENCE—IDOL OR THREAT** (3) (address as above).
5. **MAN AND PEACE** (4) (address as above).
6. **THE THREE FACES OF ART** (5) (address as above).
7. **CRISIS IN EDUCATION** (6) (address as above).
8. **WEATHER** (7) (address as above).
9. **POPULATION** (8) (address as above).
10. **THE CHALLENGE OF SPACE** (9) (address as above).
11. **SAVE YOUR HEART** (10) (address as above).
12. **SPINOFF FROM SPACE RESEARCH** (11) (address as above).
13. **THE EMERGENCY OF MAN** (12) (address as above).
Set of 12: Rs. 192 (*postage extra*)
14. **RADIO GALAXIES** *by* A. G. Pacholczyk, *Pergamon Press*, Headdington Hill Hall, Oxford OX3 OBW, U. K., Pp. 293, $ 25.00

Science in Industry

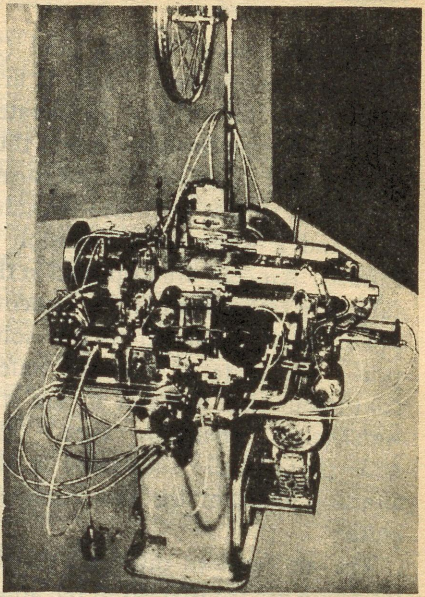
Lead sulphide cell for IR detection

A know-how is now ready with the Central Electrochemical Research Institute Karaikudi for the production of lead sulphide cells for detecting infra-red radiations. These cells can detect infra-red radiations in the region of 1-3 μm with a peak at 2.1 μm and are comparable in performance to the imported ones. Infra-red detectors have a variety of defence and civilian uses. The infra-red detector developed at CECRI is capable of detecting the 2.7μm water carbon dioxide band in the plume of heated gas from a hydrocarbon burning jet engine. Fire as well as overheating hot axles in railway wagons can also be detected. Intruding burglars and other moving objects can also be detected. These cells find use in infra-red telephony and also in detecting energy installations, as for example, factory, ammunition production units, etc. Image converters used for night driving, as for example, military movements during nights, weapon firing surveillance and satellite tracking by using the multiple element scanners are some more uses which this infra-red detectors can be put to. Amongst the civilian uses, radiation pyrometers are most important. In geological applications, infra-red detectors can be used for providing information about the near surface physical state of geological materials particularly the density, water content and heat transfer.

Materials used for the production of these cells are indigenously available. Requiring a total lay-out area of about 2,500 sq. ft. and a total capital investment of about Rs. 4 lakhs, an annual turnover of 6000-9000 cells could be produced. With suggested market price of Rs. 60/- for each cell as against about Rs. 150/- for the imported cell, a profit return of 36% on investment is envisaged.

Latch knitting needle machine

THE Mechanical Engineering Research and Development Organisation, Ludhiana, a Regional Centre of CMERI, Durgapur, has designed and developed an automatic machine for assembling various parts of latch knitting needle. The sophisticated machine performs 25 operations in a coordinated manner for the assembly of one needle. The main automatic operations incorporated in the machine are : Feeding of needles, latch cutting and inserting, latch pin grinding, pin-putting, pin-cutting and needle collecting. The machine can be adapted for assembly of all types and sizes of latch knitting needles.



Latch knitting needle machine

Prototype of the automatic assembly machine has been fabricated at MERADO Workshop. The machine has a capacity for assembling 20 needles per minute and is giving satisfactory performance.

The knitting needles manufacturing technology being a monopoly of only a few organisations in the world, the import cost of such machines is generally exhorbitant and delivery periods long.

MERADO, Ludhiana had earlier designed a machine to manufacture very small slitting cutters (15 to 20 mm dia and 0.15 to 0.5 mm thickness) required for cutting grooves in the body of knitting needles in which latch is fixed. The organisation has also been rendering technical consultancy to the knitting needle manufacturing industry.

With the experience gained over the last five years in the design of knitting needle manufacturing machines and in providing shop floor consultancy for the efficient running of such plant, MERADO, Ludhiana is now in a position to undertake the design and development of complete knitting needle manufacturing plant.

Mini rice mill

PADDY production in India is around 60 million tonnes per year. A major production of the paddy is being processed in about 60,000 huller mills distributed mostly in rice-producing regions.

The huller mills are low capacity mills which can handle about 300-500 kg of paddy per hour. Both the shelling and polishing operations are carried out simultaneously in these mills, resulting in very highly polished white rice of low yield. The husk also gets powdered along with the bran, rendering the bran uneconomical for oil extraction.

Mini rice mill developed and fabricated at the Central Food Technological Research Institute (CFTRI), Mysore, is an improvement over the huller mills. It has higher functional efficiency than that of modern rice mills of improved designs. In this mill, shelling and polishing operations are carried out separately, severity of milling treatment is reduced considerably and strict control on the yield of head rice and degree of polish is achieved. The mill is compact and does not require skilled workers to operate it. It is intended basically for use in villages.

CFTRI has so far supplied blueprints and fabrication details to eight engineering units in the country. One of the units has already fabricated a few mini rice mills for effecting supplies. These mills were tested at the premises of the unit by CFTRI scientists for their performance, and the yield of head rice was found to be 70 %. The rice obtained from these mills is free from dust, stones and brokens, and is expected to have a better market at a better price than the rice obtained from the conventional rice mills.

BIRTH DEFECTS (*Continued from page 310*)

nancy in early stage is generally not possible. It is suggested that women who have the possibility of being pregnant should conduct themselves from the tenth day after menstruation to the beginning of the following periods, as though they were in the initial stage of pregnancy. All the environmental agents and related substances listed in the earlier part of this article should be avoided by expectant women, especially in the first trimester of pregnancy (Fig. 3). This list would probably expand as additional drugs are introduced.

Careful observations of the progeny of a couple may reveal the carrier state of a defect in the parents. For some irreversible and incapacitating hazards of inheritance, surgical sterilisation is recommended. In such cases artificial insemination may be accepted by the couple.

Some foetal cranial anomalies, gross skeletal abnormalities, etc., can be discovered by radiology in some cases at later stages of pregnancy. Diagnosis of hydramnios (excessive amniotic fluid in the womb) might predict some incidence of anomaly. If a pregnant woman is exposed to known teratogens in an early stage of pregnancy, the foetus might develop into a damaged child. Abortion is recommended in such cases.

Sophisticated techniques are now available for obtaining information about the developing embryo in the uterus. Certain chemical, cellular, and chromosomal studies can be done on the material obtained by amniocentesis (the technique for obtaining fluid and cells from the environment of the developing embryo). Most countries now permit therapeutic abortions on the advice of specially trained physicians in case of a pre-natal diagnosis of foetal abnormalities. After a prolonged debate in several countries, the right to be 'born healthy' is now well recognised.

At present, it seems that an improvement of human material can be brought about by good environment of the developing embryo and good genetic material of the gametes. Improvement in environment can be ensured by better maternal health and control of infections and chemical and physical agents. Genetic counselling (*S.R.*, October 1977) may help prevent reproduction of severe genetic defects. Coming generations may have the facilities of microsurgical techniques to improve genetic material in human gametes; and, also, may accept genetic selection not only to prevent birth defects but to improve the human race not by chance but by choice!

Further reading

1. Fishbein, M. (Ed.), *Birth Defects*, Lippincot Co., Philadelphia (1963).
2. McBride, W. G., Drugs and congenital abnormalities, *Lancet*, **2**, 1332 (1962).
3. Sutherland, J. M., Light, I. R., The effect of drugs upon the developing fetus, *Pediat. Clin. North America*, **12**, 781-806 (1965).
4. Warkany, J., Congenital Malformations, *Year Book Medical*, Chicago (1971).
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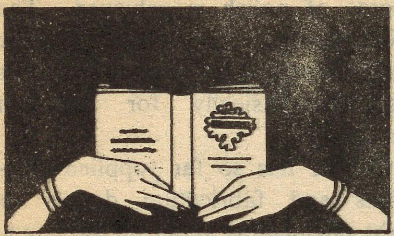

BOOK REVIEWS

THE HUMAN QUALITY *by* Aurelio Peccei, *The Pergamon Press* Pergamon International Library, Oxford, New York, Pp. 214 (Price not given)

TECHNOLOGY was born before science. In the beginning, man had to survive in an altogether hostile environment. He had to overcome his enemies and circumvent obstacles. He therefore looked around for materials that could be used as tools in his struggle for survival. Thus, technology was born. Once he had settled and had some spare time to look around, the second step towards civilization started. That was observation and reflection by him. And then science was born. Technology had preceded science because its primary purpose has been to make man secure, materially prosperous and comfortable. The race is still on. Today the superpowers are trying desperately to outdo each other in technology and to utilize it for their material prosperity, economic strength and military superiority. In this mad race, man overlooked the other face of technology, its ugly face. Technology can also harm him. In fact, the present concern of thinkers is that it is harming no less than it is benefiting mankind. The environment is being polluted, noise nuisance is on the increase, and there is a real threat to the ozone belt in the higher altitudes of the atmosphere which is so essential to shield earth from the lethal gaze of the sun. Many think that the world climate has vastly changed and is still changing for the worse. Rains all over the world have declined, earth's temperature is rising and oxygen is being depleted. These are gloomy forecasts and unless man corrects the imbalance let loose by technology, he will soon be faced with a threat to his existence.

Aurelio Peccei precisely deals with the present problem of pollution as a result of increasing use of technology in the world of today. He says that the technological revolution of today must now be followed by a cultural revolution in which the human need and greed must be balanced with earth's resources and their correct use so that man continues to live in harmony with nature. There is a need for contentment in man by containing his ever-increasing acquisitive desires. There is a need for culture in man to enable him to live in harmony with the new conditions and changes wrought by technology.

NUCLEAR TRACK DETECTION, *Pergamon Press,* Headington Hill Hall, Oxford OX3 OBW, England. Annual Subscription: $ 25.00 (individuals), $ 55 (libraries, etc.)

THE publication of this new journal by Pergamon Press has filled a long felt need of the scientists who have been using the Solid State Nuclear Track Detection (SSNTD) technique for their research. This journal is devoted mainly to the details and the refineness developed by various research workers in the SSNTD technique. The proliferation of this information among the scientific community will not only avoid duplication of effort but also lead to further advancement in the SSNTD technique. In any area of research, the refineness of a technique bears a strong correlation to the quality of scientific information. Hence the importance of this journal, whose service hardly needs to be overemphasized. Also, due to the publication of this multidisciplinary journal, a new research worker would not find himself at sea regarding the present status of the technique.

There is nothing wrong when, S.A. Durrani, the Editor of this journal, claims that there is hardly any area of science and technology where the SSNTD technique does not have applications. Subjects as diverse as nuclear physics, space physics, metallurgy, geology, medicine and biology, etc., find considerable applications of this technique. However, it would have enhanced the value of the journal if other track detection techniques such as bubble chamber and spark chamber would also have been included for in-depth discussion and exposition of the latest developments. The above mentioned techniques are the major tools for high energy physics research and a considerable amount of work is on for further development of these techniques. It is hoped that the journal is a 'seedling' at present and in the time to come it will extend its roots in several directions.

R. K. SHIVPURI

THE IMPACT SCIENCE TEACHING *by* N. Vaidya, *Oxford and IBH Publishing Co.,* 66, Janpath, New Delhi-110001, Pp. 326, Rs. 14.50

SCIENCE is that branch of human knowledge which has brought a peaceful revolution in our life. Realising the importance of science, it has been made one of the compulsory subjects upto 10th class level in the newly implemented 10+2+3 pattern of education. Because of this new emphasis on science, a critical look into the existing state of science teaching in our country is called for. Simply making science a compulsory subject is not going to serve any useful purpose. A simultaneous review of our present day science teaching has to be made. Not only the students should be made conversent with the up-to-date developments in science but a scientific thinking should also be developed among them.

In the book under review, the author has discussed the various aspects of science teaching. In the opening chapter the conditions which revitalised science teaching in Europe and the U.S.A. and the major improvement programmes undertaken by these countries in this direction, have been discussed. Thereafter the present state of science education in this country has been probed. Various steps taken by the government towards the improvement of the same have been discussed in detail. The various impediments which have hampered the teaching of such an important subject have been listed. In other chapters the author analyses various aspects connected with science teaching; these include curriculum, lesson planning, method of evaluation, etc. The author has made very many good suggestions which will be helpful in making science teaching interesting and thought provoking.

Throughout the book the author has limited himself to the secondary level science teaching, but most of the suggestions given by him can definitely be applicable to the improvement of science teaching at higher level as well.

The book, which is quite a thorough analysis of methodology of science teaching, shall undoubtedly stimulate interest among teachers, educationists and all those who can improve in one form or the other the level of science teaching in this country.

A. K. Kavathekar
A. K. Bhargava

SCIENCE DIGEST *by* H. S. Vishnoi, J. Fuste, N. A. Siddiqui, D. D. Mulherkar and Rekha Varma, *Pitambar Publishing Company*, 8888 East Park Road, Karol Bagh, New Delhi-110005, Pp. 108, Rs. 12

THE National Talent Search Scheme organized by the National Council of Educational Research & Training, New Delhi has become a well-known method to select young and promising children for identifying them as those with the necessary intelligence and aptitude for higher training in various subjects. These tests are organized every year at many centres in the country. Tricky, intelligent, witty and often wrong questions are put to them. At times, the questions are downright confusing. The utility of such tests as a correct method to spot talent in children can be disputed. The educational psychologists have yet to confirm that witty and confusing questions are the real test to assess a child's intelligence and aptitude. However, since such tests have come to stay, any publication to prepare students, or more appropriately, to warn them about the type of questions they may have to face in such tests is welcome. The publication under review is one such attempt, with success. High-school students preparing themselves for science talent research scheme will find this digest provocative, stimulating and also quite useful. It will make them familiar with the type of the so-called "witty, and intelligent" questions put to them in the science talent tests.

PRECISION, LANGUAGE AND LOGIC *by* F. H. George, *Pergamon Press* (address as above), (1977) Pp. X+216, $ 17.50

THIS book is an exposé of a miscellany of loosely related topics like logic, Boolean algebra, statistics, probability, automata theory, linguistic, philosophy, etc. The author claims that the text will serve "to guide people in the main ingredients of clear thinking and logical discussion." The claim apparently stems from his belief that there is a technique of "clear thinking" which is universally applicable irrespective of the subject matter one is thinking about. The technique of "clear thinking" will apparently arise fully formed like Athena from Zeus' head after one has had a smattering of logic, statistics, philosophy and other topics cursorily dealt with in the book. It seems to me that this is mere illusion. Since the art of "clear thinking" in a topic of one's choice as, for example, quantum mechanics, relativity physics, or molecular biology is not so simple to come by, it is not clear what is the object of lumping so many topics within the confines of a short book of only 216 pages. For it is not possible to do justice to any of them within the space available.

I will illustrate the problem facing the author because of the wide range of topics he tries to essay by confining myself to only one chapter, namely, chapter 9 on Probability & Statistics. In this chapter the main themes dealt with are : (1) frequency definition of probability, (ii) calculus of probability, (iii) inverse probability, (iv) Baye's theorem, (v) desirability matrices, (vi) decision processes, (vii) game theory, (viii) risk analysis, (ix) stochastic processes, (x) sampling theory, (xi) normal distribution, (xii) tests of significance, etc. Since all these topics are dealt with in only 16 pages—pages 90 to 106—the treatment is inevitably sketchy. It is, therefore, intelligible only to one who is already *au fait* with the subject. But to the uninformed reader the text is likely to be of little help in grasping the concepts expounded.

To give a flavour of the author's presentation I will take as an example his treatment of sampling theory in this chapter. I quote below the author's own words on this matter.

"What we can do is *sample* the population and carry out various tests and comparisons on the sample to see what the probability is, for example, of them being representative of the whole population.

"There are various statistical techniques which are mostly based on the so-called Normal Distribution. A very high percentage of variables (e.g., the height and weight of men and women, etc.) are normally distributed. We can then take these samples and test them as being significantly different from each other, highly correlated with each other and many other things besides. This is no textbook on statistics, so we shall merely take the point here that all casually related events are highly correlated but all highly correlated events are not necessarily connected at all, let alone casually connected. Similarly, we can use the test for the 'significance between means' to decide whether the chances are that any two groups (taken at random, say) have significantly different characteristics in certain respects" (p 105).

It is only fair to enquire that if it is not a textbook on statistics, why has it been included in its scope? Perhaps the author thought knowledge of the subject is indispensable for "clear thinking". If so, it was obligatory for him to give a viable account thereof. The author's account quoted above by way of sample is nothing of the sort. It is merely name dropping. In a dozen lines he has dropped three big names of statistical literature—normal distribution, correlation, significance of mean. These terms are intelligible only to one who already knows what they mean.

This is typical of his treatment of other topics. At times it requires of the reader high degree of sophistication and maturity in the subject under discussion while at others he is assumed to be rather naive. It is therefore not clear for what class of readers the book is really intended and how it is to lead him to "clear thinking" in the field of his endeavour.

JAGJIT SINGH

A TEXT BOOK OF BOTANY *by* N. S. Nathawat, P. D. Sharma and K. K. Sahni. *Ramesh Book Depot*, Jaipur, Pp. 679, Rs. 20.00

THE new approach to the study of biology (which includes both botany and zoology) has created the need for new text books. Not only is the approach to the subject different but a large number of topics on physiology, ecology, cytology, heredity, genetics, nutrition, growth, etc., now get much greater importance than taxomony. The book succeeds in meeting these requirements of the new syllabus.

Beginning with an interesting account of the "History of Biology" the book runs through 26 chapters covering the entire syllabus of botany. Though meant primarily for three universities of Rajasthan, this book would certainly be found useful by B.Sc. and Higher Secondary students all over India. The way of presentation is quite academic in addition to being thought provoking; beginning with basic definitions the various theories, rguments, etc., have been presented step by step. This makes it most comprehensible and precise. Above all, this approach enables the student of the subject to appreciate the complex way in which knowledge in the field has grown. To help the students prepare for examinations, a list of questions is given at the end of each chapter—both essay-type as well as objective type.

Before ending, one may congratulate the publisher on the production of the book. Scientific names, diagrammes, charts, etc., have been printed with great accuracy.

RATNABALI MITRA

CRYPTOGRAPHY (*Continued from page 298*)

Before concluding an interesting story about cryptography is recounted. The story has it that the British General, Sir Charles Napier, after having annexed Sindh sent to England a secret message PECCAVI. The message in Latin means 'I have sinned'. The veracity of this story was contended in a leading English daily from Calcutta in an editorial some years ago.

Further reading

1. Laffin, J., *Codes and Ciphers* Abelard Schumann (1964).
2. Galnes, H. F., *Cryptanalysis*, Dover (1956).
3. Kahn, D., Modern cryptology, *Scientific American*, July 1966.

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