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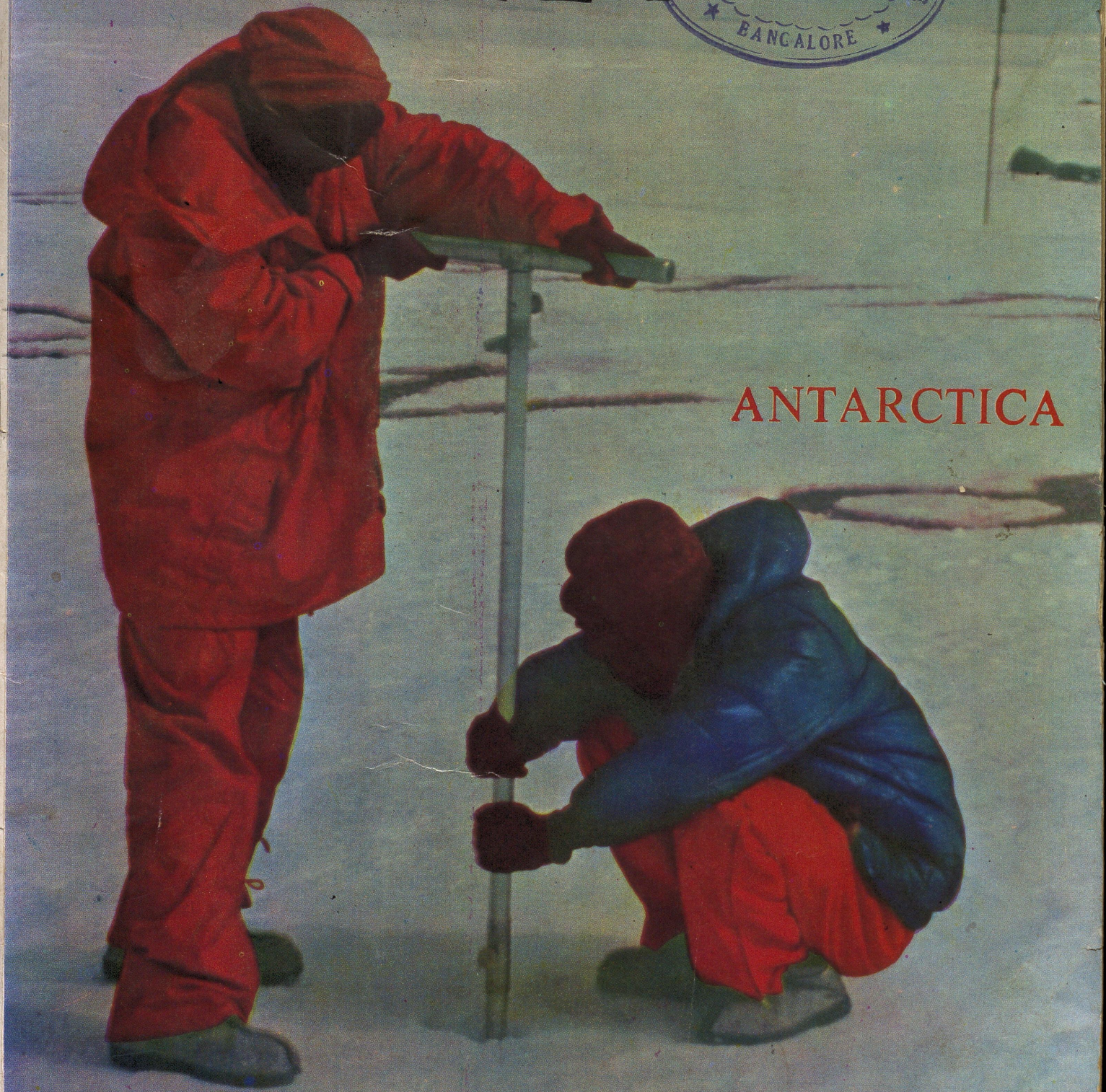

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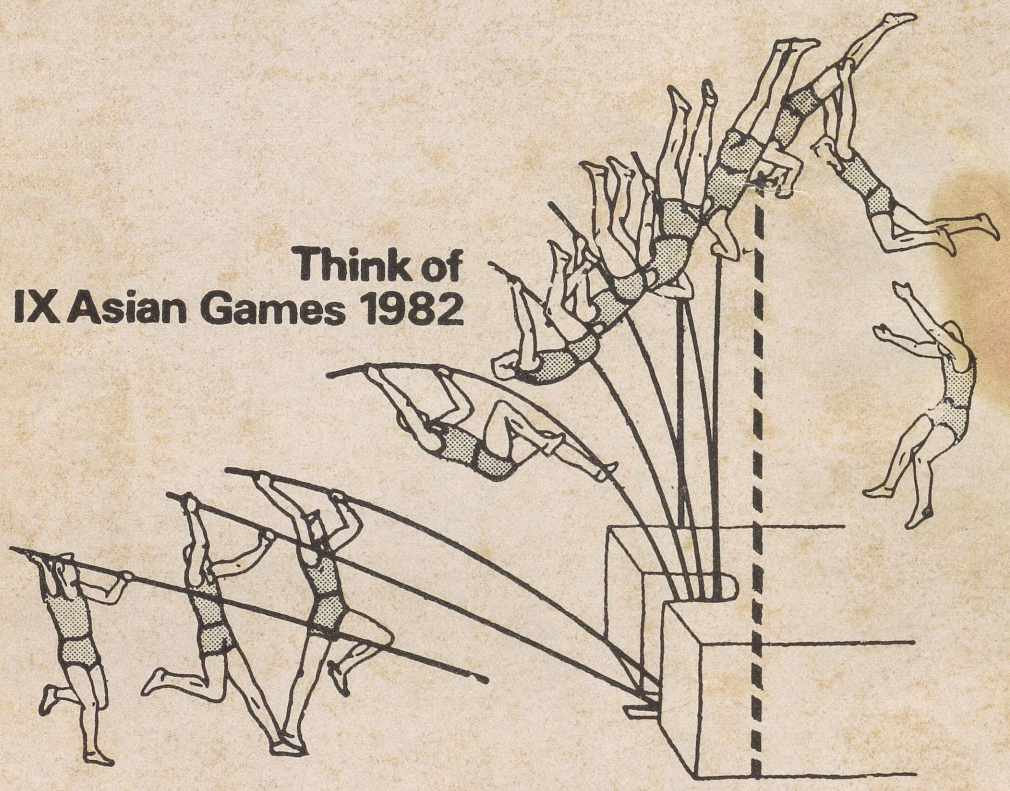

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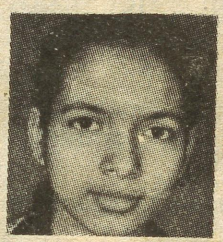

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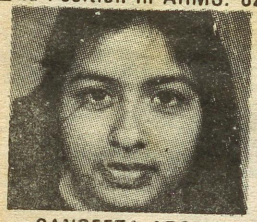

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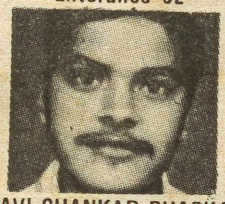

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COVER : Indian scientists setting up an experiment on the icy continent. (This transparency and photographs in the text. *Courtesy* : Dr. S.Z. Qasim)

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LETTERS

The pill

Sir, **The Pill** by S.P. Agarwal (*S.R.*, April 1982) was informative. Though progestogen has proved its effieacy, it is not routinely prescribed because of its toxicity. Rather high doses of oestrogen, e.g., diethyl stilbestrol (20 mg twice daily, for 3-5 days) are used as a post-coital pill, though such a high dose of oestrogen can also produce severe side effects and intolerance in some patients. Recently, the Central Drug Research Institute, Lucknow has introduced a new post-coital oral contraceptive 'CENTCHROMAN' (60 mg) which is now on clinical trials by the Indian Council of Medical Research.

AJOY KUMAR CHAKRABORTY
N.R.S. Medical College
Calcutta-700014

Musk deer and musk

Sir, I have read with interest **Musk deer and musk** by A.K. Mukherjee and A.K. Mandal (*S.R.*, March 1982). I would like to add :

(1) Musk is not used only in perfumery but has been described in the *British Pharmacopoeia* as a powerful 'stimulant' of medulla and hence is used in the treatment of hysteria. In India alone, some 148 Ayurvedic and 55 Unani preparations contain musk ingredients variously as cardiac, circulatory, respiratory and sexual stimulants. It is used as a sedative to cure asthma, epilepsy, and other nervous disorders. Another application of musk is in the treatment of bronchitis, pneumonia, impotency, typhus and typhoid.

(2) In the description of distribution, the authors have given some references. They should have been cited at the end of the article. The reference cited as Ellermen (1966) should have been as Ellerman and Morrison-Scott.

(3) In describing predators, the authors have given all the common predators of different groups as leopards only, which is an error.

(4) About the quantity of musk (40g-60g) secreted, the authors have indexed the age factor but have not indicated the most important age of the buck for maximum musk. The maximum yield of 60 grams of musk is obtained from a ten year old buck.

The exorbitant price and present world demand for musk (about 200 kg) used in medicines and cosmetics has now extended the range of massacre of Himalayan musk deer from 20,000 to 30,000 per year. As a matter of fact, conservation of this vanishing species of deer in the Himalayan habitat on purely ecological ground should gain momentum.

B.D. SHARMA
Secretary
Mountain Ecoconservation and
Wildlife Society of India
Jammu-180001
(J & K)

Overcrowding in space

Sir, The article **INSAT in orbit** (*S.R.*, May 1982) provides several interesting features of Indian National Satellite-1A. I would like to state certain facts which are generally ignored, but fortunately are now receiving attention.

The first satellite to be hurled in geostationary orbit was 40 kg Syncom-1 on February 14, 1963. There are now about 125 satellites in this orbit. Since two geosynchronous satellites should not come too close to one another because of interference from each others communication signals, we are now confronted, though it may sound odd, with the peculiar problem of paucity of space in space. This congestion problem has been dealt in several research papers.

It is being increasingly felt that privileged countries are rapidly gobbling up the limited parking area and developing countries not possessing satellite communication technology, being laggards, are at a distinct disadvantage vis-a-vis the developed countries.

The near earth space too is becoming overpopulated, being littered with a lot of satellite debris of no apparent utility. The disposal/retrieval of this space junk is causing considerable consternation to concerned authorities.

S.K. GURTU
Defence Science Centre
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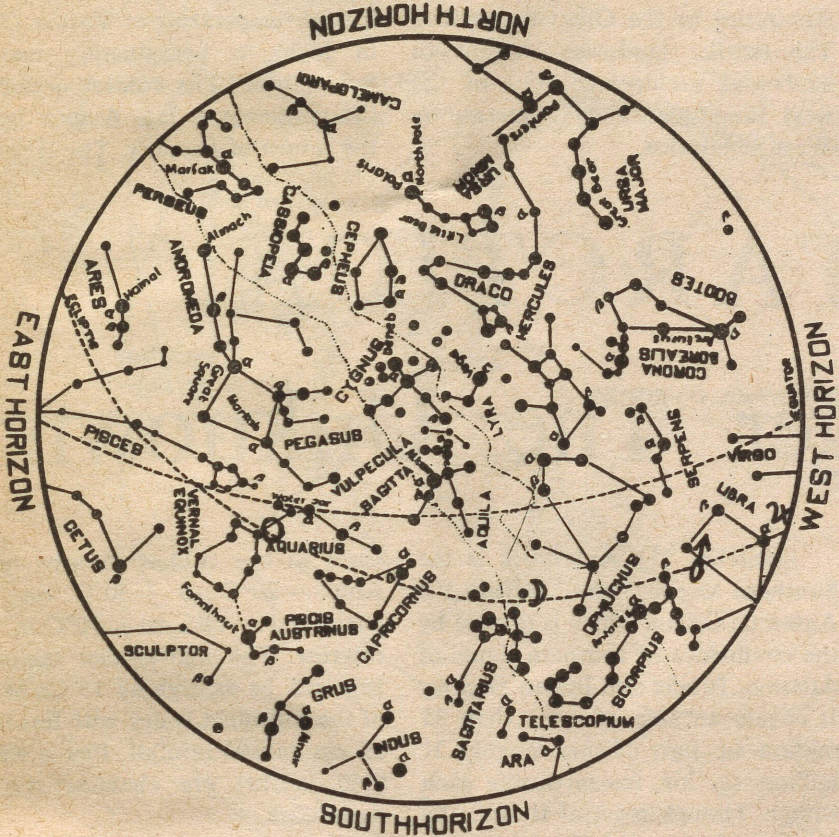
STARS AND PLANETS

SEPTEMBER 1982



Planetary positions for September 1982

Date	*1ST*		*10TH*		*20TH*	
Planets	*RA*	*DECL*	*RA*	*DECL*	*RA*	*DECL*
Mercury	12h 15m	3.4°S	12h 45m	8.1°S	12h 58m	10.5°S
Venus	9h 37m	15.3°N	10h 20m	11.7°N	11h 07m	7.2°N
Mars	14h 58m	18.1°S	15h 22m	19.8°S	15h 50m	21.4°S
Jupiter	14h 17m	12.6°S	14h 22m	13.2°S	14h 29m	13.8°S
Saturn	13h 16m	5.6°S	13h 20m	5.9°S	13h 24m	6.4°S

Adopted from figures supplied by Positional Astronomy Centre, Calcutta.

The moon

FULL moon occurs on 3rd at 5.58 p.m. and the new moon on 17th at 5.39 p.m. I.S.T. The moon passes about three degrees north of Venus on 16th, ten degrees north of Mercury and about three degrees north of Saturn on 19th, four degrees north of Jupiter on 21st and about five degrees north of Mars in the night of 22nd. The lunar crescent becomes first visible after the new moon day in the evening of 18th.

The moon is at perigee or nearest to the earth on 13th and at apogee or farthest from it on 26th.

The sun is at the autumnal equinox on 23rd.

The planets

Mercury (*Budha*), visible in the evening sky, sets about an hour after sunset during the first three quarters of the month. Thereafter, it is too near the sun to be visible. It is at the greatest eastern elongation of about 270 from the sun on 6th. It becomes retrograde on 19th. It is in Virgo (*Kanya*). Its visual magnitude varies from +0.4 to +1.0.

Venus (*Sukra*), a morning star rises, about an hour before sunrise during the first half of the month and about half an hour before it during the second half. It passes close to the star Regulus (*Magha*) on 7th. It moves from Cancer (*Karkata*) to Virgo (*Kanya*) through Leo (*Simha*). Its visual magnitude is about —3.4.

Mars (*Mangala*), visible in the evening sky, sets about three hours before local midnight during the month. It moves from Libra (*Tula*) to Scorpio (*Vrischika*). Its visual magnitude is about +1.0.

Jupiter (*Brihaspati*), visible in the evening sky, sets about three hours after sunset during the first half of the month and about two hours after it during the second half. It is in Libra (*Tula*). Its visual magnitude is about —1.3.

Saturn (*Sani*), visible in the evening sky above the western horizon, sets about two hours after sunset during the first half of the month and about an hour after it during the second half. It is in Virgo (*Kanya*). Its visual magnitude is about +1.0.

(*Source:* Director, Positional Astronomy Centre, P-546, Block N, New Alipore, Calcutta-700053)

K. SATYANARAYANA

Antarctica—the remotest, coldest, and unspoilt continent endowed with minerals, oils and food resources—is Nature's unique treasure

ANTARCTICA: No Longer The Unknown

ANTARCTICA, 'once isolated by time, distance and ignorance', no longer remains the unknown continent. Thousands have set foot on this icy continent ever since its discovery one and half centuries ago. The news of Capt. Scott's death, 70 years ago in the frozen wastelands took months to reach England, his homeland. Today telex messages from Antarctica take only seconds to reach any part of the world via satellite. Antarctica is no more an isolated continent.

Antarctic—opposite of Arctic—is a near circular landmass but for its northern bulge, the Antarctic Peninsula, which extends towards the southern tip of South America more than 1000 km away. It lies almost centrally about the South Pole (Fig. 1) within the 60° parallel south of the Equator. Of the 14,200,000 sq. km landmass, only less than 5% is visible while the rest is covered by vast expanse of ice more than 2000m thick and equals to 90% of world's ice reserves.

Antarctica resembles an oceanic island. It has been isolated geographically and climatically from other continents for at least 20 million years. Seismic soundings indicate 8 million sq. km of mountainous continent below the ice. The landmass is divided into 2 unequal parts by the Trans Antarctic Mountains. The larger, mainly ice covered high plateau, lies mostly in the east longitudes and is called the East Antarctica or the Great Antarctica. The smaller landmass, largely an ice-bound archipelago, lies in the west longitudes and is known as West Antarctica.

Encircling the Antarctica is the Southern Ocean, also called the Antarctic Ocean, which is formed by the confluence of southern limits of Atlantic, Pacific and Indian Oceans. It covers an area of more than 35 million sq. km; of this roughly 21 million sq. km freeze during each winter. Though most of it melts by the end of each summer, nearly one fifth remains frozen. Such large ice cover transfers heat and moisture to atmosphere and affects winds, precipitation and climatic regimes. It is difficult to define the boundary of the Southern Ocean. The one arbitrarily established corresponds to the position of Antarctic Convergence, situated between 50° S and 60° S latitudes, where the warm water flowing south meets the cold mass of northward flowing Antarctic water.

Antarctica, which lies mostly in the polar circle, receives long hours of daylight during summers and very little in winter. Its high mean elevation (2000 m) makes it the highest continent with lowest surface temperature. The temperature goes as low as —88.3°C which is the world's lowest temperature at Vostok (3,420 m high), a permanently manned Soviet base. The coldest period on the continent is late August before the return of summer. The temperatures in the coldest months range from —20°C to —30°C on the coast and —40°C to —70°C in the interior. The midsummer temperature can be as high as 15°C. Much of the continent is dry with less than 15 cm annual rainfall. Fierce winds (250 km/hr) are characteristic of Antarctica.

It is estimated that if the entire ice cover of Antarctica melts, the sea level would rise by nearly 60 m-90 m with devastating consequences. However, recent studies have shown that its great ice mass contributes little, if any, water to the oceans at present. It appears to be in near equilibrium, neither losing nor gaining significantly. The Antarctic ice sheet contains the chronological history of the earth's atmosphere. It is possible to reconstruct variations in past climate, global volcanic activity and atmospheric pollution by analysing ice cores obtained by deep drilling.

Sh. Satyanarayana is Editor, Indian Journal of Marine Sciences, Publications & Information Directorate, Hillside Road, New Delhi-110 012

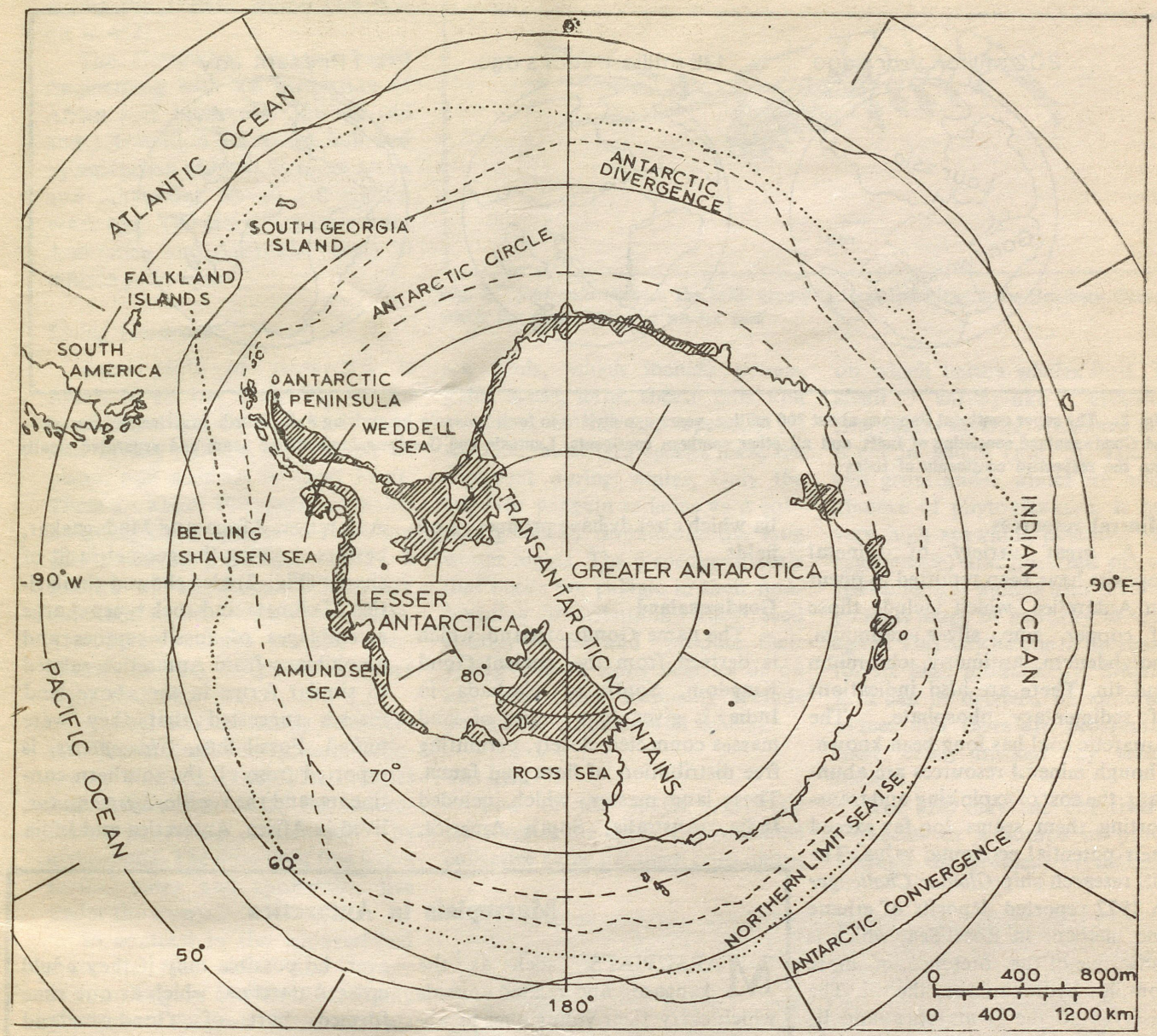


Fig. 1. Antarctica lies centrally about South Pole within 60° South Latitude

Dating with radioactive isotopes suggests that the ice caps of the present day Antarctica may have been formed about 8 million years ago and reached the great heights around 5 million years ago. Preponderance of heavy isotope of oxygen (^{18}O) in relation ^{16}O in summer ice (i.e., $^{18}O/^{16}O$ is more in summer ice than in winter ice) provides information on world climate in the past.

Another interesting feature of Antarctica is its massive slabs of ice, the icebergs, which constitute a major hazard to navigation in the Southern Ocean. They break up and drift away from ice shelves mainly in Weddell and Ross seas. The icebergs may rise 60 m above sea surface and measure upto 60 km in length.

The Antarctica ice has embedded in it specimens of meteorites. More than 1200 specimens have been discovered so far. Because of little weathering, the meteorites can throw light on the early history of solar system. Evidence of the existence of amino acids, the basic building blocks of proteins, associated with the meteorites coming from space has also been noted in samples from Antarctica. Meteorite study also helps in determining the age of the icy continent.

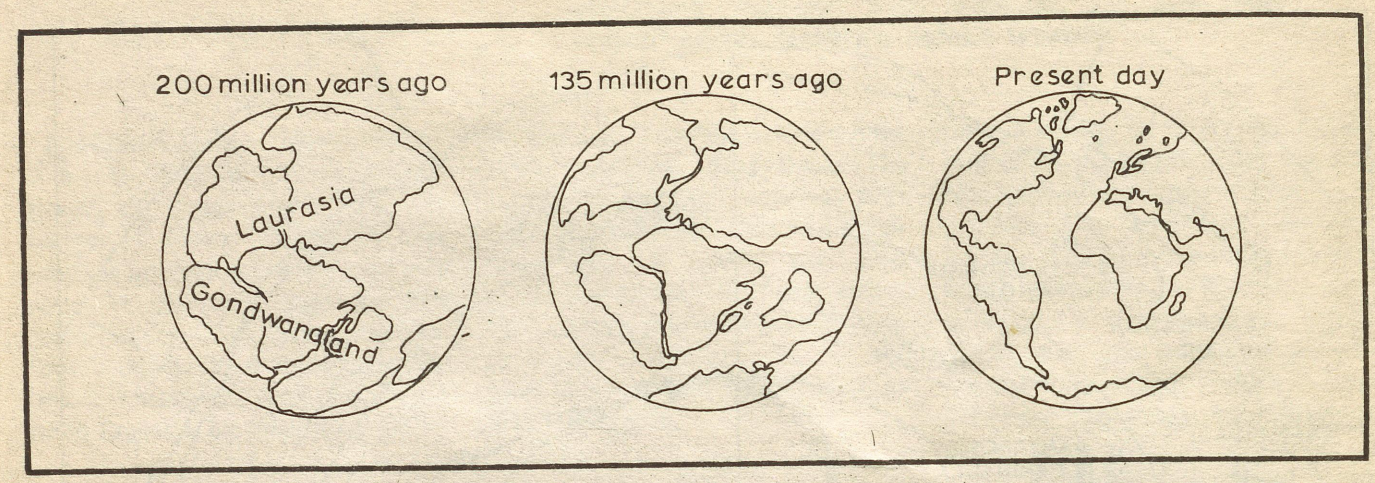


Fig. 2. The super continent Pangaea about 200 million years ago divided to form Laurasia comprising Asia, North America and Europe—, and Gondwanaland consisting of India and all other southern continents. Laurasia and Gondwanaland drifted apart and separated finally into the respective continents of today

Mineral resources

A great variety of mineral deposits have been reported to occur on Antarctica, which include those of copper, zinc, silver, cadmium, molybdenum, antimony, chromium and tin. There are also indications of sedimentary phosphate. The Antarctic coal has long been known. Though mineral resources are abundant, the cost of exploiting and transporting them seems too far exceed their potential economic value. The US research ship *Glomar Challenger* in 1972 reported deposits of ethane and methane in Ross Sea, which is indicative of the presence of more complex hydrocarbons, like oil. The reserves on the Antarctica and its continental shelf is estimated at nearly 15 billion barrels of oil and 2 trillion cubic metres of gas.

The origin of mineral deposits on Antarctica possibly lies in the close similarities between the geological areas of Antarctica and those of South America, South Africa, Australia and India which at one time formed a single land mass called Gondwanaland. Similarly oil deposits in the continental shelf of Antarctica can be inferred from similar continental shelves of Argentina, New Zealand and Australia which already have productive oil fields.

Gondwanaland

The name Gondwanaland, which is derived from the ancient Gond Kingdom, South of Narbada in India, is given to a series of land masses connected closely, permitting free distribution of flora and fauna. These land masses, which included India, Australia, South America, Antarctica, Africa and Madagaskar, besides showing the geometric fit of shapes (Fig. 2) also showed similarities of climate and rock types. Large assemblages of fossil reptiles and amphibians from Antarctica related to similar forms in the above land masses suggested that they were united. Fossil fern, *Glossopteris,* is reported from all the southern continents, and the reptile, *Lystrosaurus,* lived in Africa, Antarctica and India

Marsupials in Antarctica

MARSUPIALS, such as the kangaroo and related animals which carry their young ones in abdominal pouches, were once widely distributed in North and South America. But, today these marsupials are confined to Australia and South America and very few are found in North America. It is not known when and how these marsupials reached Australia.

Some palaeontologists believe that the kangaroo and other marsupials which orginated in North America must have travelled down through South America to reach Australia. This type of migration would, however, be possible only if they could cross Antarctica, which at one time formed part of Gondwanaland along with Australia and South America.

Recently a team of American scientists have found a fossil measuring 22.5 cm of an extinct marsupial, a distant kin of present day kangaroo, called *Polydolops* on Seymour Island, near the northern tip of Antarctic Peninsula. This discovery provides the first direct evidence to show that marsupials might have migrated from South America to Australia via Antarctica before they separated.

during the Triassic period (see box on p. 452).

The Gondwana complex began fragmenting with the separation of Africa and Antarctica between 140 and 130 million years ago followed by separation of India from Australia and Antarctica about 110 million years ago. The last to separate were Antarctica and Australia nearly 50 million years ago.

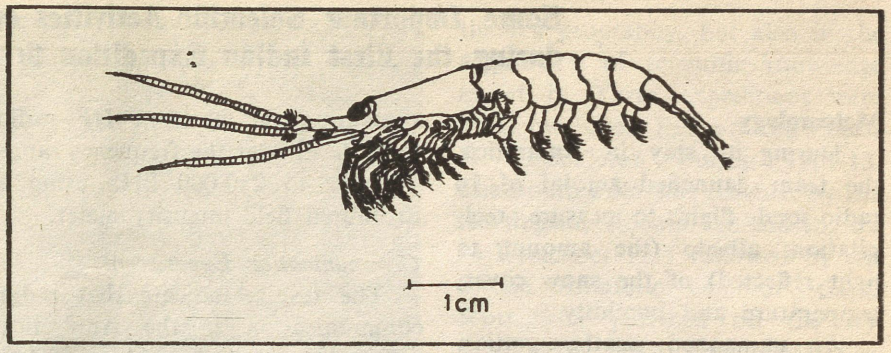


Fig. 3. *Euphausia superba,* **the krill, occurs in large quantities in the Southern Ocean on which the giant Antarctic whales feed**

Living resources

Land biota of Antarctica is restricted to less than 4% of the landmass. High winds, extreme cold and aridity inhibit the growth of plants and animals in most areas. There are about 800 species of plants including the 2 species of flowering plants—one a grass and another a relative of carnation. Lichens are dominant with more than 350 species. The others include mosses, liverworts, moulds, fungi, fresh water algae and bacteria.

Animal life is mostly invertebtes. The microfauna includes heliozoans, rotifers, nematodes, ciliates and protozoans, while the macrofauna is mostly dominated by arthropods. The dominant free living forms, mites and springtails, live under the stones.

In contrast to the impoverished Antarctic land mass the waters surrounding the continent are highly productive. They are rich in nutrients and oxygen and support vast phytoplankton (microscopic surface floating plants) which, in turn, support zooplankton (small crustaceans, fish larvae and others). The zooplankton forms the food of fish, squid, birds, seals and whales. The animals of the sea bottom of near shore zone include sessile hydrozoans, corals, sponges, bryozoa, etc. More than 100 species of fish occur in these waters. Absence of land predators and rich offshore food simply make the Antarctic coast a paradise for sea birds, which include petrels, gulls, skuas, terns, sheath bills, and penguins. As they are dependent on sea food, most bird species leave the continent during winter. Only the emperor penguin remains as a solitary guardian throughout the long winter nights. The 6 species of seals that occur are palagic in their non-breeding distribution. They feed entirely at sea and produce their young ones on stony beaches or on ice. The other mammals include porpoises, dolphins and whales.

The krill

One of the major Antarctic treasures is the krill—a Norwegian collective name for small crustaceans on which baleen whales feed. This small shrimp-like crustacean (*Euphausia superba*) measures 2.5 to 6 cm in length (Fig. 3). The krill can grow under winter ice and in absence of phytoplankton. It has a very high spawning potential (2000 eggs/female) and does not die after spawning but moults and reverts to younger stage of maturity to spawn again. This may be one of the reasons for its high productivity. Shoals of krill can be detected by sonic techniques and there are prospects of their being tracked by satellite sensors.

The krill may one day rival the soyabean as a source of protein. Though the problem of making it



Fig. 4. The Norwegian ship *Polar Circle* **which took the Indian expedition to Antarctica**

Some Important Scientific Activities carried out during the First Indian Expedition to Antarctica

Meteorology

During its stay in Antarctica, the team launched a total of 14 radio-sonde flights to measure precipitation, albedo (the amount to light reflected) of the snow cover, temperature and humidity.

An unmanned weather station was set up in Antarctica to measure wind speed, wind direction, air temperature, humidity and casing temperature. A snow-cum-rain gauge for measuring snowfall has also been left behind.

Radiowave propagation studies

Four different areas of work in these studies were covered :

Very Low Frequency (VLF) Propagation Studies

These consisted of measuring phase and amplitude of wireless signals transmitted by two OMEGA navigation transmitters.

High Frequency (HF) Propagation Time Delay

HF standard time signals were measured during the cruise. For this, a synchronised atomic clock was kept running on board the ship.

Measurement of High Frequency (HF) Radio Noise Level

This experiment was made for measuring the ambient HF radio noise level over the frequency range 10 kHz to 230,000 kHz using a calibrated field intensity meter.

Communication Experiment

The results indicate that radio communication in the Antarctica suffers from several problems. There are radio black-outs caused by the polar cap which lasts from a few hours to a few days.

Magnetic measurements

The magnetic studies during the expedition can be sub-divided into two parts : (i) Magnetic studies in ocean; and (ii) Magnetic studies on the Antarctic continent. Magnetic studies in the ocean were carried out using a marine proton magnetometer with the towed sensor. In total, 20,000 line kilometres of magnetic data were collected from the sea. In magnetic studies on land, a proton magnetometer was used for recording the total field continuously.

Aerosol measurements

Samples of aerosol were collected during the cruise by running an indigenously fabricated sampler. The observations will give an insight into pollution levels on the oceanic areas between Goa and Antarctica.

Oceanic studies

A continuous temperature profile up to a depth of 70 m was taken between Goa and Antarctica. The records will enable study of the energy transfer mechanism.

Distribution of chlorophyll-bearing plankton and zooplankton was studied to assess primary productivity of Antarctic waters.

Several hundred water samples were collected for carrying out chemical analysis for dissolved oxygen, phosphorus, nitrogen and silicate silicon. Nearly 500 samples of sea-water were collected for analysis of calcium, magnesium, sulphate, fluoride, bromide and iodide.

Samples for the study of physics of the ocean were collected from many stations. Salinity and temperatures at different depths were recorded. The data, when processed, will help in determination of Antarctic convergence and divergence.

Collection of living organisms from Antarctic rocks

Several samples of primitive vegetation such as mosses and lichens from rock crevices were collected. These are now subjected to detailed investigation.

(*Source*: Deptt. of Ocean Devpt., G.O.I.)

acceptable as a product of human consumption is yet to be solved, it can, however, be used as an animal feed. The estimated annual production of the krill is around 200 million tonnes, which is more than 2 times the world fish catch. The total annual krill catch at present is 20,000 tonnes. There is a growing concern in many quarters that excessive exploitation of these crustaceans may cause ecological imbalance because besides whales, many other animals like seals, birds and squids also feed on the krill.

Adaptations

Survival of life-forms on Antarctica depends entirely on their ability to adapt to the severity of climate, cold stress and arid conditions (in areas which are ice-free). Ability to synthesize food through photosynthesis at low light intensities and low rate of respiration makes the plants tide over severe winter. Algae, both in fresh and salt water ponds, can tolerate water temperature as high as 14°C in summer. They can also survive better after freezing than temperate forms. Colourless bacteria, algae and fungi (the latter two in primitive lichen association) are found growing beneath the surface of sandstones. The space between mineral grains of sandstone provides congenial habitat for these organisms. Mosses, lichens and bluegreen algae are also reported



Fig. 5. The expedition camp on the Antarctica

to thrive under white marble chips in Antarctic soil. Lichens are better suited physiologically to Antarctic life than mosses.

Arthropods of Antarctica are primitive or ancient cold tolerant groups which can withstand temperature as low as —50°C. Special body fluids protect marine invertebrates against freezing. Protective mucus excreted by a species of limpet (a kind of snail) prevents the formation of ice crystals over its body. In temperate marine fish, the blood freezes around —0.8°C and sodium chloride seems to be responsible for this freezing point depression. In Antarctic fish, blood freezes between —2°C and—2.5°C. From the Antarctic fish, *Trematomus*, a group of glycoproteins has been isolated from blood which acts as an antifreeze compound. Antifreeze compounds are reported in many other fishes.

In quest of the continent

The earliest approach to Antarctica was possibly made by a New Zealand polynesian war canoe more than 650 years ago. It sailed as far south as the frozen ocean. The Englishman, James Cook (1772-75), went round the continent without actually sighting land. It was Charles Wilkee of U.S. Navy who in 1839 sailed deep into the frozen seas and sighted the coastline. He appears to be the actual discoverer of Antarctica! During the first two decades of 1900, known as the 'Heroic era', great inroads were made not only in the study of the continent's geography, but also in the acquisition of scientific knowledge about it. Three expeditions were made by Robert F. Scott and Ernest H. Shackleton during 1901-13. The South Pole was reached by the Norwegian, Ronald Amundsen, on 14 December 1911 followed by the British Antarctic explorer Capt. Scott who perished on the icy wilderness. Since then Antarctica has been explored thoroughly. Recently India has joined the select band of nations, who have sent scientific teams to study Antarctica; (see also *S.R.*, February 1982).

Braving the icy winds, sub-zero temperatures, magnetic storms and needlesharp snow, the Indian scientific team led by Dr. S.Z. Qasim set foot at a point 70.3° S and 41.7° E on the Antarctica during the early hours of 9 January 1982. Though some Indians had earlier visited the continent, this was the first successful Indian scientific expedition to make it to the icy continent (Fig. 5).

Besides the collection of various types of samples and meteorological data, the Indian team established an unmanned weather station named *Dakshin Gangotri* (Fig. 6). It has an

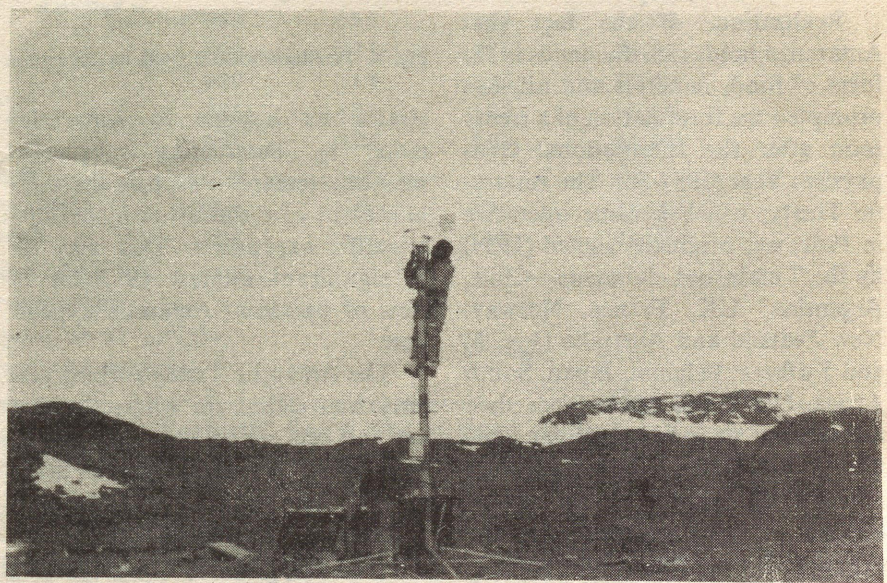


Fig. 6. Indian scientists setting up weather station at *Dakshin Gangotri*

JOHN'S MEDICAL COLL

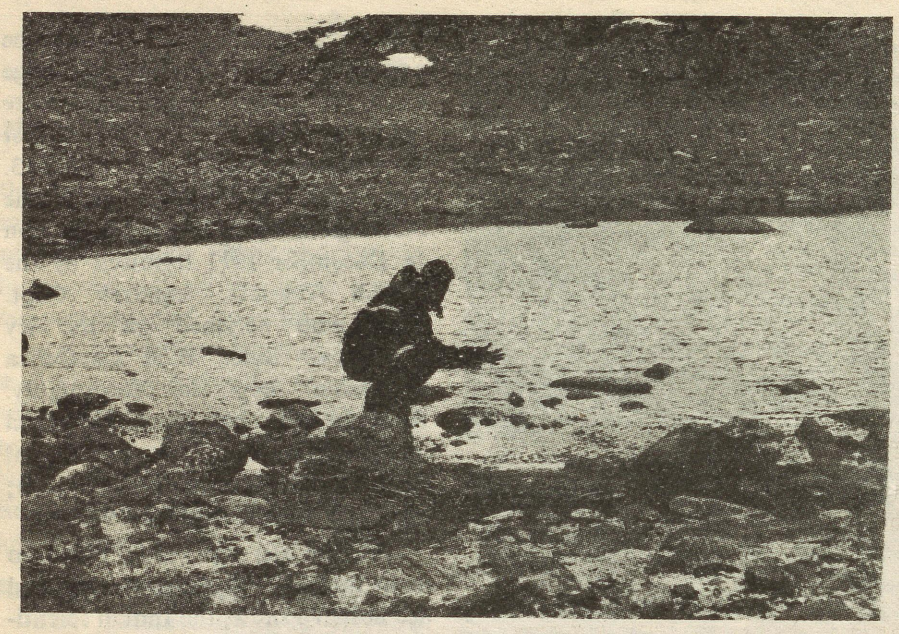


Fig. 7. A fresh water lake in Antarctica

automatic solar powered weather mast and will be operational for nearly a year (See Box, p. 454).

Antarctica is of special significance to India in view of the possible geological similarities and closeness of land masses that existed during the Gondwana Period. Besides, Antractica is also known to influence the monsoons in India.

The Antarctic Treaty

Realization of the fact that Antarctica holds rich dividends in the form of food, minerals and oil, has prompted the formulation of a treaty soon after the International Geophysical Year (1957-58). The Antarctic Treaty, which became operative in 1961, was originally signed (1959) by the 7 mainland claimants—Chile, Argentina, UK, France, Norway, New Zealand and Australia (Fig. 8) and 5 others: Belgium, Japan, South Africa, USSR and USA. Since then a few more nations have joined the treaty. Admission to the important consultative group of the treaty appears to be reserved for the original 12 signatories, and for any later signatory (nation) who demonstrates its interest in Antarctica either by conducting substantial scientific research—such as the establishment of a station or by sending scientific expedition. This may be of significant interest to India in view of its recent Antarctic expedition.

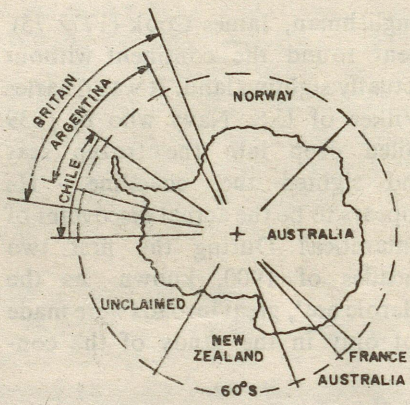


Fig. 8. Territorial claims made on Antarctica

The Antarctic Treaty forbids new territorial claims on Antarctica but has no effect on the previously asserted claims and rights made before the treaty. The treaty endeavours to keep Antarctica demilitarized, nonpolitical and pollution-free. It ensures the conservation of flora and fauna, especially the krill and seals. Recently it has been proposed to have a programme named 'Biological Investigation of Marine, Antarctic Systems and Stocks (BIOMASS), with a view to gaining better understanding of the structure and function of Antarctic marine ecosystem.

Antarctica—the remotest, coldest and unspoilt continent endowed with minerals, oil and food resources—is Nature's unique treasure. Here the environment and population are as yet undisturbed. Because of its unsploit nature it offers a reference point for the study of the challenging problems concerning marine ecosystems—their ecological processes, energy flow and production rates; weather systems including cyclones (since global climate in general and that of the southern continents in particular is regulated by Antarctica); atmospheric pollution, etc. In view of its geographic and geomagnetic position, it offers an ideal platform to study sun-earth relationship. However, isolated individual efforts may not suffice in this undertaking. Only complementary and cooperative endeavours by all the world's nations may yield fruitful results and keep Antarctica, for years to come, a common heritage of all mankind.

Further reading

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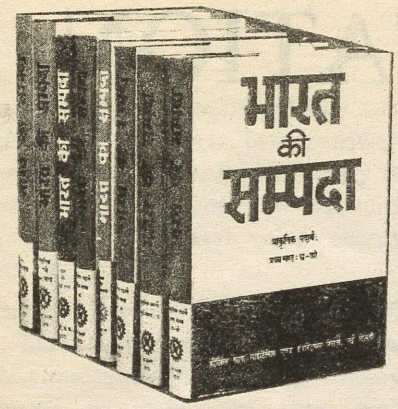

हिन्दी में वैज्ञानिक विश्वकोश

भारत की संपदा

प्राकृतिक पदार्थ

भारत के प्राकृतिक पदार्थों—वनस्पतियों, खनिजों, प्राणियों के बारे में वैज्ञानिक तथ्यों से परिपूर्ण 'वेल्थ ऑफ इण्डिया-रॉ-मैटीरियल्स' का लगभग 5,000 पृष्ठों में परिष्कृत एवं परिवर्धित हिन्दी संस्करण प्रामाणिक जानकारी के लिए हिन्दी आकारादि क्रम में, 10 खण्डों में 'भारत की सम्पदा' नाम से सचित्र वैज्ञानिक विश्वकोश के रूप में प्रकाशित हो रहा है. लगभग 3,000 पृष्ठों में इसके छः खण्ड और दोनों पूरक खण्ड प्रकाशित हो चुके हैं.

लेख किस बारे में हैं

भारत की सम्पदा में विशेषज्ञों द्वारा लिखे गये विनिबंधी (मोनोग्राफिक) लेख ऐसे खनिजों, जीवों और पेड़-पौधों के बारे में हैं जिनसे औषधियां, खाद्य-पदार्थ, फसलें, पेय-पदार्थ, फल, नट और मसाले अथवा वसा, तेल, शाक, सगंध तेल, स्वापक, धूमक तथा चर्वणीय पदार्थ या रंगरोगन, रेशे और लुग्दी, प्रकाष्ठ तथा वन उत्पादों आदि में से कोई पदार्थ प्राप्त होता है.

लेखों में क्या मिलेगा

वनस्पतियों की सही पहचान और उनके वैज्ञानिक नामों के साथ भारतीय भाषाओं के प्रचलित नाम मिलेंगे. अतिरिक्त जानकारी प्राप्त करने के लिये संदर्भ ग्रंथों की सूची मिलेगी. संदर्भों के उचित उल्लेख के साथ अद्यतन आंकड़े मिलेंगे. प्रत्येक खण्ड के अंत में उसमें आये भारतीय भाषाओं के नामों की अनुक्रमणिका (इण्डेक्स) मिलेगी. फसल पौधों के बारे में उनकी खेती, कटाई, भण्डारण, रोग तथा नाशक जीव और उनका नियन्त्रण मिलेगा. प्राकृतिक पदार्थों के उत्पादों के रासायनिक संगठन तथा उपयोग मिलेंगे और महत्वपूर्ण आर्थिक उत्पादों के भारत में प्राप्ति-स्थान, उत्पादन, आयात, तथा निर्यात के आंकड़े मिलेंगे.

प्रकाशित खण्ड	पृष्ठ	शीर्षक	चित्र	मूल्य (रु.)*
प्रथम (अ-ओ)	404	723	150	38.00
द्वितीय (क)	446	650	124	36.00
तृतीय (ख-न)	450	501	166	36.00
चतुर्थ (प)	430	312	115	83.00
पंचम (फ से मेरे)	391	448	103	60.00
षष्ठ (मेल-रू)	400	398	109	80.00
प्रकाशित पूरक खण्ड				
पशुधन और कुक्कुट पालन	298	145	125	34.00
मत्स्य और मात्स्यिकी	173	—	107	49.00
सप्तम खण्ड (रे से बं) प्रेस में तथा खण्ड आठ से दस प्रकाशनाधीन				
*संस्थाओं और पुस्तकालयों को 10% छूट; पैकिंग और डाक व्यय 20 रु. अतिरिक्त			योग	416.00

यह ग्रंथमाला वैज्ञानिकों, उद्योगपतियों, विद्यार्थियों, शिक्षण और अनुसंधान संस्थानों, पुस्तकालयों, विकास अधिकारियों तथा जन साधारण के लिये समान रूप से उपयोगी है.

व्यवस्थापक (बिक्री एवं विज्ञापन)

प्रकाशन एवं सूचना निदेशालय (सी. एस. आई. आर.),

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ENERGY PLANTATION For Power Generation

Small plantations of fuelwood tree alongside power generating units can reduce transportation costs of fuel and transmission losses of electricity—a chronic problem in large thermal stations

K. GURUMURTI D.P. RATURI

THE vulnerability of our green revolution to energy shortages has been severely exposed by the widespread drought coupled with inadequate supply of diesel and electricity in the country in the past years. It is, therefore, necessary that innovative research be initiated for development of alternative sources of energy, especially for our villages on a decentralised basis. The most promising solution to energy crisis in our country is the establishment of energy plantations for purpose of power generation by using quick growing fuel wood trees. It is often argued that the major constraint in giving shape to this concept is requirement of large areas of land which is difficult to mobilise in a thickly populated country like India. However, if the contemplated power generation is of the order of a few kilowatts rather than megawatts, the area requirement for energy plantations can be drastically reduced. Further, establishment of small energy plantations with small power generation units on a decentralised basis throughout the country would greatly help in reducing transport costs of fuel and transmission losses of electricity which is a chronic problem in large thermal power generation structures.

Unit power generation structures

For purposes of power generation on a decentralised basis by using energy plantation, it is necessary to estimate the unit group of villages for which one power generation structure would be created. A unit may be assumed to consist of 3,000 families distributed over 10 to 15 villages. The power requirement per family per day for lighting and domestic work is about 2 kilowatt-hrs. The total requirement for lighting domestic work alone would be 6,000 kilowatt-hrs per day. Approximately an additional 14,000 kilowatt-hrs per day would be required for energising waterpumps for agriculture and for small-scale industries situated in this group of villages. Thus, a power generating plant should be capable of generating 20,000 kilowatt-hrs per day for a group of 10 to 15 villages.

How much wood is required

Air-dry wood, having 10 to 15 per cent moisture, has a calorific value of not less than 3,700 k cal per kg. Therefore one tonne of wood has a calorific value of $1 \times 1000 \times 3700 = 37 \times 10^5$ k cal. Wood-fuelled thermal generators have conversion efficiency of 35%. Even assuming it to be 30 per cent efficiency of conversion works out at $0.3 \times 37 \times 10^5 = 11.1 \times 10^5$ k cal per tonne of wood. Now one k cal is equal to 1.163×10^{-3} kilowatt-hrs. Therefore, 11.1×10^5 k cal will be equal to 12.9×10^2 kilowatt-hrs. Assuming the power plant works at 85 per cent overall efficiency, as the transmission losses are expected to be low in a decentralised power generation system, one tonne of wood can be converted into $12.9 \times 0.85 \times 10^2 = 1100$ kilowatt-hrs. Therefore, to generate 20,000 kilowatt-hrs. of electricity per day about 18 tonnes of air-dry wood would be required daily.

Our next question, therefore, is what type of plants are to be grown and how much minimum area is required for cyclic growing and

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harvesting to attain perpetually sustained yield. However, before answering these questions, it is necessary to understand the potential capacity of plants to convert solar energy into dry matter.

Potential power of green land plants

Land plants, through the process of photosynthesis, produce many organic products. The basic unit however is glucose. For simplification, let us consider the formation of one-sixth mole of glucose sub-unit from carbon dioxide (CO_2) and water (H_2O) :

$$CO_2 + H_2O \xrightarrow{\text{Light}} CH_2O + O_2$$

(1/6 Glucose)

The free energy stored in this reaction is about 114 k cal per mole of CO_2 reduced to starch. In this reaction, four electrons from oxygen atoms of two water molecules are transferred to CO_2 resulting in formation of a water molecule, oxygen and carbohydrate. From knowledge of detailed mechanism of light absorption and electron transfer, it is known that each electron must be transferred through a number of intermediate steps, two of which require light energy. Every electron, when transferred through each of the light energy requiring step, takes up one unit of light energy (one photon or one einstein). As mentioned above, four electrons must be transferred through a number of intermediate steps; two of which require light energy for every mole of CO_2 reduced to sugar. Therefore the total energy requirement is: four electrons multiplied by two light energy requirement step per electron which is equal to eight photons or eight einsteins. This total requirement of eight einsteins for each mole of CO_2 reduced to sugar is known as quantum requirement. Green plants use light only in the wavelength of 400 nm to 700 nm (called Photosynthetically Active Radiation-PAR) which constitutes about 43% of the total radiation. The total energy input of light in the wavelength of 400 nm to 700 nm is equivalent to that of monochromatic light of about 575 nm wavelength on the average. One einstein of 575 nm wavelength of light has an energy of 49.74 k cal. Therefore, eight einsteins make a total of $8 \times 49.74 = 398$ k cal, which is the amount of energy required for reducing one mole CO_2 to glucose. Since this process stores 114 k cal in the form of chemical energy, the maximum efficiency of photosynthesis is $114/398 = 0.286$, which is the efficiency of conversion of PAR. The efficiency based on total solar radiation would be 0.286×0.43 (as PAR is 0.43 of total solar radiation) $= 0.123$. Forest plants with well developed leaf canopy have an absorption capacity of 0.80 of PAR. Using this value, the efficiency works out at $0.123 \times 0.80 = 0.0984$. Now, the plants respire during day and night and do not photosynthesise during night. These processes reduce the efficiency by approximately one-third, giving a factor of 0.67. Multiplying 0.0984 by 0.67 and converting it into percentage, overall maximum daily energy efficiency of 6.6 per cent is obtained. Using this value, it is possible to calculate absolute upper limit of stored solar energy to be expected from land plants.

The solar energy incident on earth's furface, averaged over 365 days, is 3300 k cal per m^2 per day at Dehra Dun. It is over 4,000 k cal pef m^2 per day in Rajasthan and southern part of peninsular India. This amount of energy is not uniformly available but varies during the day and with weather, and there may be too much or too little at various times. That is one reason why the actual energy storage under the most optimal conditions will be less than theoretical. Using 3300 k cal per m^2 per day and an efficiency factor of 0.066 (6.6%), we get solar energy storage of 217.8 k cal per m^2 per day. On an average, 1 gm dry matter contains 4.23 k cal of energy. Therefore, 217.8 k cal means 15.5 gm per m^2 per day. This is equivalent to 188 tonnes per hectare per year. Other values of daily solar energy may be converted into expected maximum dry weight stored in tonnes per hectare per year by multiplying them with a factor of 0.057. We have, thus, established the upper (doubtless unobtainable) limit of potential productivity of the area on theoretical constraints.

Actual rate of productivity

In the above estimates, the efficiency factor was worked out at 0.066. However, even under intensively cultivated conditions using sugarcane, which has a high photosynthetic efficiency, the energy conversion rarely exceeds 2.5% to 3%. As a matter of fact, for forest plants it is rarely above 0.5%. As the productivity is directly dependent upon efficiency of plants to convert solar energy into dry matter, the above estimate is modified in the form of following equation:

$$P = I.E. \frac{10^4 \times 365}{4.23 \times 10^6}$$

where,

- P = Productivity in tonnes per hectare per year.
- I = Total solar radiation (insolation) in k cal per m^2 per day.
- E = Ecosystem efficiency.
- 10^4 = Area in square meter per hectare.
- 365 = Number of days in a year.
- 4.23 = Average amount of energy in k cal per gram dry matter.
- 10^6 = Denominator factor for conversion of grams into tonnes.

That is, P = I.E. 0.863.

At Dehra Dun, for example, with daily insolation of 3300 k cal per m^2, forest plants with efficiency of 0.005 can produce 3300 × 0.005 × 0.863 = 14.2 tonnes of dry matter per hectare per year.

Energy plantations and power generation

An energy plantation is one where plant material is grown for its fuel value. For power generation, the plant material is used as such without any further processing. The land used for this purpose is usually a cultivable wasteland that is unavailable for agriculture. It is needless to say that only quick-growing fuel wood trees are suitable for systematic cultivation.

The traditional silvicultural practices for raising plantations are uneconomical as ecosystem efficiency of solar energy conversion by these methods is very low because of large spacing and longer rotations. In energy farming for power generation, it is necessary to select fast-growing plants with very close spacing of less than one meter and short rotations of 3 to 4 years. This concept is based on the principle that yield of dry matter of certain fast growing species of forest plants is independent of spacing.

In such a method, canopy closure occurs rapidly at a very early stage resulting in more dry matter production per unit area then in traditional silvicultural methods of larger spacing.

Choice of species

Choice of species plays a vital role in the success of energy plantations. There are two basic requirements of a species to be used for energy plantations, namely, its suitability to a site and fast growth so that it can be harvested on short rotation of not more than four years, if not earlier. The other requirements of species include its ability for quick germination, ability to propagate from branch cuttings quickly and to resprout vigorously (coppicing power) when the main stem is harvested. A number of these species, data on yield, their ability to propagate from stem cuttings, and reproductive capacity have been recorded in the book, *General Silviculture for India,* (1968) by H.G. Champion and S.K. Seth (Manager of Publications, Govt. of India, New Delhi). But, in no case, have the data been obtained for energy plantations. However, the data can serve as a guide for selecting suitable species.

C.V. Seshadri, G. Venkataramani and V. Vasant of A.M.M. Murugappa Chettiar Research Centre, Madras have shown that *Casuarina equisetifolia* is capable of yielding upto 250 tonnes of dry wood per hectare of four years when 10,000 plants are planted in one hectare. In Dandeli, Karnataka, yields as high as 75 tonnes of stalk per hectare per year (air-dry with 10% moisture) have been obtained with *Sesbania sesban* raised at 30 cm × 30 cm spacing under irrigated conditions. A number of leguminous plants like *Leucaena leucocephala* (Ipil-Ipil), *Sesbania grandiflora* (commonly known as *Basna* in Hindi and *Agathi* in Tamil) are capable of producing very high yields. Eucalyptus trees with modified silvicultural practices are also a good choice for energy plantations because they grow rapidly and resprout vigorously from cut stumps after harvest. The fast growing leguminous plants are ideally suitable as they have the capacity to fix atmospheric nitrogen with the help of their root nodules, thus improving soil fertility.

So, we find that a number of quick growing forest trees are available which can yield from 250 to 300 tonnes of dry wood per hectare in four years.

Design and operation

As already estimated, 18 tonnes of air-dry wood would be required everyday to generate 20,000 kilowatt-hrs of electricity daily for a group of 10 to 15 villages consisting of a total of 3,000 families. The wood requirement for the whole year would be 18 × 365 = 6570 tonnes. The seasonal energy requirement for different activities like irrigation and small-scale industries are different. In hot summer conditions the energy required for pumping water may be high and during rainy seasons it may be low. So depending upon energy requirement it may be necessary to burn more, or less, wood than the average of 18 tonnes per day. As such, a sufficient stock of wood should be available for power generation. Further, plantation operations can only be successfully carried out during certain seasons of the year. Also, after harvest, sufficient amount of time is required to prepare plots for subsequent rotation of planting. It is also necessary to define a minimum area from which required biomass would be produced perpetually for uninterrupted supply for power generation. Taking all these aspects into account, the following design and operation of energy plantation is proposed.

A minimum area of 145 hectares would be necessary. Out of this, 137.5 hectares would be divided into 5 blocks of 27.5 hectares each and the remaining 7.5 hectares would be occupied by a network of roads inside the plantations for mobility of harvesting and transporting equipment. Storage facility for harvested wood would also be constructed within this area. In the first year, during the months from June to September, the first block of 27.5

hectare would be planted with species like *Casuarina* or *Sesbania* or *Eucalyptus* or *Populus* depending upon the region. All these plants are capable of yielding 250 tonnes of dry wood per hectare in four years. Plantings would be done at the rate of 15,000 plants per hectare. Assuming a mortality rate of 33%, 10,000 plants per hectare are expected to survive which would give the required yield.

Likewise, the 2nd, 3rd, 4th and 5th block of 27.5 hectare each would be planted in successive years. When plantings are completed in the 5th block, the first block of 27.5 hectare would be 4 years old and ready for harvest. The wood available in this block would be $250 \times 27.5 = 6875$ tonnes which could be harvested and stored by the end of 5th year. The wood requirement for whole year, as already worked out, is 6570 tonnes. So from the beginning of 6th year electricity generation can start using this wood fuel. After the harvest of the first block, sufficient time would also be available for preparation of this block for the ensuing planting season. By the end of next year the 2nd block would have put in four years of growth, which would be harvested and used for power generation in the subsequent year.

From the time the energy plantation operation begins in the 1st block, there would be a lag period of five years before power generation can actually start. After this, however, the cycle of planting and harvesting would perpetually continue. With such management it is possible to obtain 6875 tonnes of wood every year from a 27.5 hectare plot in a cyclic manner. This management technique also allows sufficient time for harvesting and subsequent preparation of plots for planting without causing any intervening lag. In this method it is also possible to generate necessary electricity during different seasons as per requirement.

The ash from fuel-using facility would be transported back to the plantation and used as a fertilizer. The use of fast growing leguminous plants would further improve nitrogen content of the soil.

At present power generation units are mainly being designed for large power generation structures. The scaled down version of these units with suitable modifications could be easily installed which may use 18 tonnes of wood at 30 per cent efficiency for generation of 20,000 kilowatt-hrs of electricity daily. The recent and most exciting development is the invention of the world's first commercial fluid-bed combustion boiler by Michael Pope, a 55 year-old consulting engineer of New York city. This small experimental power plant is undergoing trials in Riverville, Virginia in the United States of America. According to Amory B. Lovins, a British physicist and energy planner, this fluidized-bed system is capable of burning any material. The scaled-down version of this system can function as a tiny power house. Lovins further suggests that this system could be modified to recover combustion heat with an efficiency of 80 per cent.

Use of fast growing leguminous plants like *Sesbania* in these energy plantations has further advantages. The leaves of these plants have over 25 per cent crude protein. Therefore, proteins from leaves of these energy plantations can be extracted, processed suitably and marketed, preferably in the villages. This would help overcome protein malnutrition in our rural areas.

Technology for processing leaf proteins is already available. In fact, using the processes developed by the U.S. Department of Agriculture, leaf proteins can be freed of the flatulance factors, stachyose and raffinose, making them as good as milk proteins. They need not even be enriched with amino acids.

Technologically these energy plantations use only renewable resources for harnessing energy in usable forms. Apart from mitigating energy crisis, they open up tremendous employment opportunities for the local population. Ecologically and sociologically, energy plantations are much sounder investments. Afforestation and harvest carried out in a systematic manner could lead to long-term benefits by way of soil and moisture conservation. Energy plantations, thus, have a definite edge on energy sources in a decentralized, rural biased economy where capital investment per work place needs to be low and land utilization for traditional skills needs to be high.

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PLASMIDS : The Tiny Bearers Of HEREDITY

D.K. SANDHU

M.K. KALRA

Plasmids, found in bacteria, fungi, plant and animal cells, can integrate themselves with the host chromosomes and play a part in transmission of characters

PLASMIDS are groups of genes physically separated from the chromosome of the host cell and are capable of stable maintenance in this extra-chromosomal state (Fig. 1). Certain plasmid elements are also capable of integrating with the host chromosome as an alternative to their extra-chromosomal state. Plasmids with this dual property have been termed as episomes. Plasmids were first discovered in family Enterobacteriacea (enteric bacteria), but later they were found in many groups of bacteria. Now they are known to exist in fungi, plant and animal cells. Their presence can be demonstrated by genetical and physical techniques.

Naturally occurring plasmids vary in size from 2 to 250 nucleotide base pairs and carry upto 600 genes. Some of the chief characteristics of the plasmids discovered so far are that all have been found to be composed of circular double-stranded DNA and give expression to specific phenotypic characters. If a plasmid controlling a specific phenotypic character is lost, then that character is also lost. Most plasmids mediate their own transfer from cell to cell conjugation, but some of them lack the transfer factor and can only replicate. The presence of a plasmid in a cell usually prevents the replication of a second closely related plasmid. This interference, referred to as superinfection immunity or incompatibility, has proved useful in classifying plasmids as homologous or heterologous. The number of copies of a plasmid in a cell can vary from one to many. According to the functions that they control in the host cell, plasmids are classified into three major groups; the F-factors (sex factors), the R-factors (drug resistant factors), and Col-factors (production of colicins), although plasmids carrying other characters such as breakdown of complex molecules are also known, e.g., in *Pseudomonas*. The plasmids can be irreversibly eliminated by such agents as heat, acridine dyes or ultraviolet irradiation.

F-factors

F-factor is also termed sex factor for the reason that this extra-chromosomal element determines specific cellular traits that render a cell capable of mating with a suitable female recipient (F-) cell. In this mechanism, the plasmid induces synthesis of a specific male pilus, which forms a fragile conjugation bridge with recipient cell, through which passes the genetic material from a male to a female cell (Fig. 2). Most pili fall into one of the two classes, F or I. Each class is morphologically and antigenically distinct and also adsorbs a different set of male-specific phages. The sex factor is able to exist either independently or incorporated in the chromosome of the host cell. In its autonomous state, as in F^+ strains, the F factor mediates its own transfer to recipient cell with high frequency. When integrated with the host chromosome, as in Hfr (high frequency of recombination) strains, it promotes transfer of chromosome with a frequency many times greater than in the independent state. "Integrated" F-factors occasionally recombine out of the chromosome and may incorporate adjacent chromosomal genes into their structure in the process (Fig. 5). These modified or substituted F-factors are called F-prime factors. They are often

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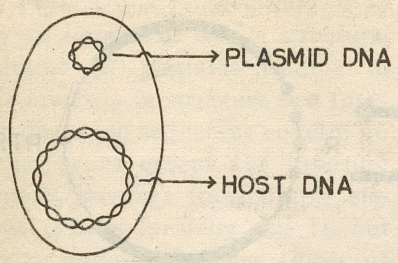

Fig. 1. A bacterial cell showing host DNA and plasmid DNA

defined by chromosomal genes they carry, e.g., F-lac refers to an F-factor carrying the lactose operon.

R-factors

Among the most widespread and well studied groups of plasmids are resistance transfer factors(R-factors), which confer resistance to antibiotics. The cause of drug resistance is the synthesis of enzymes by R-genes which modify the antibiotics so that they cannot act on bacteria producing infection. R-factors were discovered in Japan in 1959 in strains of *Shigella flexneri* which had developed resistance to a number of antibiotics like streptomycin, chloramphenicol, tetracycline, etc. The emergence of bacteria resistant to several antibiotics is of considerable medical significance and was correlated with the increasing use of antibiotics for the treatment of infectious diseases. Soon after the resistant strains were isolated, it was shown that they could transfer resistance to sensitive strains via cell to cell contact. This is probably the reason that the rise of multiple-resistant strains was so rapid; it would be unlikely for resistance to a number of antibiotics to develop simultaneously by mutation and selection. The infectious nature of R-factors permits rapid spread of the characteristic through a population. R-factors with genes for resistance to kanamycin, penicillin, neomycin and gentamycin are also known today.

R-factors may coexist with F-factor in F^+R^+ strains. On the basis of this effect on F-factors, they have been classified into two groups, viz., fi^+ R factors which suppress the expression of F-factors, and fi^-R factors which have no effect on the fertility of F-factors.

The map of R-factor has been shown to have a resistance transfer factor (RTF), segments determining resistance to drugs (R-determinant) and a replication region (Fig. 3). Genes for characteristics not related to antibiotic resistance may also be carried by R-factor. One of these is the production of F I pili. R-factors also carry genes controlling production of repressors that prevent the introduction of other related plasmids.

In *Escherichia coli* the two parts, i.e., RTF and R-genes, are usually found as one unit. However in *Salmonella* and *Proteus* they are often found as separate plasmids (Fig. 4) which can be independently transduced and inactivated by acridine dyes. In extracts such plasmids can be separated on the basis of difference in their density. Though both plasmids in such a complementary pair are complete replicons, R-determinant plasmids are not transferred unless they fuse with RTF. In nature some bacteria carry R-determinants alone and some carry RTF without resistance genes. Indeed the latter factors are widespread in bacteria in nature, but because they do not transfer host genes efficiently they were

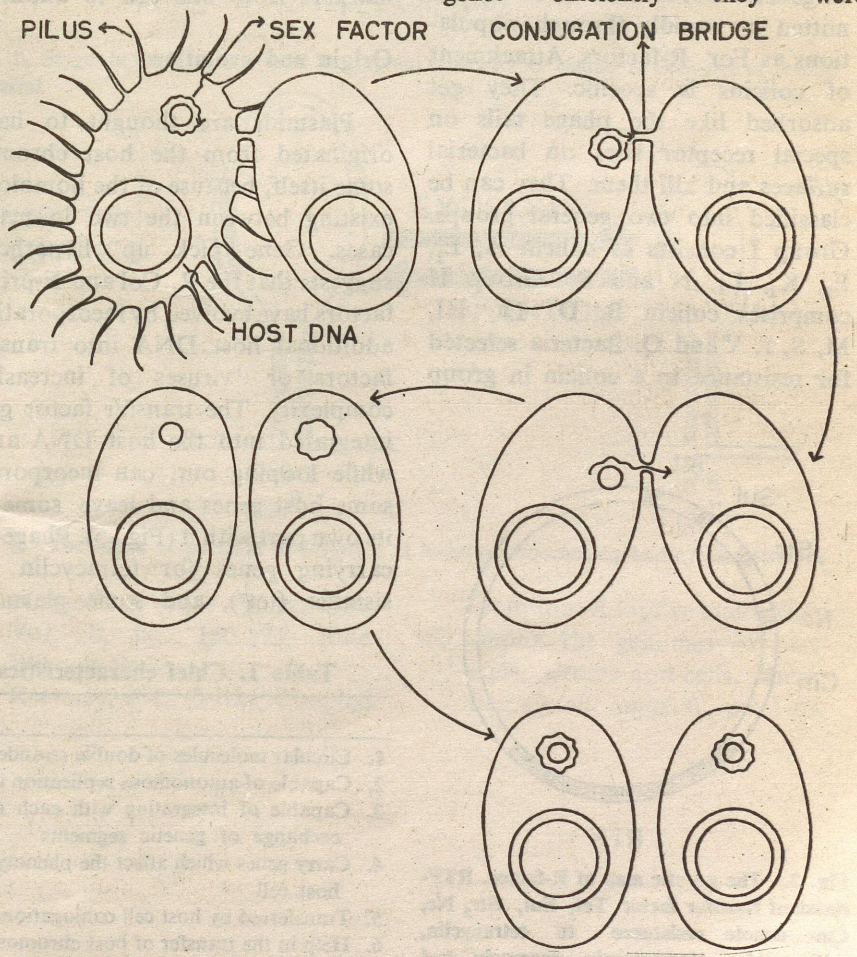

Fig. 2. Bacterial conjugation and stages in the migration of F-factor from donor to the recipient cell

discovered much later than the rarer F-agent.

Col-factors

Most bacteria produce agents that inhibit or kill closely related species. These agents are called bacteriocines to distinguish them from the antibiotics which have a wider spectrum of activity. Bacteriocines are a diverse group of substances, usually proteinaceous in nature and frequently of high molecular weight. The ability to produce bacteriocines is also inherited via plasmids. Bacteriocines produced by *E. coli*, called colicins, have been studied and the elements controlling their production are called Col-factors. In general Col-factors are not transmitted as rapidly through populations as For R-factors. Attachment of colicins is specific. They get adsorbed like the phage tails on special receptor sites on bacterial surfaces and kill them. They can be classified into two general groups. Group I consists of colicin A, E_1, E_2, K_1, L_1, N and S. Group II comprises colicin B, D, La, HI, M, S, I, V and Q. Bacteria selected for resistance to a colicin in group I may or may not be resistant to other colicins in this group, but are never resistant to any colicin classified in general in group II. The reverse is true of group II colicins. Some transmisible Colfactors can also transfer chromosome markers from one cell to another.

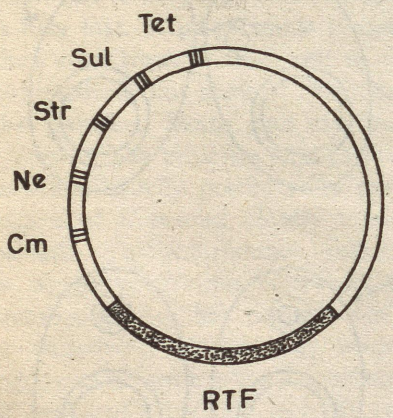

Fig. 3. The genetic map of R-factor. RTF-resistant transfer factor Tet, Sul, Str, Ne, Cm- denote resistance to tetracyclin, sulfonamides, streptomycin, neomycin and kanamycin respectively

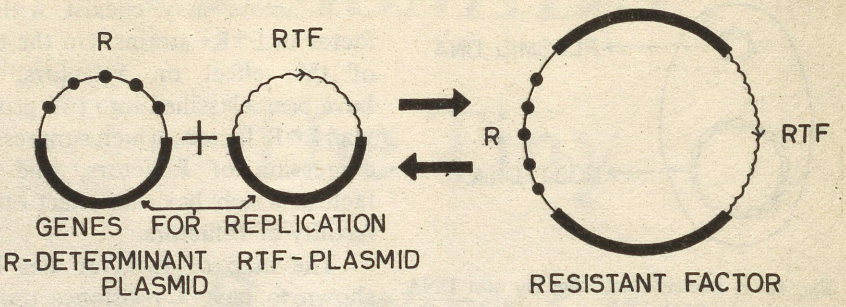

Fig. 4. R-determinant and RTF plasmids can exist separately or integrated and undergo interconversions

Origin and evolution

Plasmids are thought to have originated from the host chromosome itself, because of the homology existing between the two in many cases. 'Gene pick up' hypothesis suggests that the R, Col and F-prime factors have evolved by incorporating additional host DNA into transfer factors or viruses of increasing complexity. The transfer factor gets integrated into the host DNA and, while looping out, can incorporate some host genes and leave some of its own part with it (Fig. 5). Phage-22 carrying genes for tetracyclin resistance (tet^r), and some plasmids performing the function of lactose fermentation are good examples of interaction between the plasmid, viral and host DNA leading to the evolution of plasmids.

The production of some bacteriocines with similarities to phage tails may imply evolution either from phage to bacteriocines or vice versa. A comparison between phages, plasmids and chromosomes shows that if phages were to acquire the property of transfer by conjugation there would be very little difference between phages and plasmids (Table 1). It has been proposed that R plasmid genes resistant to antibiotics originate from the organisms which produce these antibiotics. For example, β-lactamases, produced by R plasmid genes which inactivate the penicillin group of antibiotics, are found in *Penicillium* and *Aspergilus*, the organisms producing these antibiotics.

Recently, transposable genetic elements and insertion sequences

Table 1. Chief characteristics of phages, plasmids and chromosomes

	Phages	*Plasmids*	*Chromosomes*
1. Circular molecules of double stranded DNA	+	+	+
2. Capable of autonomous replication in the host	+	+	+
3. Capable of integrating with each other and exchange of genetic segments	+	+	+
4. Carry genes which affect the phenotype of the host cell	+	+	+
5. Transferred by host cell conjugation	—	+	+
6. Help in the transfer of host chromosome	+	+	—
7. Dispensable to host cells	+	+	—

(IS) of DNA have been shown to play an important role in structural evolution of plasmids leading to their diversity in structure and function. Insertion sequences contain no known genes except the insertion function, whereas transposable elements behave formally like IS but contain additional genes. Both of them can get integrated into several sites in a genome. After insertion, they not only abolish the function of the gene into which they get integrated, but can also affect the functioning of genes distal to the insertion site, e.g., R-6-5 factor is a variant of R-6 with same structure, but R-6-5 does not express (tet^r) like R-6, because it carries an additional segment of DNA. After excision of this segment the same factor behaves (tet^r) like R-6. This shows that R-6-5 carries the tet^r gene but has been inactivated by the insertion of DNA segment. So this IS turns off and on the expression of (tet^r) in R-6-5 plasmid (Fig. 6).

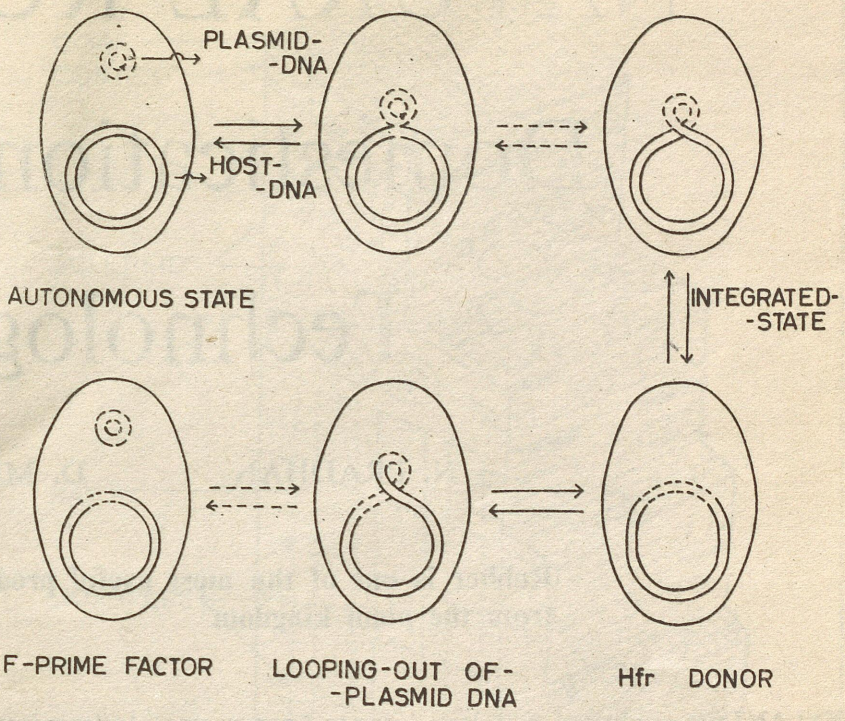

Fig. 5. Stages in the integration and looping out of sex factor leading to exchange of genetic material

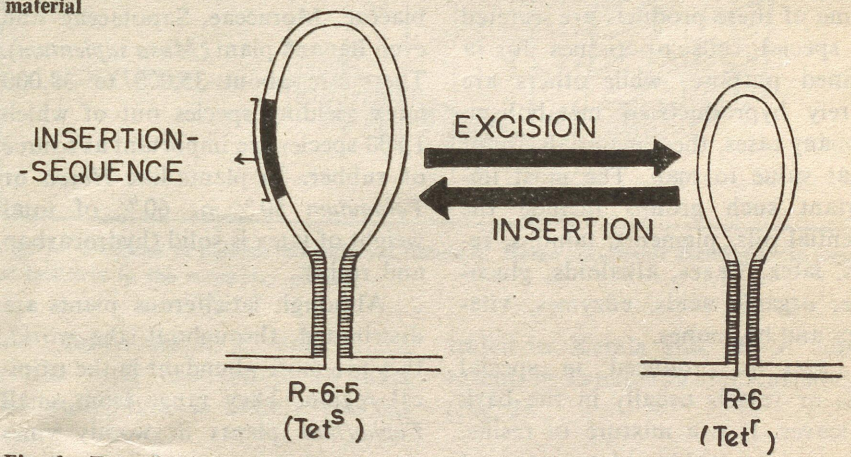

Fig. 6. The effect of excision or insertion of insertion sequence on tetracyclin resistance

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NATURAL RUBBER: Domestication And Technology

N. PRADHAN D. MISHRA

Rubber is one of the most useful products obtained from the plant kingdom

PLANTS produce a large variety of different substances. Some of these products are secreted in special cells or tissues for a defined purpose, while others are merely byproducts of metabolism. In many cases, these materials are of great value to man. The most important such groups include the essential oils, pigments, tannins, resins, latex, waxes, alkaloids, glucoside, organic acids, enzymes, vitamins and hormones.

Latex is produced in special cells or vessels usually in the bark or leaves. It is a mixture of resins, oils, proteins, acids, salts, sugar and caoutchouc hydrocarbon and other substances. In the plant, it is of some value in the healing of wounds and may serve for protection, nutrition, transport of materials or as a fluid reservoir. The latex from the lower part of the trunk is important commercially. The latex of Para rubber tree (*Hevea brasiliensis*) is the source of rubber.

Latex is found in plants belonging to Apocynaceae, Asclepiadaceae, Caricaceae, Compositae, Euphorbiaceae, Moraceae, Sapotaceae and even Banana plant (*Musa sapientum*). There are about 35,000 to 38,000 latex yielding species out of which 1,800 species are important as source of rubber. In plants like *Hevea* or *Palaquium* 50% or 60% of total weight of latex is solid (hydrocarbon and resin).

Although laticiferous plants are distributed throughout the world, they are more abundant in the tropical region. They range from small *Euphorbian* plants to woody vines (in central and west Africa) and the most important *Hevea* on the Amazon basin or the *Dyera* of south-east Asia. Economically important latex producing plants are mostly found in the tropics and very few (e.g., *Parthenium*) are found in temperate climate.

Latex

The colour of latex ranges from milky white (when fresh) to grey, yellow or pink according to season and local conditions. Fresh latex has a sp. gr. of 0.970-0.980 and viscosity at 28°C of 8.0. Viscosity of ammoniated latex is lower. When it flows from the plant it is neutral but soon becomes acidic owing to bacterial action and coagulates.

Composition of latex from young branches and leaves differs from the latex obtained from trunk. The latex from the hard bark is richer in rubber than from soft bark. The rubber and non-rubber contents increase as the age of the tree advances from 4 to 10 years after which no change is noticeable (Table 2). Non-rubber constituents of latex include proteins, resins, sugars, glucosides, tannins, alkaloids and mineral salts. Some of them are adsorbed on the surface of the rubber particles while others are found in the serum. Some of them help in stabilizing the latex and some caure change in colour. The nitrogenous component of latex consists of 3 types of proteins

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i.e., glutelin, globulin and albumin. A few amino acids and amides are also present.

Latex resins are a mixture of fatty acids, fats and phytosterols. Some of these particles are retained in rubber and protect it from atmospheric oxidation.

To avoid coagulation 3 parts of 25% ammonia solution to 100 part of latex is added. Stabilised latex (normal latex) contains 30%-40% solids.

Rubber

Rubber is obtained from latex of various erect or climbing woody plants. Majority of rubber plants belong to the families Moraceae, Euphorbiaceae, Apocynaceae. The name "rubber" was first coined in 1770 by English Chemist, Joseph Priestley owing to the fact that "Caoutchouc" could be used for removing pencil marks by rubbing. The properties which make it so valuable include its plasticity and elasticity, its resistance to abrasion and to electrical currents and the fact that it is impermeable to liquids and gases.

Hevea brasiliensis, belonging to the family Euphorbiaceae is the source of 95%-98% rubber produced throughout the world. A native of the Amazon basin of South America, it has been introduced into India and is cultivated as a plantation crop. The tree is very large growing to a height of 18-30 metres or more and has a girth of 2-3 metres. The smooth and straight stem is normally unbranched upto a considerable height and bears a profusely branched leaf canopy towards apex (Fig. 2).

The quality that gives *Hevea* such importance is its higher hydrocarbon content and lower resin content than other rubber yielding plants (Table 1).

Among the rubber producing countries, India occupies 9th place, and contribution is only 1.2% to the total production. In India the cultivation is mainly concentrated in Kerala and, its to some extent, in Tamilnadu and Karnataka (Fig. 3).

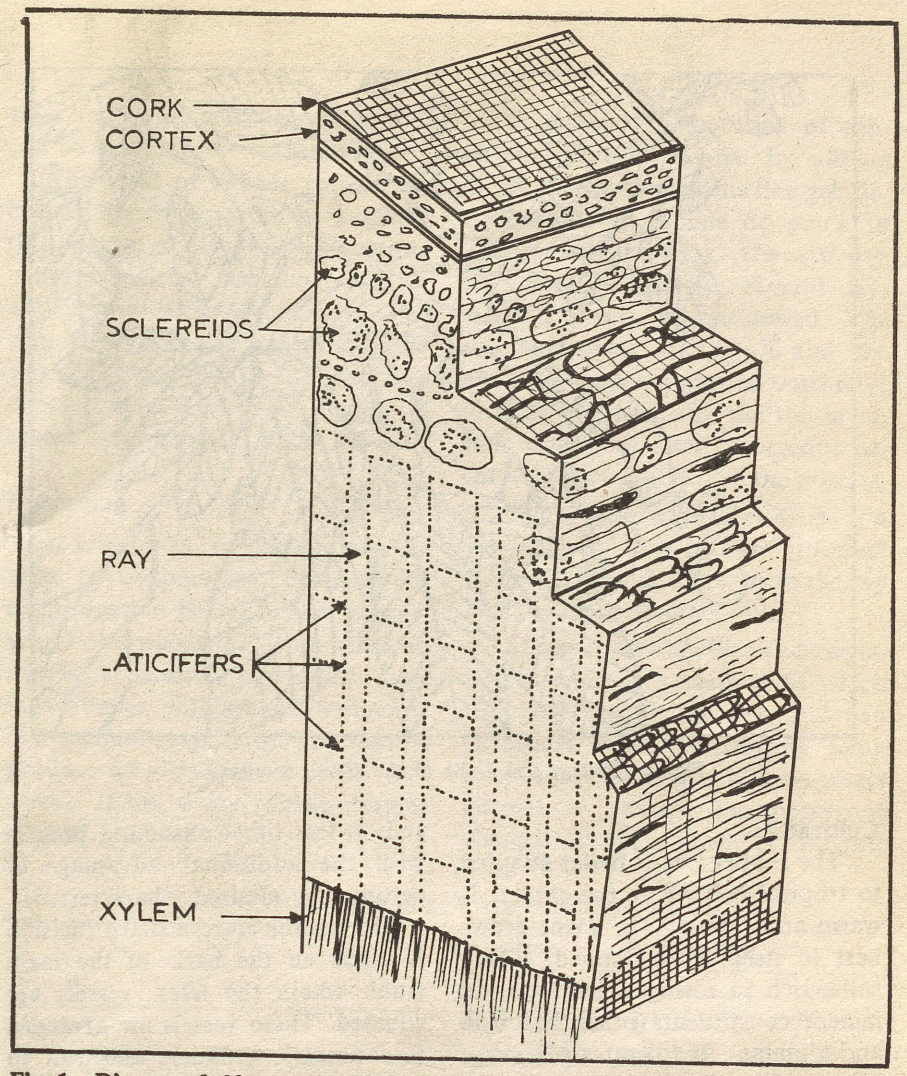

Fig. 1. Diagram of phloem and adjacent tissues of *Hevea brasiliensis* showing arrangement of laticifers in the secondary phloem

Table 1. Rubbers from different plants in percentage

	Rubber hydrocarbon	*Resin*	*Protein*	*Ash*
Hevea brasiliensis	94	3	2	0.2
Castilla elastica	93	6	0.5	0.1
Landolphia thollonil	93	5	1	0.5
L. owariensis	93	6	0.1	1.0
L. kirkii	91	8	0.1	1.0
Taraxacum Kok-saghyz	90	5	2	3.0
Funtumia elastica	88	8	3	0.5
Manihot glaziovili	88	4	6	1.5
Cryptostegia grandiflora	88	9	2	0.3
Ficus elastica	78	20	1	0.5
Parthenium argentatum	72	22	3	2.5

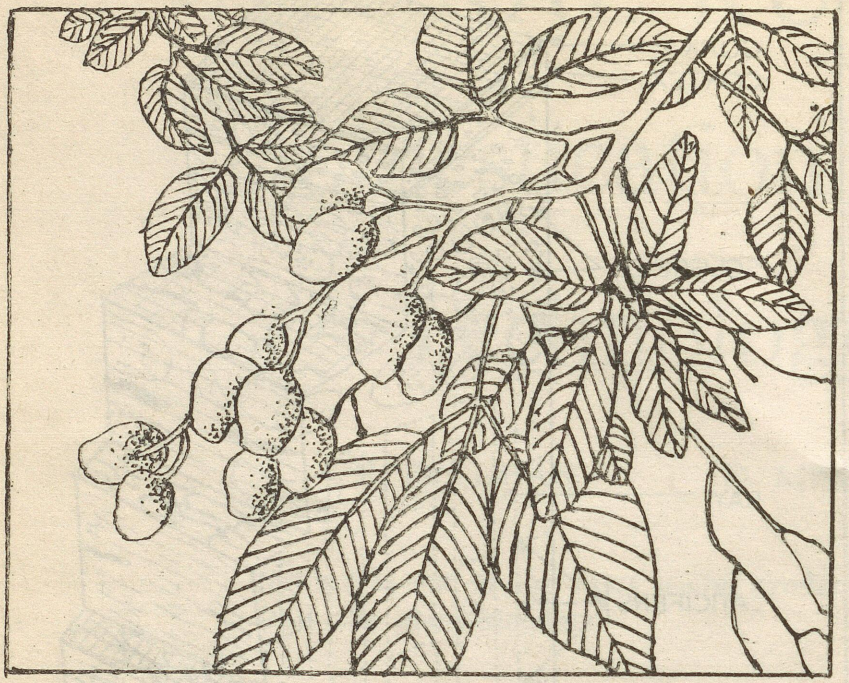

Fig. 2. Foliage and fruits of the *Hevea brasiliensis*

Cultivation

The rubber tree is better adapted to tropical belt where the climate is warm and humid. The plant grows best in deep, well drained, loamy soils, rich in nitrogen but poor in mineral constituents (other than iron and alumina). It tolerates pH range between 3.8 and 8.0.

The plant is propagated by seeds or vegetatively by budding, or more commonly by a combination of both. In order to obtain maximum benefit, vegetative propagation is done by grafting buds from high yielding trees on seedlings. Such bud grafts are called *clones*. High yielding plants may be raised from seeds obtained by artificial or natural crossing between high yielding clones. It is a less time-consuming process with the additional advantage of getting the desired characteristics.

To tap the latex, a sharp incision is made on the bark of the main trunk where the latex vessels are situated. These vessels are arranged in concentric cylinders and run in counter clockwise spirals up the trunk. The first flow of latex is vigorous; it then decreases and ultimately coagulation takes place in the cut end of the bark. After each cut, the tree is given a rest period. Tapping is resumed by removing the coagulated latex (plug) along with a thin strip of bark. During tapping, viscosity of latex decreases gradually until an equilibrium between the amount of latex and its rubber content is reached.

Usually 0.8cm-1.25 cmthick bark is removed at regular intervals. There are several systems for tapping, such as half spiral, full spiral, 'V' cut, herring bone system, etc. (Fig. 6). In the half spiral system, the cut is made at an angle of 30°-35° to the hirozontal from the upper left to lower right halfway around the trunk. A vertical cut is then made towards the lower end and is fitted with a cup at the base (Figs. 4 & 5). The cup is made of tin, aluminium or sometimes enamelled iron.

Full spiral system includes the full circumference at a time. In the 'V' cut system, two oblique cuts are made and the latex is collected by placing a cup at the junction where the two cuts meet. The herring bone system is elaborated by the vertical incision with 4-6 diagonal cuts opening into the vertical cut from either side and extending from 1/4 to 1/2 of the circumference of the tree. The prevalent system in India is the half spiral system. Usually the basal portion of the trunk upto 1.3 meters from the ground is tapped.

The frequency of tapping is expressed as a fraction of the trunk

Table 2. Rubber and non-rubber content in percentage

	4 years old	*10 years old*
Water	70.00	60.00
Rubber hydrocarbon	27.07	35.62
Acetone soluble matter (Latex resin)	1.22	1.65
Protein	1.47	2.03
Ash	0.24	0.70

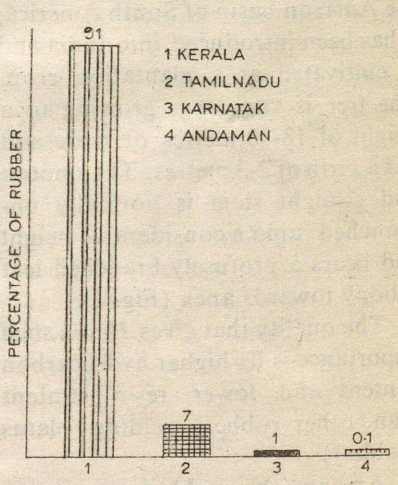

Fig. 3

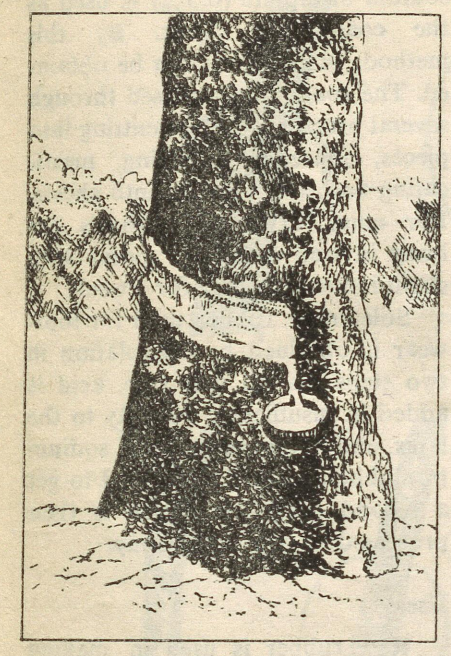

Fig. 4. *Hevea brasiliensis*—**basal portion of tree with tapping panel and latex cup**

circumference. A quarter cut tapped daily is taken as the standard (100%). In South India, for example, the half spiral alternate day tapping is expressed as S/2, d/2, 100%.

The most suitable time of tapping is early morning. The flow stops within 3 hrs of making the incision. Usually the flow is vigorous in early morning and gradually slows down with the rise in temperature. A standard tapper taps 200-300 trees in 3 hrs. After making the incision in the last tree (i.e., 300th tree), collection starts in the pots. To prevent coagulation, a few drops of ammonia solution are added to the collection. A safe margin of 2-2½ mm of bark above the cambium zone is left untapped.

By adopting the half spiral system, one-half of the tree trunk is removed down to the ground level within 60-80 months or 5-6 years. Then the other half of the trunk in the opposite side is taken for tapping which takes 5-6 more years. Tapping is normally started on 7-8 years old trees and under suitable care, a tree can be tapped upto 40-50 years.

The yield of rubber can be increased by treating the bark below the tapping cut with yield-stimulating mixture such as hormones like 2, 4-dichlorophenoxy acetic acid. The response is better in poor to average yielding plants than in high yielding ones. Indolebutyric acid, indole-3-acetic acid help in bark renewal.

Processing

It is essential to concentrate the latex by evaporation, creaming or centrifugation before further processing. For evaporation, latex is heated in a water jacketed horizontal rotating cylinder with air-circulation or in a vacuum evaporator. The viscous product so obtained is called *Revertex*. It has a dry rubber content (D.R.C.) of 68%.

Creaming. This method of concentrating is achieved by adding 0.5% of creaming agents like gelatin, hemicellulose, pectins or gums to the ammoniated latex. After stirring, it is kept as such for several days when 2 layers are separated. The lower layer is drawn off and the above process is repeated until 60% D.R.C. is obtained in the top layer. It is somewhat disadvantageous because of the instability of the process.

Centrifugation. On centrifugation the refined concentrate product (D.R.C. 60%-62 %) floats to the top and the rest separates out.

Modern method. Electrodecantation is a modern method in which the latex is placed between two electrodes with a separating semi-permeable membrane. When a direct current is passed, the negatively charged rubber particles migrate

Table 3. Properties of raw and vulcanised rubber

	Raw rubber	*Vulcanised rubber*	
		(*a*)	(*b*)
Physical			
Tensile strength (kg/sq. cm)	20—40	275—350	275—350
Elongation (%)	800—1200	675—850	550—650
Hardness (Shore Durometer A)	20—30	40—45	62—67
Permanent set (after 200% elongation 24 hr.)	75—125	3—5	8—12
Modulus of elasticity at 300% elongation (kg/sq. cm)	5—10	11—24	50—90
Sp. gr. 20°	0.914	0.96	1—13
Thermal			
Co-efficient of linear expansion (10^{-5}/°C)	15—20	16—19	12—15
Specific heat (Cal./g/°C)	0.55	0.5	0.4
Brittle pt (°C)	—62 to—58	—58 to —53	—58 to —56
Electrical			
Volume resistivity (ohm × cm)	10^{16}	10^{16}	—
Dielectric strength (K.V/mm)	10—20	—	—
Dielectric constant × 10^{-3} (1,000 cycles)	2.5	—	
Power factor × 10^{-3} (1,000 cycle)	2—3	—	—

(a) Not loaded with pigment
(b) Loaded with 25% carbon black + 10% softner

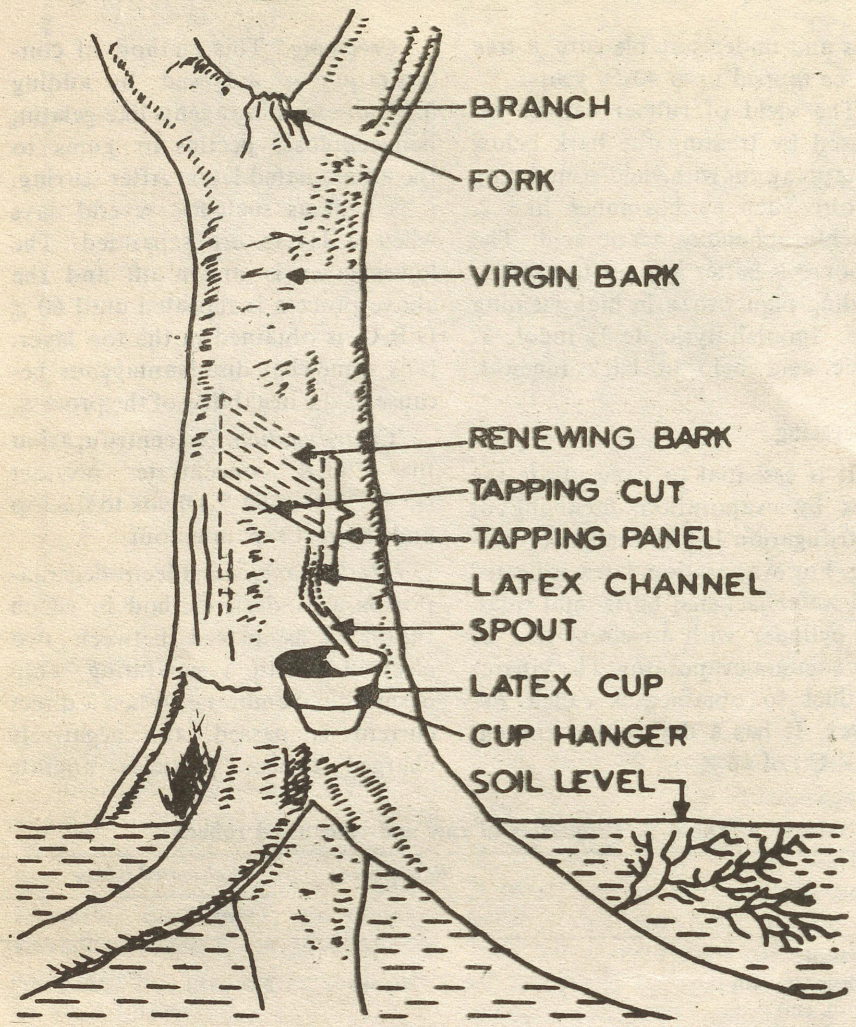

Fig. 5. Bark of *Hevea brasiliensis* and the panel system for repeated tapping (ibidem method)

towards the anode but accumulate near the membrane. With the reversal of current, they rise to the surface and can be skimmed off.

Manufacture of raw rubber

Commercially two types of rubber are known: 1. Smoked sheet rubber, 2. crepe rubber.

For making smoked sheet rubber, the concentrated latex is diluted with water to 15% D.R.C., then filtered to remove impurities. 1 kg of acetic acid is added to coagulate 200 kg of rubber latex. The acidified latex is kept overnight in pans or tanks. The rubber coagulates and floats to the surface as soft, white spongy slabs. The slabs are taken out, washed in water and then rolled between smooth rollers to remove water and to flatten them to a thickness of 3.2 mm. The sheets are again passed through marking rolls to get the ribbon pattern. This helps in quick drying and convenient piling. At this stage, the sheets contain 20% moisture. They are partially dried on racks for a few hours. They are then transferred to the 'smoke house' (40°C-50° C temp.) and kept there for 4 days. After drying the sheets are amber coloured, translucent and have elasticity and durability. For production of crepe rubber, sodium bisulphite (0.5%) is used as the coagulating agent. By this method, white rubber can be obtained. The coagulum is passed through several processes such as cutting into pieces, squeezing, shearing, masticating and finally rolled into sheets. For quick drying, the sheets are hung in well-ventilated rooms with slight increase in heat for a week.

Sole crepe rubber used for footwear is obtained by coagulation in two steps. In the first step, acid is added in insufficient quantity to the latex, and in the second step, sodium bisulphite and acid are mixed to get a second coagulum which is then processed in the usual way.

Uses

Raw rubber is used in making insulation tapes, shoe soles, adhesives and erasers, but for industrial uses vulcanised rubber is preferred.

For vulcanisation, raw rubber is masticated, plasticised and mixed with several substances such as vulcanising agents (sulphur), accelerators, antioxidants, reinforcing agents, fillers and other ingredients and heated to 113°C-130°C under pressure.

In cold vulcanisation process used for thin products such as thin sheets, raw rubber is treated with sulphur monochloride dissolved in carbon disulphide.

The electrical properties of rubber are not very much affected by vulcanisation.

By changing the concentration of ingredients, dark or light coloured hard rubber can be obtained. Sulphur content of such a material is usually 32%. Ebonite has high electrical insulation properties and can resist chemical corrosion.

Rubber derivatives are prepared from unvulcanised rubber through several processes such as addition, substitution and cyclisation reactions.

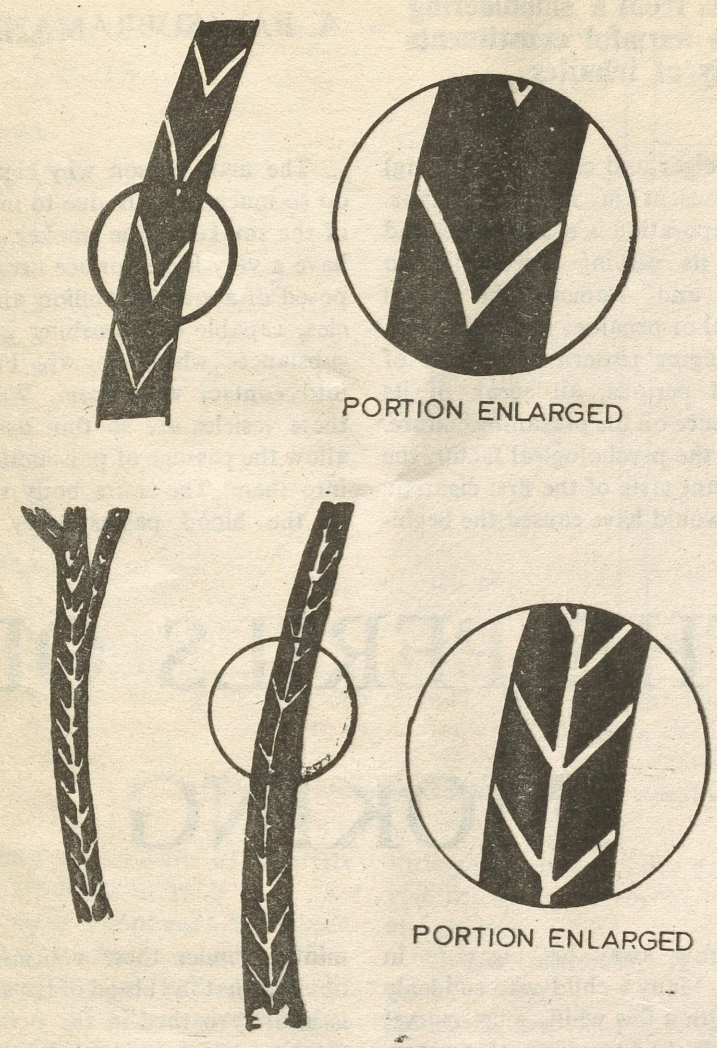

Fig. 6. 'V' Cut system

Commercial chlorinated (65%-66% Cl) rubbers are obtained by reacting rubber with carbon tetrachloride. They are utilised in corrosion-resistant paints and lacquers.

Reaction of rubber with stannic chloride and many other substances gives cyclised rubber used in rubber to metal adhesives, shoe soling and resistant paints. Such rubber has properties intermediate between rubber and guttapercha.

The major rubber producing countries such as India, Malaysia, Thailand, Brazil, Sri Lanka and China are expanding rapidly their average annual rubber production by bringing new areas under cultivation. Rubber research has made impressive strides in India, Sri Lanka and Malaysia. Brazil, the homeland of rubber, is still in the formative stage of rubber production, whereas Malaysia which obtained just 22 seedlings from Brazil has come out to be the largest producer of natural rubber. Sri Lanka introduced rubber plantation only in 1905 with seeds sneaked out of Brazil and germinated in England. But today it has become the 4th largest producer of rubber. It earns half of its foreign exchange by exporting rubber. In India, technologists and scientists of the Rubber Research Institute are actively engaged in revolutionising indigenous rubber production technology. As rubber is one of the most useful materials needed for industry and commerce, research on rubber at the production, tapping and manufacturing stages warrant attention of all the developed as well as developing countries of the world.

THE PERILS OF SMOKING

A. BALASUBRAMANIAN

Smoking is injurious to health. However, what is more alarming is the smoke which emanates from a smouldering cigarette, as it is unfiltered and its harmful constituents are substantively retained in the body of inhailer

A recent WHO Technical Report on smoking described smoking as "a worldwide epidemic, causing serious diseases and immense health problems." It said, "In countries where the habit has become widespread for many years, it is responsible for 90% of lung cancer, 75% of bronchitis deaths and 25% of ischemic heart disease deaths in men under 65 years of age. A smoker in fact doubles his risk of dying before the age of 65. Yet, inspite of known dangers of smoking, the habit is spreading through the developing countries and resolute action will be needed to stop it" (See also box on p. 475).

There is no evidence that smoking promotes physical health; its so called benefits are supposed to be psychological and social which are hard to express in quantitative terms. The social values are widely endorsed. The profferring of a tobacco or cigarette pouch constitutes a gesture of friendship between strangers, between negotiators, between assessors and between applicants for jobs. Smoking is also supposed to relieve stress and boredom. But there is still much to be learnt about the harmful health effects of tobacco smoking, the mechanisms whereby smoking exerts its pathogenic effects, the reasons why people smoke and about the best why to help a smoker who wants to give up smoking.

Smoking and culture

Cultural factors undoubtedly play a large part in smoking as they do in drinking of coffee, tea or alcohol, i.e., beverages. Different ways of enjoying tobacco (snuffing, chewing, piping, cigar and cigarette smoking) are prevalent in many countries. Its incorporation in social usages and rituals, its varying accessibility to minors and women, the social approval or penalties it entailed with the changing pattern of lifestyle of different periods, all speak of its dependence on the prevailing culture. But for the psychological factor, the unpleasant taste of the first cigarette smoke would have caused the beginner throw away his cigarette in despair. Many a child who suddenly starts with a few whiffs must marvel that adults find smoking so pleasant. Tobacco, like alcohol, is an acquired taste. The school boy is usually initiated by his companions. While they smoke, they feel they are like grow ups and this establishes a bond with their smoking companions. They find the value of tobacco as a social asset. This is undoubtedly one of the reasons for its popularity among the young.

Nicotine in cigarette smoke in proper doses acts as a powerful stimulant, but the effect is followed by depression. The stimulation unconsciously felt by the smoker makes smoking more attractive. Similar is the case with alcoholics and drug addicts.

The main reason why cigarettes do so much harm is due to inhaling of the smoke by the smoker. Lungs have a very large surface area composed of about 30 million air vesicles, capable of absorbing gaseous substances when they are brought into contact with them. Walls of these vesicles are so thin that they allow the passage of poisonous gases into them. The entire body volume of the blood passes every three minutes under these vesicles. It is obvious that the blood of the smoker is entirely bathed in the poisonous nicotine vapour inhaled into the lungs.

Chemistry and pharmacology of smoking

Scientists, physicians and others are unanimous in pronouncing the nicotine content of tobacco as one of the most deadly poisons known. With the exception of prussic acid, no other chemical will cause death so quickly. Tobacco smoke contains a mixture of gases in minute droplets of the size 0.3 omicrons to 1.0 omicrons. About 50% of the inhaled smoke is retained in lungs. Some droplets are deposited directly on walls of the bronchial tubes, others are taken up by motile cells.

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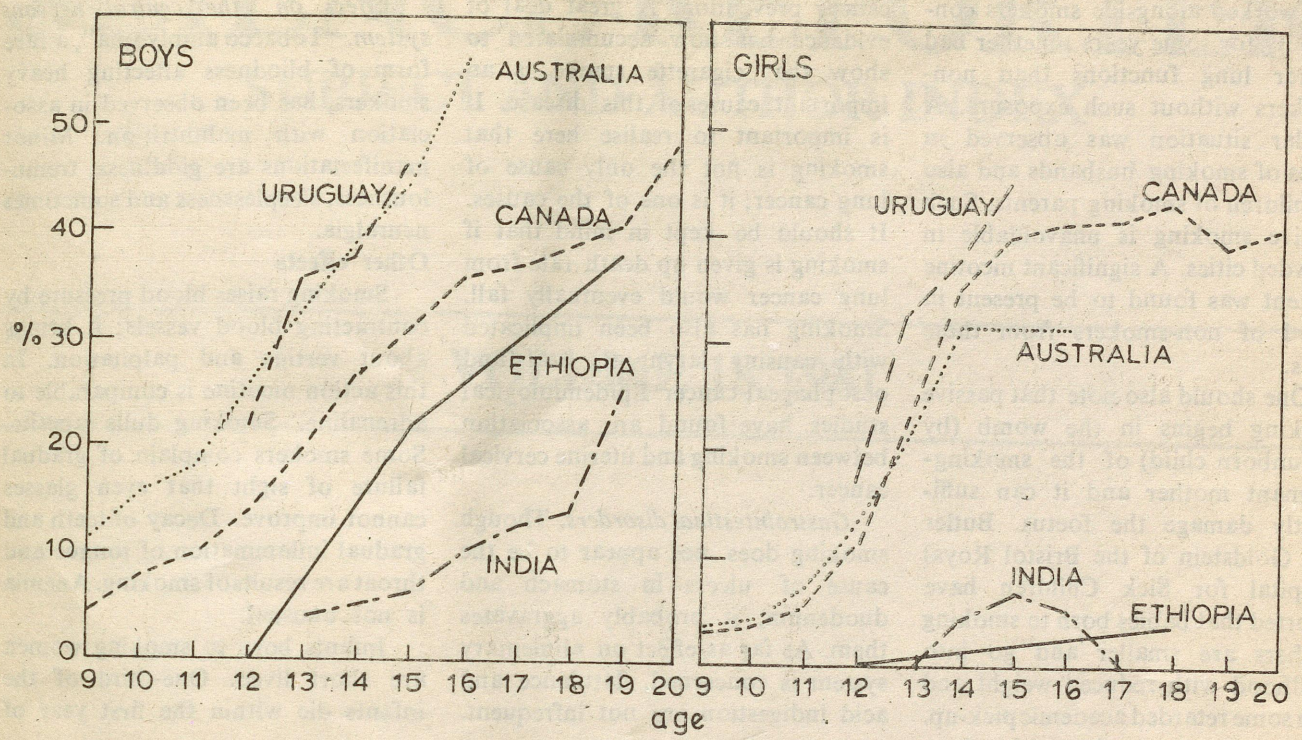

Approximate percentage of smokers in selected countries by age and sex (*Source:* WHO)

Important constituents of cigarette smoke are listed in Table 1.

Some 33 compounds have been identified in cigarette smoke. Compositions vary with the type of tobacco. The mainstream of smoke of cigarette is faintly acidic, whereas cigar smoke is faintly alkaline.

Nicotine. The amount of nicotine that can be recovered from the mainstream smoke of one cigarette varies from 1 mg to 3 mg. More than 75% of the smoke is absorbed by lungs. Hence 0.75 mg to 2.25 mg of nicotine is presumably absorbed per cigarette. The amount of nicotine in half a kilogram of tobacco is estimated at 24 gm and 6.5 mg of nicotine is enough to kill a dog in three minutes. The deadly nature of nicotine can now well be realised.

Carcinogens. Many carcinogens (cancer causative chemicals) have been identified in tobacco smoke, most of them in microgram levels. Irritant action of tobacco smoke upon mucous membranes is due to a variety of substances like ammonia, volatile acids, aldehydes, phenols and ketones.

Carbon monoxide. A cigarette generates upto 70 mg carbon monoxide. But the combining capacity of haemoglobin with carbon monoxide is only 5% to 10% even after a number of cigarettes have been smoked.

Passive (side-arm) smoking

Smoking a cigarette produces two main kinds of smoke: (1) What the smoker draws into his mouth (usually into his lungs) called mainstream smoke, and (2) Smoke which issues into the atmosphere when cigarette is held smouldering; it is called passive or side-arm smoke. Side-arm smoke is more dangerous because the volume of this smoke produced is double that of mainstream smoke. Secondly, several chemicals in tobacco smoke are present in higher concentrations in side-arm smoke. Thirdly, side-stream smoke is unfiltered both by the cigarette, and more important, by the smoker himself, whose body retains substantive amounts of the constituents of the smoke that he inhales.

Passive smoking or the side-arm smoking is often heavy and, if continued over a lifetime, could give rise to the same alarming spectrum of diseases suffered by the smoker himself. About 50% of non-smokers say that they suffer definite ill-effects from passive smoking. Non-smokers with allergic diseases like asthma suffer more when they are exposed to cigarette smoke. Similar is the case with non-smoking patients with chronic angina pectoris, bronchitis and emphysema. Nitrosamines which are extremely powerful, organ-specific carcinogens have been found to be present in side-stream smoke.

In 1979 White and Froeb of the California University, San Diego, USA, found that non-smokers who

had worked alongside smokers continually for some years together had poorer lung functions than non-smokers without such exposure. A similar situation was observed in wives of smoking husbands and also in children of smoking parents. Such passive smoking is unavoidable in crowded cities. A significant nicotine content was found to be present in blood of non-smokers from these areas.

One should also note that passive smoking begins in the womb (by the unborn child) of the smoking-pregnant mother and it can sufficiently damage the foetus. Butler and Goldstein of the Bristol Royal Hospital for Sick Children have reported that babies born to smoking mothers are smaller and go into childhood with reduced weight and with some retarded academic pick-up. Further, in women who smoke, there is an increase in still-births and neonatal death rate, probably because of placental disorders. A report from the Edinburgh State College, Pennsylvania, says that non-smoking women, whose husbands have long been cigarette smokers, die on an average four years earlier than women married to non-smokers.

Effects on body

Lung diseases. Chronic bronchitis is one of the major effects of smoking. Lung infection with breathlessness due to associated emphysema tend to increase in severity and persistance with heavy smoking. In many cases heart failure follows.

Productive cough. Smoking causes cough and expectoration. This is called smoker's cough which is more persistent and prevalent when more cigarettes are smoked. The common experience is that most smokers with "smoker's cough" get cured of it when they give up smoking.

Smoking and cancer. Avoidance of tobacco smoking and chewing would be two examples of primary cancer prevention. A great deal of evidence has now accumulated to show that cigarette smoke is an important cause of this disease. It is important to realise here that smoking is not the only cause of lung cancer; it is one of the causes. It should be kept in mind that if smoking is given up death rate from lung cancer would eventually fall. Smoking has also been implicated with causing laryngeal, oral and oesophageal cancer. Epidemiological studies have found an association between smoking and uterine cervical cancer.

Gastrointestinal disorders. Though smoking does not appear to be the cause of ulcers in stomach and duodenum, it probably aggravates them. As far as effect on alimentary system is concerned, flatulance and acid indigestion are not infrequent.

Effect on the central nervous system. "Tobacco amblyopia", a rare form of blindness affecting heavy smokers, has been observed in association with malnutrition. Minor manifestations are giddiness, tremulousness, sleeplessness and sometimes neuralgia.

Other effects

Smoking raises blood pressure by contracting blood vessels; it brings about vertigo and palpitation. In this action nicotine is comparable to adrenaline. Smoking dulls apetite. Some smokers complain of gradual failure of sight that even glasses cannot improve. Decay of teeth and gradual inflammation of tongue and throat are results of smoking. Anemia is not unusual.

Infants born to smoking women are short lived. One-third of the infants die within the first year of

Third World's 'Smoking epidemic'

THE World Health Organisation (WHO) has expressed concern at the spread in the third world of what it calls the "Smoking epidemic".

Statistical evidence at WHO headquarters shows a steady increase in the consumption of cigarettes in developing countries accompanied by soaring rates of lung cancer and cardiovascular diseases. The statistics, though incomplete, suggest that tobacco use has been climbing by an overall five per cent annually in the third world in recent years while it has slowed in the west.

In India, consumption of cigarettes has gone up 90 per cent in 20 years, in Pakistan 60 per cent in 10 years and in Sri Lanka it is increasing by eight per cent annually according to WHO surveys. In Bangladesh, 71 per cent of men and 20 per cent of women in the "lower socio-economic groups" smoke, the survey says.

In some countries, growth of cigarette consumption has been spectacular. Sales in Thailand, for example, increased by 50 per cent between 1970 and 1977, with one person in five over the age of ten smoking in third world countries. People there spend one-fifth of an average income on cigarettes.

Lung cancer is now the most common type of cancer among men in the Philippines and is slowly increasing among women. In Pakistan, it jumped in four years from fourth to first place in the list of the most-often observed malignant growths.

WHO warns that increased smoking also increases another threat indirectly—turning forests into deserts—because developing countries cure tobacco using wood instead of more expensive gas and oil burners.

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their birth. One-fifth of the children show evidence of poisons of brain and nerves and die in convulsions. Breast milk of such women smell of nicotine. Passive smoking by the foetus results in premature birth or birth of babies with defects. Though born normal the child may suffer from insomnia, restlessness, diarrhoea, etc. Athletes customarily abstain from smoking because of the widespread belief that it is "bad for the wind". Smoking is believed to impair their athletic performance.

The cure

First thing a smoker should do is to impress upon his inner consciousness. The suggested (six) great gains which should win upon his inner consciousness are : (1) improved health, (2) better spirits, (3) freedom from bondage, (4) improved mental abilities, (5) increased efficiency in work and plan, and (6) a substantial saving in money. Let these great gains be fixed in a smoker's mind and let him ask himself whether these benefits are worth striving for. It should be impressed upon him that each cigarette he smokes is impregnating his system with a deadly poison. He should never forget that the longer he continues to smoke, the worst the slave he becomes. The most essential step to be taken by a person who desires to give up smoking is to stop the unrealistic, hocdwinking of oneself that is exceedingly prevalent among smokers.

Preventive measures

(1) Removal of harmful substances from tobacco smoke by filtering the smoke or by manufacturing filter-tipped cigarettes; (2) Modification of tobacco: Some strains of tobacco plants have a low nicotine content. Tar and carcinogen content of tobacco smoke can be reduced by various methods of treatment of tobacco; (3) Antismoking

(*Continued on page 492*)

How to quit

THE American Cancer Society suggests two possible "recipes" for breaking the smoking habit. Of course, trying the suggestions from one list does not rule out those from the other list.

Recipe A:

1. Decide to smoke only once a hour; or decide to stop smoking for an entire hour, and then start lengthening that time by half hours.
2. Make it hard to get at a cigarette. Wrap up the package and put elastic bands round it. Smoke with your left hand if you usually smoke with your right.
3. Switch to a brand you don't like. Buy only one pack at a time.
4. If you always have a smoke with your coffee, switch to tea or fruit juice.
5. Do something for your body. Get back in shape. Exercise is great for relaxation.
6. Call up your friends and tell them you are going to quit.
7. If you quit for one day, you can quit for another. Try it.
8. Save all the money you would have spent on cigarettes and buy yourself something. You deserve it.
9. If you break down and have a cigarette, don't worry. Some people have several tries before they at last succeed.

Recipe B:

1. Cut out one cigarette a day.
2. Make each cigarette a special decision—and put off making the decision.
3. Don't give up cigarettes—completely. Carry one around with you in case of need. You will find in the end you are saving it —permanently.
4. Don't quit "forever". Just stop for a day, and tomorrow try it for another day; and tomorrow, and tomorrow, and tomorrow.
5. Tell your friends and family you are quitting. A public commitment bolsters willpower.
6. Pick a Q-Day—the Day you Quit. And quit.
7. Hide all evidence of cigarettes. Ashtrays and matches, so you are not reminded of the habit.
8. Lay in a supply of chewing-gum, cough sweets or peanuts to nibble instead of reaching for a smoke.

(Source: *World Health*)

Table 1. Important constituents of cigarette smoke

Substance	*Property*
Particulate phase	
Polycyclic aromatic hydrocarbons	Cancer initiators Cancer promotors and Carcinogens
Dibenzacridines, dibenzocarbazoles and other azarenes	Cancer initiators
Methyl indoles, methyl carbazoles and catechols	Co-carcinogens
Aromatic amines	Bladder carcinogens
Nicotine and other alkaloids	Toxins, co-carcinogens & Irritants
Phenols	Cancer promotors
Gaseous phase	
Nitrosamines, hydrazines, vinyl chlorides, urethane, pyridines, aldehydes (formaldehyde acetaldehyde acrolin), hydrogen cyanide, nitrogen oxides, ammonia, carbon monoxides	Carcinogens Toxins or irritants

SCIENCE SPECTRUM

Is MHD an answer to energy problem?

SIMPLE in concept though long in name, the phenomenon of magnetohydrodynamics (MHD) holds promise for clean, efficient power. It is more or less a technique identical to directing flame (lightly salted) of a blow torch through the poles of a magnet. Electrodes extending into the flame pick up the current and carry it further.

In an actual MHD generator, powdered coal burns fiercely in chamber (1) at a very high temperature with a small amount of potassium salt. The salt increases conductivity of the flame, i.e., the flame easily conducts electricity. Squirting through a nozzle (2) at supersonic speed, combustion gases stream between magnets (3) yielding an electric current taken off by electrodes (4).

The recent Russian success towards commercialization of this technique may prove an epoch-making event in this era of energy crisis. Presently, the work is in full swing on world's first commercial MHD station in the USSR.

Basically, MHD is an efficient way of making electricity using fossil fuels. In fact, this is the need of the hour as commercial exploitation of new and renewable energy sources will take some time. They still need a great deal of developmental work. Till such time fossil fuels like oil, gas and coal could be used by more efficient systems like MHD.

In an MHD generator, one tonne, of coal will produce 360 MW of electricity whereas the same amount of coal produces only 200 MW electricity by conventional techniques. Moreover, in the former case, the electricity generation cost is expected to be cheaper by 6 paise per kWh.

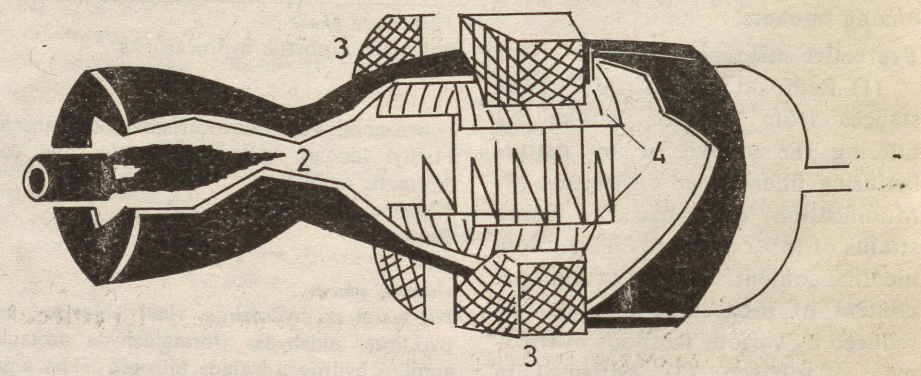
The efficiency of MHD power stations is expected to be as high as 50 per cent; it can even be 60 per cent. This means an improvement in efficiency over conventional thermal stations. More important, the MHD generators will help reduce considerably harmful discharges of ash, dust, smoke and heat into the atmosphere.

Economic experts have calculated that the MHD generators will pay back the expenses on their construction in a short period. One great advantage with MHD technique is that apart from generating electricity, an ordinary steam turbine plant can use the heat of the waste gas of MHD generator and produce additional electricity.

The work on commercialization of MHD technology, which has earned recognition recently, is going on in many countries like the USA, USSR, Japan and Poland. It seems the scientific aspect of MHD generation problem has been successfully solved. From now on, it is the problem of machine builders.

In late 50s, Arthur Kantrowitz, Director of the Avco Everett Research Laboratory in Massachusetts, and Richard Rosa built a small MHD device; they are vigorously promoting the idea ever since. While the doubt 'Will it work on a large scale?' was still lurking in the Americans' minds, the Russians, taking cue from them, piled their resources on MHD project to generate electricity on a commercial scale.

They built their first experimental MHD generator way back in 1964 under the code name U-02 and commissioned it at an old power station in Moscow in a record time of six months. The rated capacity was only 20 MW. The U-02 was followed by the construction of U-25 pilot industrial plant in 1971 by the Institute of High Temperature of the



1. Chamber, 2. Nozzle, 3. Magnetes, 4. Electrodes

USSR Academy of Sciences. Essentially built as a half experimental and half commercial plant, U-25 developed a capacity of up to 20 MW. Today, the problem of fuelling the MHD installations with coal has been solved and both the U-02 and the U-25 installations have been switched over to coal. A 500 MW capacity MHD station is to be commissioned during the 11th Five Year Plan (1981-85).

MHD technology in India

India has also joined the race for developing MHD technology. Developmental work on MHD system is in progress at the Atomic Energy Commission in collaboration with the Bharat Heavy Electricals Ltd. (BHEL) and the Department of Science and Technology.

The first step in developing Soviet-Indian cooperation in the use of MHD method was taken up in 1973. An MHD experimental model is being built at Tiruchirapalli (Tamil Nadu). Indian specialists working on the adaptation of the Soviet technology to Indian conditions have made much progress. Close cooperation has been established between the High Temperature Institute of Moscow, the Bhabha Atomic Research Centre (BARC) and BHEL.

Work on the project for setting up a coal-based experimental MHD power plant of 5 MW at Tiruchirapalli is in progress. It is expected to be completed by 1982. The MHD channel has been fabricated and tested in the U-02 facility in USSR. Civil construction work relating to the plant has been proceeding satisfactorily. A large protion of the equipment and machinery has been received and installed. Further equipment and instrumentation as well as materials for the magnet are being procured. The project is proposed to be extended up to 15 MW level by the end of the Sixth Plan (1985). The revised outlay for this project for the year 1980-81 was Rs. 2.5 crores. It is expected that the outlay of this project during the Sixth Plan will be Rs. 10 crores.

Already proved to be successful with coal as basic fuel, MHD brings a ray of hope in the field of power generation and power conservation for countries like India which has huge deposits of coal.

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The versatile organofluorine compounds

FLUORINE is widely distributed in nature and is available in abundant quantities as fluorspar, CaF_2. The two major inorganic fluorine compounds, viz., aluminium fluoride and cryolite (Na_3AlF_6) are mainly used in aluminium industry; others are used in metallurgy, electrode making, abrasives, novel lubricants, ceramics, textiles and other industries. Fortunately, large deposits of the mineral have recently been discovered in Gujarat.

Despite high reactivity of fluorine, several fluorine compounds are very inert. Specially its compounds with carbon are so inert that they are considered harmless and are being used as refrigerants, propellants, in plastics, as detergents, dyes, pesticides, drugs and polyurethane foams. Aerosols (which are colloidal dispersions of a liquid dispersed in gas) are nowadays chiefly incorporated in various preparations like hair sprays, air freshner and insecticide sprays (see also *S.R.*, Feb. 1982).

Bromofluoro compounds are now extensively used for fire fighting purpose and have replaced the conventional carbon tetrachloride. The most recent use of fluorine compounds lies in the search for artificial blood.

Chlorofluoro derivatives of methane and ethane are used as refrigerant gases in refrigerators, as propellants for insecticides, hair sprays, shaving creams, etc., due to their non-inflammable, non-explosive and non-toxic nature and low boiling points. Chlorofluoro ethanes are thermally stable up to 400°C, and have extraordinary resistance to chemicals and are both water and oil repellents.

Teflon (Polytetrafluoroethylene)

After its discovery in 1938, teflon (polytetrafluoroethylene) was used in World War-II for many military needs; most of its uses were owing to its anti-corrosive effect. After the War, tetrafluoroethylene was copolymerised with other fluorocarbon gases like hexafluoropropylene, and found its use in motorcars, jet planes and rockets for its resistance to oil and heat.

Teflon is similar to polyethylene molecule except that fluorine has replaced hydrogen atoms on its carbon chain. The plastic has gained importance for its inertness and is largely used as frying pan coatings and other utensils as food will not stick to it (Fig. 1). Because of its inertness, teflon does not burn, corrode or otherwise damage any material with which it comes in

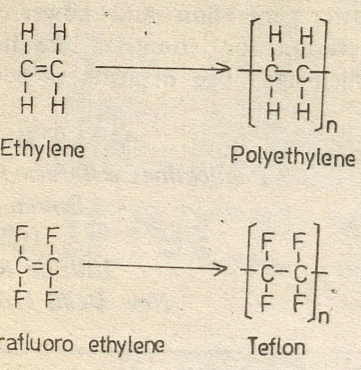

Fig. 1

contact. It is a bad conductor of electricity. Since it does not combine with oxygen, Teflon supports life. It is, therefore, immune to the attacks of fungi, moulds or pests.

No liquid can dissolve Teflon; it does not react with acids or alkalis. Temperature has no effect on it. Temperature as high as 333°C can be achieved without melting; it can withstand low temperatures upto —268°C (only a few degrees above absolute zero) without any change. Until the development of polyfluorocarbons, no giant molecule could withstand the effect of both oil and water.

Several fluorinated compounds have been synthesised and used successfully as pesticides, e.g., difluoro analog of the well-known pesticide D.D.T. (may be abbreviated as DFDT) has more rapid action and is used in place of DDT in instances where a short exposure of the pesticide is required.

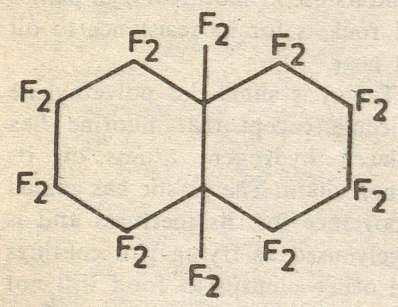

Fig. 2

During the last three decades, fluorine compounds have entered in medical world for use as drugs. Fluorinated drugs are largely used as inhalation anaesthetics, as adrenocortical and anti-inflammatory agents, as anti-psychotics, sedatives, hypnotics and anticancer agents. 5-Fluoro uracil is used as an anticancer drug.

Inorganic fluorides find applications in biology and medicine. They are responsible for the control of certain metabolic diseases of the bones and are used for preventing caries.

Artificial blood

Fluorocarbons are now being tried as a blood substitute. Oxygen gets easily dissolved in fluorocarbons. This blood substitute offers many advantages over natural blood, the greatest being the absence of any blood group.

Fluorocarbons have been experimented as blood substitute on animals during the last two decades. A group of Japanese doctors is reported to have saved the life of an old man by transfusing one litre of artificial blood for over forty minutes until his rare blood type could be matched. American physiologist Clark claims several advantages of artificial blood. In his words, "I like to think of the fluorocarbons as a pure, white, snowy, life saving synthetic and whole blood as dirty, diseased, fragile and hard to get".

Research work on formulating fluorocarbon emulsions with long-term stability for use as blood substitute is going on. It is hoped that this milky white 'fluorocarbon-in-water emulsion' will one dayow totally replace natural blood in hospitals and emergency wards.

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Caution: photocopying may be hazardous

SUBSTITUTED pyrene and arene derivatives, present as impurities in the carbon black of xerographic toners, have been reported to be mutagenic in nature. Mutagenic action has also been observed with the Xerox copies indicating that the toners are directly responsible for such property. However, experiments to confirm whether these compounds volatilize during the copying process or are directly transferred to skin while handling the copies are in progress. High pressure liquid chromatographic analysis of pyrene derivatives has revealed the presence of 1-nitropyrene, 1, 3-, 1,6- and 1,8-dinitropyrenes, 1,3,6-trinitropyrene and 1,3,6,8-tetranitropyrene compounds responsible for such mutagenic effects. Laboratory tests have also suggested that there is a possible cancer risk from long-term exposure to nitropyrenes. In response to the tests, Xerox Corporation, USA is changing the way the toner is being manufactured.

Photocopying machines have also been identified as indoor sources of ozone, a severe pulmonary irritant. It causes sensory irritation and

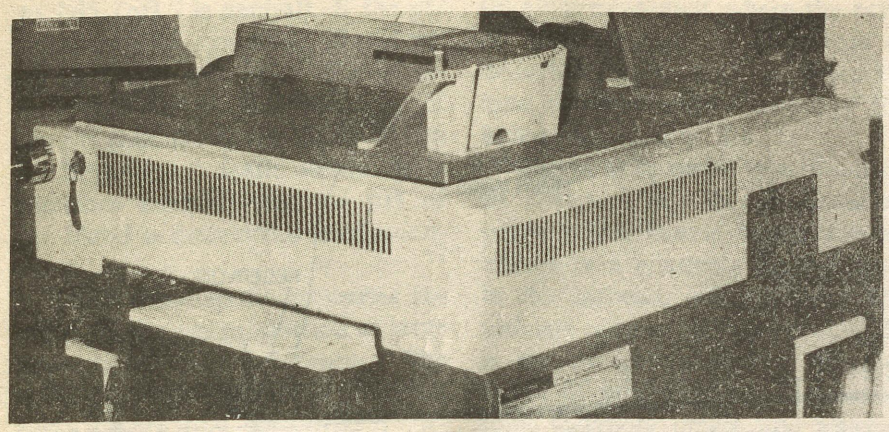

Fig. 1

inflammation of airways and alveoli of the lungs and reacts with the components of the cell membrane and lung tissue. In addition, it is known to cause breakage of red blood cells, act synergistically with sulphur dioxide to impair lung function and to produce changes in various blood enzyme levels. Ozone is also known to cause eye irritation, headache, drowsiness, anoxia, nausea, vomiting and fatigue. A study conducted at the University of Illinois School of Public Health, USA has revealed that out of ten photocopiers of different makes and models, nine machines produced detectable amounts of ozone while in operation. Ozone emissions varied from 1 to 54 μg/copy and most of the copiers produced enough ozone to affect the work room air quality with concentrations as high as 0.153 ppm (300 $\mu g/m^3$). Servicing and cleaning reduces ozone emissions from photocopiers. However, the effect does not last long suggesting that alterations in design may be necessary to minimize the ozone discharge. In addition to photocopiers, certain machines and processes, particularly those operating at high voltages on ultraviolet light can generate ozone. Typical examples include electrostatic air cleaners and electric typewriters.

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The Dead Sea Project—a new concept in power generation

THE Dead Sea is an inland sea and is situated not far away from one corner of the Mediterranean Sea. As it stands today, the Dead Sea water level is about 400 m below that of the Mediterranean. Israel, which is in control of half of the Dead Sea, wants to exploit this difference in the water levels between the Mediterranean Sea and Dead Sea for production of power. The Dead Sea Project, as it is known, is one of the most important engineering projects under consideration for generation of electricity. The power generating station is to be located about 400 m below sea level near the Dead Sea (Fig. 1). For this purpose, the Mediterranean Sea has to be connected to the Dead Sea by means of a suitable channel.

A preliminary study of the Med-Dead Sea scheme has indicated that a power station that will generate 300 MW or more during peak demand periods appears feasible and should offer economic and other benefits. For example, it could provide cooling water to future power stations and industrial facilities along the route of the channel. It has been calculated that 100 million cubic metres of water falling from a height of 400 m would produce 100 MW-150 MW of electricity. Preliminary estimates suggested that the project would pay for itself in 30 years.

Apart from generating a substantial amount of hydroelectric power, the Med-Dead Sea Channel may open the door to other schemes and benefits. For one, it may immediately arrest the decreasing level of the Dead Sea. The single main source of water input to the Dead Sea at present is the Jordan River. For the last twenty years or so, water-starved Israel and Jordan have been heavily drawing the Jordan River's water for irrigation purposes as a result of which very little of it now flows into the Dead Sea. The loss of water from the Dead Sea by way of evaporation is about 1200 million cubic metres per annum. Due to this, in that century alone, the level of the Dead Sea has dropped by 10 m. At this rate, it is feared, the Dead Sea will gradually disappear. The Med-Dead Sea Channel proponents claim that such a death of the Dead Sea can be averted by injecting the Mediterranean water into it.

Another important benefit expected from the scheme is the conversion of the whole Dead Sea into a vast solar pond. A solar pond is one where a salt concentration

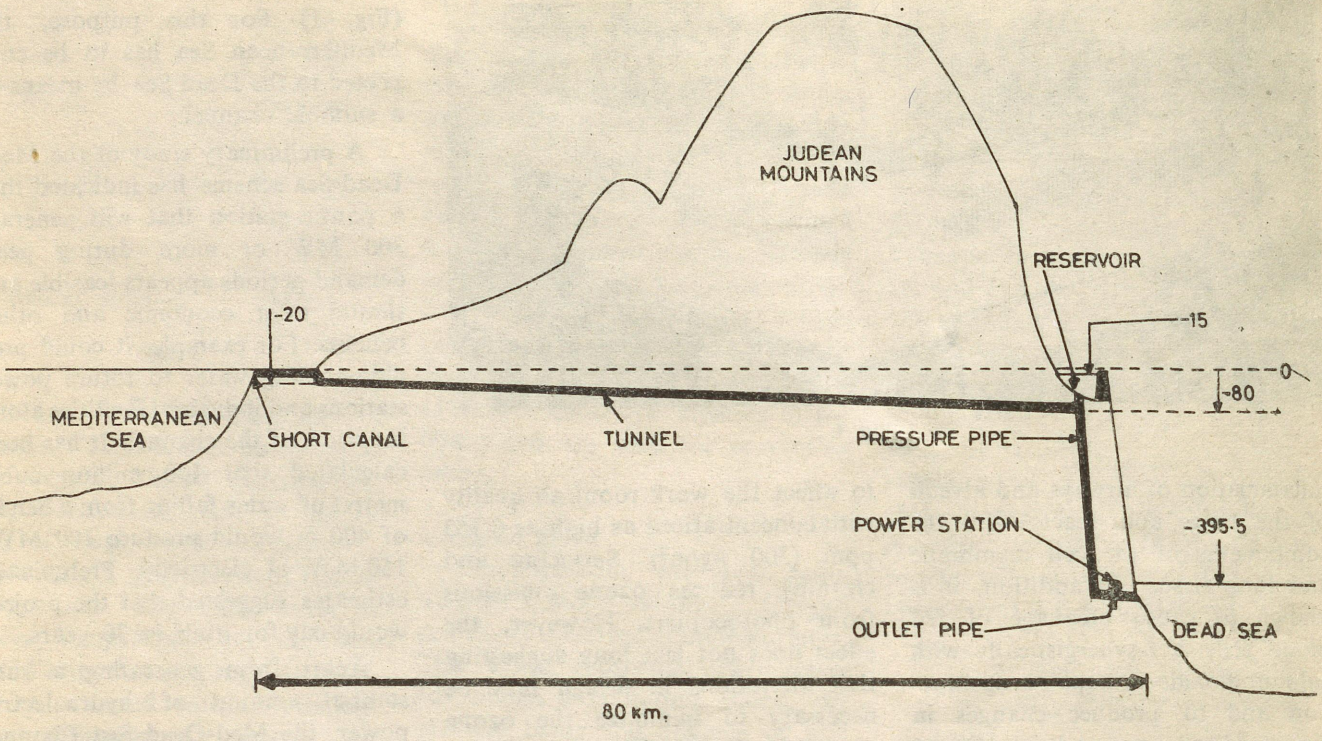

Fig. 1

gradient is maintained with the lighter fresh water (or lower salt content water) on top and heavier salt water at the bottom. (See *S.R.*, ...). Such a pond, when exposed to the sun, will get warmer at the bottom and the bottom water may even reach boiling temperature. This heat at the bottom of the solar pond can be extracted and used as a source of power. The salt concentration of the Dead Sea is about five times that of the Mediterranean. So, accumulation of Mediterranean water over the more salty Dead Sea water would constitute an ideal solar pond arrangement. Enormous power can be generated from such a vast solar pond.

Another method is also being explored for extraction of power from the Med-Dead Sea System. This method was proposed some time back by Sidney Loeb of the Research and Development Authority, Ben Gurion University of Israel. This scheme postulates converting the free energy released by mixing two solutions with different concentrations into potential mechanical energy, to be used subsequently for the generation of electricity. The method involves a process called pressure-retarded osmosis (PRO), whereby the low concentration solution (water, for instance) flows, via a semi-permeable membrane, into a high-concentration solution (such as Dead Sea brine) against a hydraulic pressure gradient. If the Jordan River water is used as the dilute solution and Dead Sea brine as the concentrate, PRO—at about $ 0.07/kWh—could be cost-competitive with other techniques. The trouble is the required quantity of water, about 4 million m^3 for a 100 MW power plant may not be available from the Jordan River. In place of fresh water, as Loeb indicates, Mediterranean water can be utilized. But the use of sea water in place of fresh water will definitely introduce certain process problems and is likely to increase the production cost.

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Acidosis—how it is caused

THE fluid in the cells and tissues of plants and animals is usually close to neutrality. Consequently, the concentration of hydrogen ions (which is a measure of acidity) in biological systems is exceedingly minute but still its precise value is of great importance. The reaction of blood is faintly alkaline with a pH range of 7.35

to 7.45. (pH 7 is neutral). If the pH falls below 7.3, symptoms of acidosis set in and a pH below 7.0 is incompatible with life. Similarly, if the pH goes above 7.5, alkalosis sets in. Beyond 7.8 death occurs. It is therefore essential that the pH of the blood is maintained nearly constant.

Normal metabolic processes involve continuous production of large amounts of acid substances. The most important of these is carbonic acid; others are sulphuric, phosphoric and hydrochloric acids and organic acids like pyruvic, lactic, uric, acetoacetic and β-hydroxy butyric acids. Food also provides certain amounts of basic substances. Both acids and bases get into the bloodstream as they are formed, and the body has to continuously remove relatively large quantities of them. The mechanisms involved in the control of acid-base balance are buffer systems, respiration and renal mechanism.

The term acidosis is applied to a condition in which the H^+ ion concentration of the body fluids increases. This happens when the rate of formation or absorption of acids exceeds the rate of their neutralization or elimination; or when excessive quantities of base are lost from the body fluids without comparable loss of acid. The change in H^+ ion concentration is due to disturbances in the carbonic acid-bicarbonate buffer system of blood. Under normal conditions, i.e., when the blood pH is 7.4, the ratio of carbonic acid to bicarbonate in blood is 1:20; any alteration in this ratio disturbs the acid balance of blood and tissues in the direction of acidosis or alkalosis.

Acidosis may be of two types: (a) Compensatory, in which the quantities of carbonic acid (H_2CO_3) and bicarbonate in the blood are abnormal, although the ratio is 1:20. (b) Uncompensated, where the ratio of carbonic acid to carbonate is disturbed having relatively more H^+ ions, with the result that pH of the blood falls below 7.4

The most common type of acidosis is caused due to a decrease in primary bicarbonate with either no change or a relatively slight change in the carbonic acid fraction. The ultimate cause of this type of acidosis is the overproduction or accumulation of non-volatile acids due to some metabolic defect, and hence it is also known as metabolic acidosis. It is found in uncontrolled diabetes (owing to the overproduction of acidic ketone bodies), renal insufficiency (overproduction of phosphoric, sulphuric and organic acids), anoxia, hemorrhage, ether anaesthesia and as a result of prolonged strenuous exercise (overproduction of lactic acid). Metabolic acidosis may also occur due to excess loss of base ($BHCO_3$) as in some cases of vomiting, renal disease, poisoning by an acid salt, excessive loss of intestinal fluids and excessive loss of electrolyte.

The respiratory apparatus and kidneys, if functioning normally, tend to maintain blood pH within normal limits. Any abnormality in respiratory system can give rise to respiratory acidosis. It can occur under following conditions: (i) depression of the respiratory centre (as by morphine or barbiturate poisoning), (ii) extensive pulmonary lesions (as in pneumonia, emphysema, fibrosis, congestion), (iii) mechanical obstruction of air passages, and (iv) breathing air with high (5%-7%) content of carbon dioxide.

Since the fundamental reason of this type of acidosis is the inability of the respiratory apparatus to remove CO_2 from the body, it is compensated for mainly by the kidneys. The latter tend to compensate acidosis by increasing urinary for ammonia and returning increased amounts of bicarbonate to the blood. If fully compensated for, respiratory acidosis is characterized by the following points: (i) the CO_2 content is high, (ii) the ratio of bicarbonate to carbnoic acid remains within normal limits, (iii) the urinary ammonia and titratable acidity are increased, provided the kidneys are functioning normally. On the other hand, if respiratory acidosis is uncompensated for, it is characterized by (1) disproportionate increase in carbonic acid and partial pressure of CO_2 (2) increase in bicarbonate and CO_2 content, and (3) decrease in bicarbonate/carbonic acid ratio and PH.

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The horrors of house dust

MANY people believe that in a clean, well ventilated room dust is absent. But they are wrong. Even in the cleanest living room or bedroom, house dust is always present and is one of the major causes of allergic respiratory disorders. A man breathes in something like 10-20 thousand litres of air a day and therefore has to cope with many millions of dust particles they contain.

House dust is almost indefinable, since it differs from one place to another. No one dust is a replica of another, but is a complex mixture of lint, snips of hair, textile fibres, mold spores, spores of bacteria, pollens,

mites and their excreta, etc. Common household chemicals like cleaners, polishes, pesticides, toiletries also contribute to house dust (Table 1). The dust in the house is thus composed of much more than the ordinary dirt of common knowledge, and is dangerous for health.

Sources of house dust

The dust sources may be classified as natural, industrial and domestic. Natural dust comes from deserts, volcanoes, the soil, and even from forests and seas. Domestic and industrial dust comes from the combustion of fuels, open fireplaces, etc. Dust of various kinds is formed by handling of materials, e.g., loading and unloading, mixing, crushing, grinding, sawing and cutting. It is formed in cement and pencil factories, casting mills, metal working industries, quarries, etc. Much dust is also whirled up from bad roads by motor vehicles. Dust is a

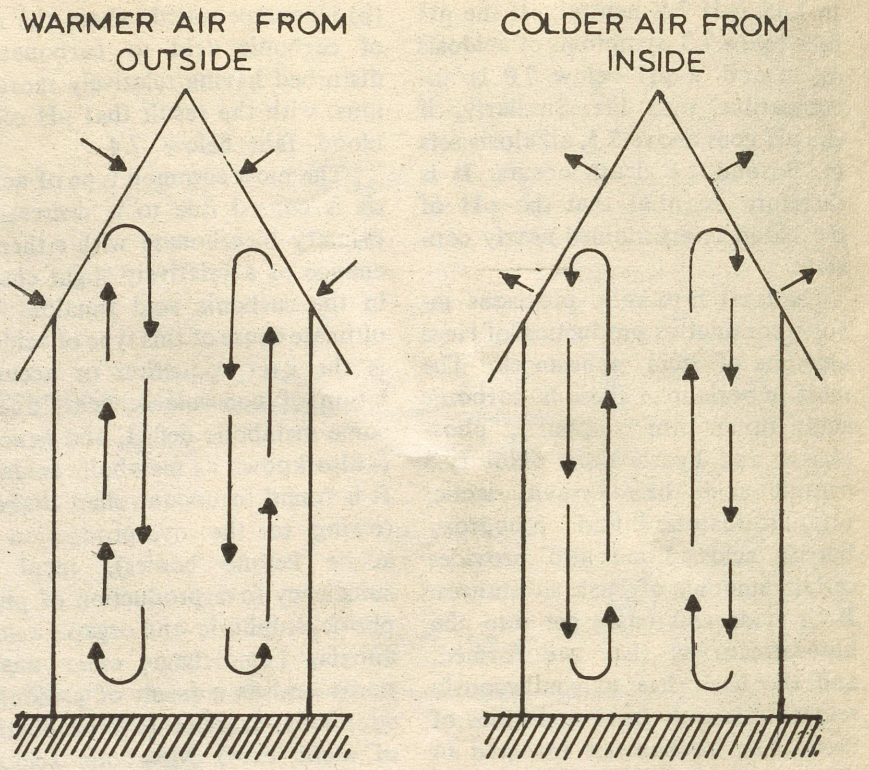

Fig. 1. Changes of air circulation in a room according to relative temperature of walls and indoor air

Table 1. Possible sources of house dust particles

Plant	*Animal*	*Man-made*
Mold spores	House dust mites and faeces	*FUELS* : Cooking and heating gas, kerosene, fire-smoke.
Cellulose	Pet dander	*SOLVENTS* : Alcohol, Naphtha, cleaning fluids.
Textile fibres	Silk	*FINISHES* : Varnish, lacquer, floor and furniture wax, synthetic paint.
Linen	Felt	
Kapok	Horsehair	*POLISHES* : Metal, shoe, floor and table polishes.
Jute	Wool	*CLEANSERS* : Soap, detergents, ammonia, bleaches.
Wood	Hair fragments	*PERFUMES* : Hair oil, tonics, scented soaps and shampoos, hair sprays.
Pollen grains	Feathers	*COSMETICS* : Powder, lipstick, nail polish, creams.
Bacteria	Moths	*SOFTWOOD FUMES* : Turpentine, vapours from sanding or sawing pine or cedar.
Viruses	Cockroaches	*INSECT CONTROL* : Insecticides, mothballs,
	Spiders	repellent lotions, etc.
	Mosquitoes	*PLASTICS* : Table cloth, book covers, handbags, curtains, adhesive tape.
	Beetles	
	Ants	*DRUGS* : Vitamins, antibiotics, steroids, aspirin, penicillin, etc.
		MISCELLANEOUS : Cigarette smoking, stuffing, clothing, bedding, furnishing, air conditioning, crafts and hobbies.

general name for finely divided solid matter, which can be moved by air of normal wind velocity.

In general, the particle size ranges in diameter from 0.01 μm-100 μm, (1μm=10^{-6}m), but those of diameter less than 0.1 μm behave like molecules and generally aggregate. Particles of diameter larger than 1 μm sediment out of the atmosphere under gravity. Thus, most particles in the atmosphere at any time are of diameter between 0.1 μm and 1 μm. Eventually all atmospheric particles reach the earth's surface. Under dry conditions, this occurs by sedimentation, impaction or diffusion. Impaction refers to particles forcibly deposited under wind action. Diffusion is the normal random motion of small particles in a gas. Some particles collide with and adhere to the earth's surface.

Atmospheric dust in indoor air may come from the outside by ventilation or it may originate within the house. Even without any ventilation, air circulates in a room because of thermal convection. Convection currents alone are often sufficiently active to diffuse dust particles in an enclosed space. Within a building, the temperature of the air may be less changeable than outside, and this may lead to characteristic air movement patterns. Warmer walls generate an up draught, colder walls a down draught — each being balanced by opposite currents in the centre of the room and often moving fast enough to counteract sedimentation under the influence of gravity (Fig. 1). Circulation of air within a house is complex but there is evidence of a fairly rapid exchange of air and its suspended dust particles throughout a house.

Dust particles inside a house are generally found on mattresses, carpets, upholstered furnitures, old shoes, books and stacked magazines.

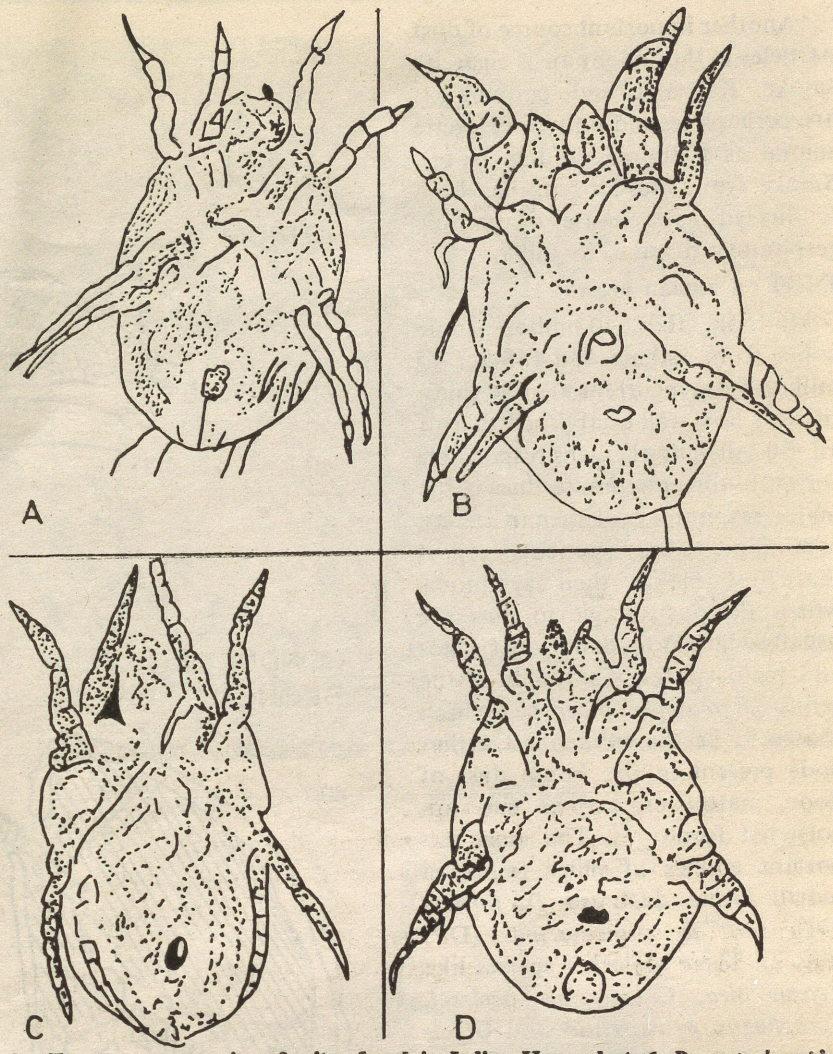

Fig. 2. Two common species of mites found in Indian House dust. 1 *Dermatophagoides fdrinae*—**A. Female, B. Male. 2;** *Dermatophagoides pteronyssinus*—**C. Female, D. Male**

It can also form on basement walls, in closets, room crevices, on wall paper glues, etc. The concentration changes greatly with mechanical and human activities. In bedrooms, activities such as making of beds, brushing of carpets and building-repairs have been found to increase the dust content of the air several times high. But it rapidly returns to normal when the activity is stopped. Tests have shown that the air-borne dust in inhabited rooms is commonly dominated by fragments of human skin in the form of minute, flattened scales from the stratum corneum of the epidermis. Concentrations of several thousands of these potential bacterial rafts per cubic meter are common indoors. These epidermal scales probably carry a large proportion of air-borne bacteria of indoor air.

Coughing and sneezing also contribute to the contamination of house dust. Large numbers of 'droplet-nuclei' of mucus and saliva are propelled into the atmosphere during sneezing and coughing. An estimated 20,000 to 40,000 droplets enter the atmospheric air from a single sneeze. Droplet nuclei are the particles formed from the smallest droplets, which evaporate before falling to the ground and so remain suspended in air.

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Another important source of dust particles in the indoor air is cigarette smoke. Kerosene and cooking-gas are perhaps second only to cigarette smoke as a source of dust (soot). Smoke from fires in huts has been implicated as a cause of chronic respiratory diseases in India.

Effect on human health

In India, about 10 million people suffer from asthma and another 15 million from recurrent allergic rhinitis. It is now well established that of all the inhalent allergens responsible for such ailments, house dust is the major respiratory allergen in Indian conditions. Many patients report that dust makes their symptoms worst. Persons allergic to dust are usually allergic to house dust mites and mold spores. The mites of the genus *Dermatophagoides* have been shown to be the commonest arthopods present in the house dust of floor, mattresses, carpets and upholstered furnitures. The most important species of mites found in Indian house dust are *D. farinae* (DF) and *D. pteronyssinus* (DP) (Fig. 2). There are other species like *Acarus siro, Caloglyphus berlesei, Tyrophagus pytresventie* and *Glyciphagus domasticus* found in Indian house dust, which are also allergic. A single gram of house dust probably contains over 250,000 faeces particles (from about 2,000 mites). Physical properties of these particles are similar to those of pollen grains, they contain highly concentrated allergen (allergy-producing substances). In a recent study at K.G.'s Medical College, Lucknow, 60% of the patients attending the allergy clinic were found sensitive to house dust. Microscopical examination of the sputum of patients revealed the presence of mites which had probably entered the lungs or bronchi through inhalation of contaminated air or dust. 'Nocturnal attacks' occur commonly in patients of bronchial asthma. Much of the non-seasonal hay fever and perennial rhinitis are thought to be caused by house dust containing spores of fungi such as *Aspergillus niger, A. flavus, A. fumigatus, A. versicolar* and *Helminthosporium* spp., which grow indoors.

In general, diseases such as pseudo-tuberculosis, eosinophilia, tropical eosinophilia, broncho-pulmonary aspergillosis, tonsilitis, common cold, influenza, pneumonia, etc. can be attributed to house dust and house dust mite infestation of the respiratory system. However, further studies on larger number of patients are needed to draw a definite conculsion regarding the cause and effect and the direct relationship between house dust and allergic reactions.

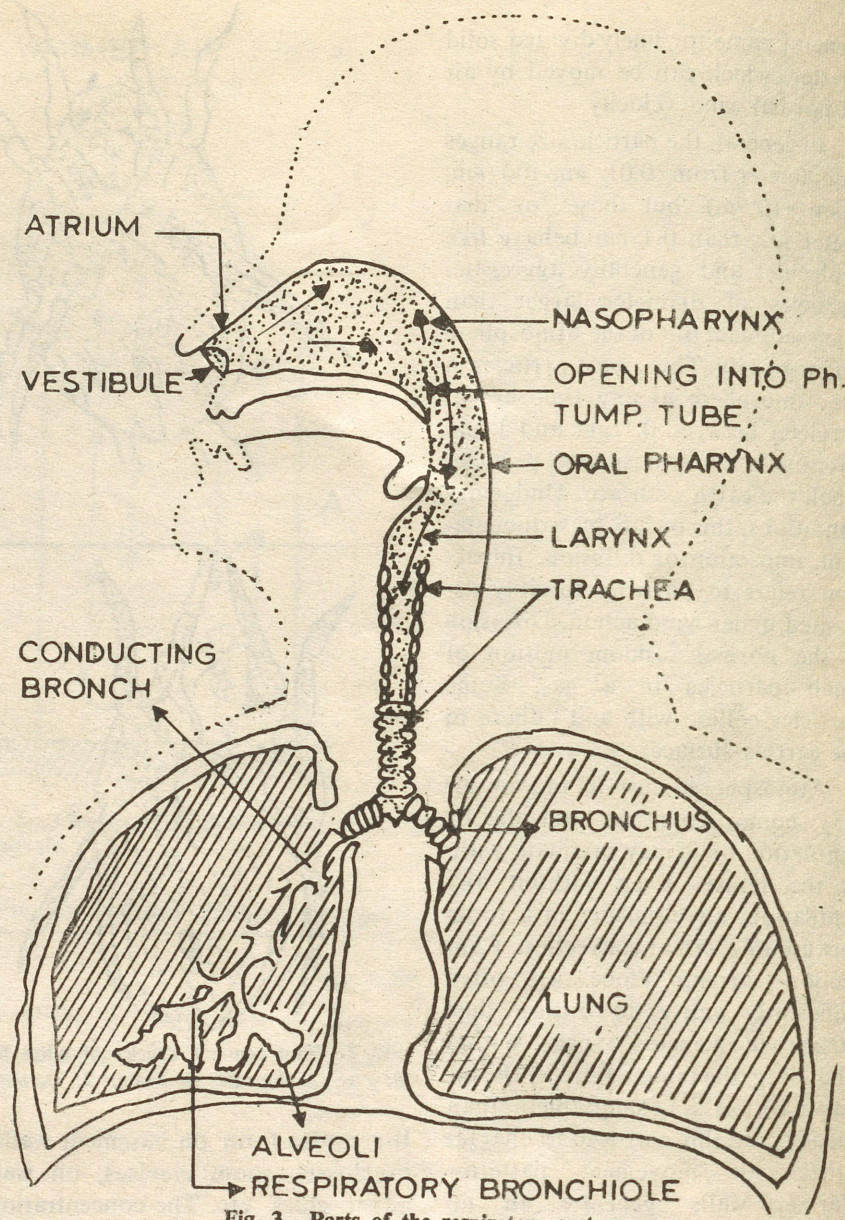

Fig. 3. Parts of the respiratory system

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Ker—a pickle fruit of Indian desert

THERE are many wild plants found in Indian deserts which yield edible fruits and have potential for commercial exploitation. One of them is *Ker*, a perennial woody plant of the species *Capparis decidua* of family *Capparidaceae*. The genus *Capparis* consists of about 270 species, out of which 40 species occur in India. It is also known in local language as *kharir, teet,* or *dela*. *Ker* is found growing in association with *Pilu* in arid and semi-arid regions of the country. *Ker* has acquired special xerophytic adaptive mechanisms to thrive in arid regions, viz., deep tap root system, scanty foliage, mucilagenous sap and tough conical spines. It can stand odd conditions very well and shows profuse fruiting even during extremely hot summers. Because of its abundance and ecological behaviour, *Ker* is an important vegetation in arid and semi-arid regions where it offers firewood and food for the local inhabitants.

The *Ker* plant is a much branched, straggling shrub with greyish bark. It is found growing on rocky, degraded and sandy soils of arid regions. Sometimes, it grows even on sand dunes forming chief feature of the landscape. Its branches are green, often zigzag, leafless and smooth. Leaves are found only on young shoots. Brick red flowers, 2.5 cm in diameter occur in groups of 2-8. Berry-shaped fruits are 0.7 cm-1.5 cm in diameter with many seeds. Immature fruits are dark green and astringent in taste. On ripening, they turn scarlet red and become sweet in taste. They are known as *pinju* in local language. Flowering takes place twice a year, viz., in March-April and July-August. Fruits ripen in May-June

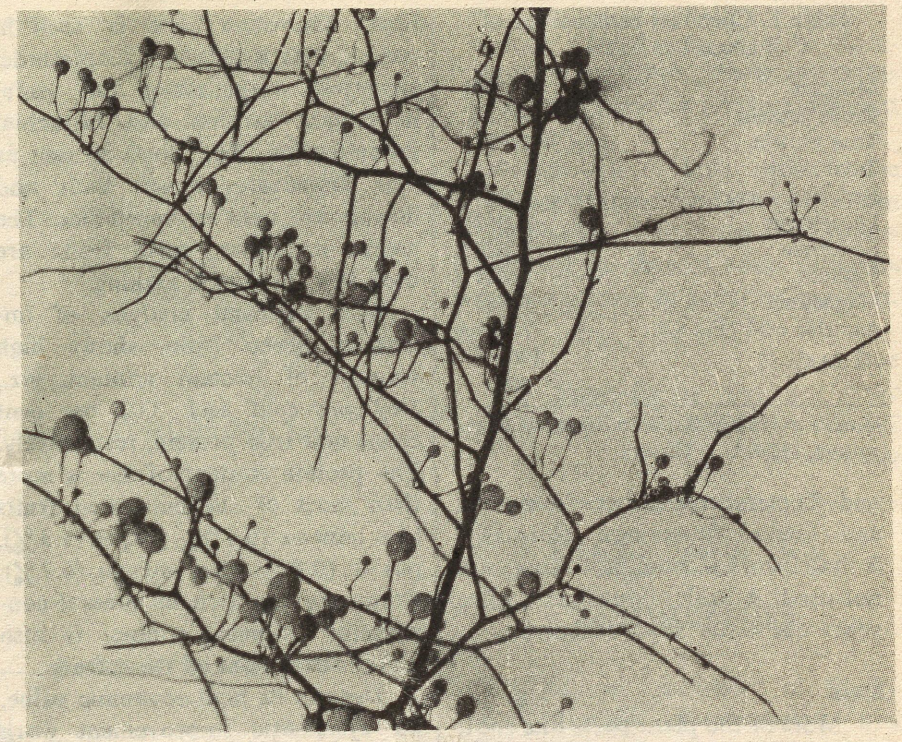

Fig. 1. A bush of *Ker* laden with fruits

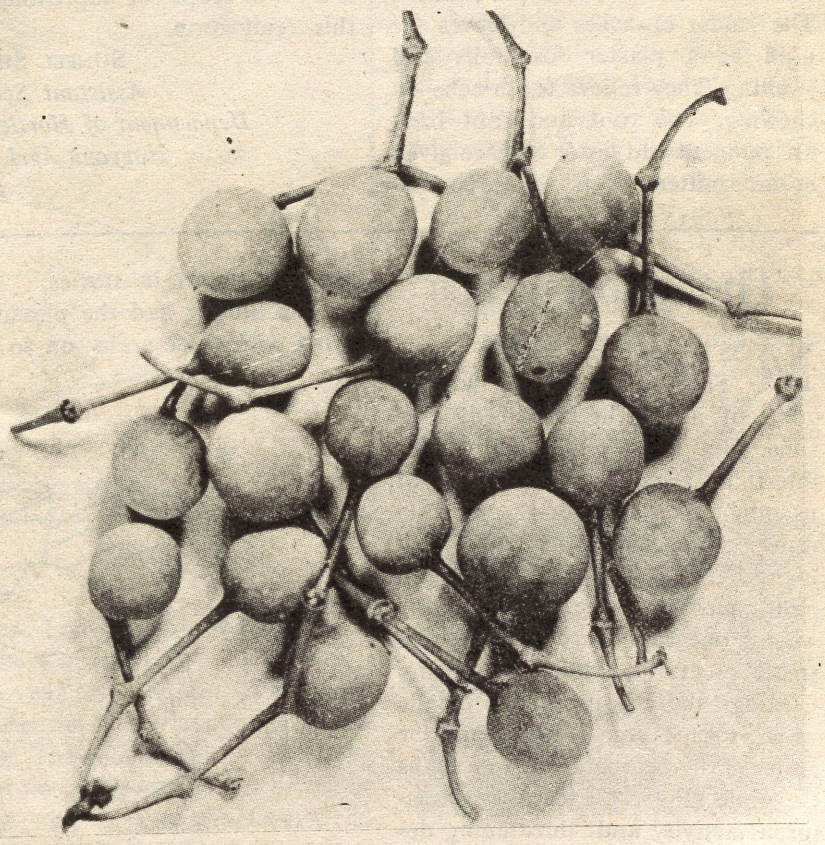

Fig. 2. Fruits of *ker*

Table 1. Chemical composition of green *ker* fruits

Moisture	—	55.10%
Crude protein	—	8.62%
True protein	—	5.02%
Total sugar	—	1.76%
Reducing sugar	—	1.14%
Phosphorus	—	0.057%
Potassium	—	1.026%
Calcium	—	0.055%
Magnesium	—	0.053%
Ascorbic acid (Vit. C)	—	7.81mg/ 100g of pulp

(*Source* : 1973-74 Report of Deptt. of Horticulture, H.A.U., Hissar)

and September-October from first and second flowerings. Normally, fruits from second flowering are not used. A bush about four to five years old bears 5 kg of berries.

Uses

Most of the plant parts like root, bark, stem, leaves and fruits have economic as well as medicinal values. The tender branches and leaves are used as a plaster for boils and swelling. They relieve tooth-ache on chewing. The root and root bark are pungent and bitter and are given in intermittent fevers and rheumatism. The stem bark is used in medicine as a laxative, diaphoretic, alexeteric, anthelmintic and useful in cough, asthma and bronchial inflammation. The wood is used as fuel. Immature flower buds and flowers are used as vegetables. The green, immature, acrid fruits are used raw for pickle making.

The chemical analysis of immature, green fruits shows high amount of protein content, viz., 8.62 per cent and 5.02 per cent crude and true protein, respectively. The protein content of *Ker* is more than most of the cultivated fruits like banana (0.7%), grapes (1.3%), guava (0.8%) and mango (0.7%). Fruits are also rich in mineral constituents. Mineral content is also higher than most of these fruits.

Despite its high economic value, no systematic improvement work has so far been done on *Ker*. There is a lot of scope for improvement of this fruit crop.

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The ghost crabs

MOST of us might have enjoyed the wave washed zone of a sea beach during day time. But the lively scene of the intertidal region, which many of us might have missed, is seen only during night, especially on moonlit nights. Apart from lovely moon light, pleasant breeze and rolling waves, one can enjoy thousands of small creatures, running, chasing, fighting and digging all along the wave washed region. They are the ghost crabs belonging to the genus Ocypode (Fig. 1). Except their nocturnal activity and threatening defence behaviour, they are not at all like the ghosts in stories.

The author had the pleasure of living with these crabs on so many nights for his research. Apart from many common interesting behaviour, these crabs are peculiar for their burrow building, defence and sound producing behaviour.

Abundant grazing of these animals can be observed during night time, low tide periods especially on new moon or full moon days. One may wonder how these crabs emerge during night from underground burrows where there is little indication of day and night changes. This can be explained by the inbuilt rhythmic activity seen in them. They have different time schedules for their grazing. On new moon days, they graze throughout night, but on full moon days they finish grazing and go into their newly built burrows around 1 a.m.

The burrow building behaviour is quite interesting. Their house is 'V'-or 'Y'-shaped (Fig. 2). The open arm is the entrance, while the ascending arm is closed and ends just below the soil surface which serves as an escaping or emergency exit. Another interesting aspect of this burrowing behaviour, exhibited by a genus of ghost crab, is the decoration of its burrow entrance by piling up sand in the form of a pyramid by the adult male crab to attract females. These special types of

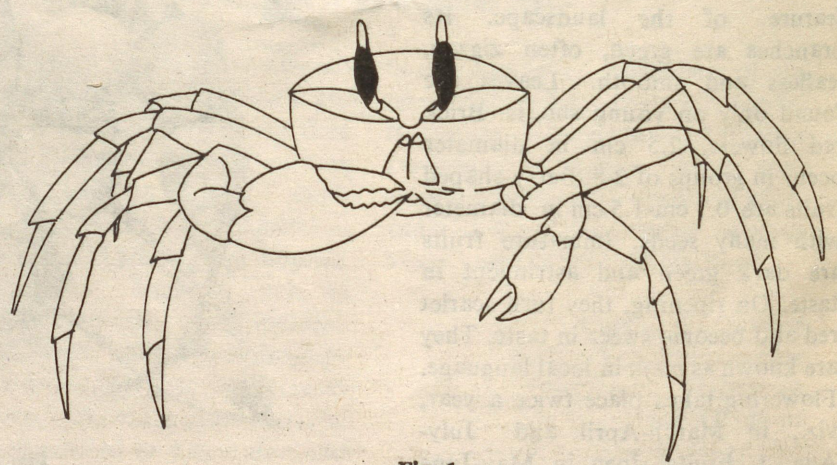
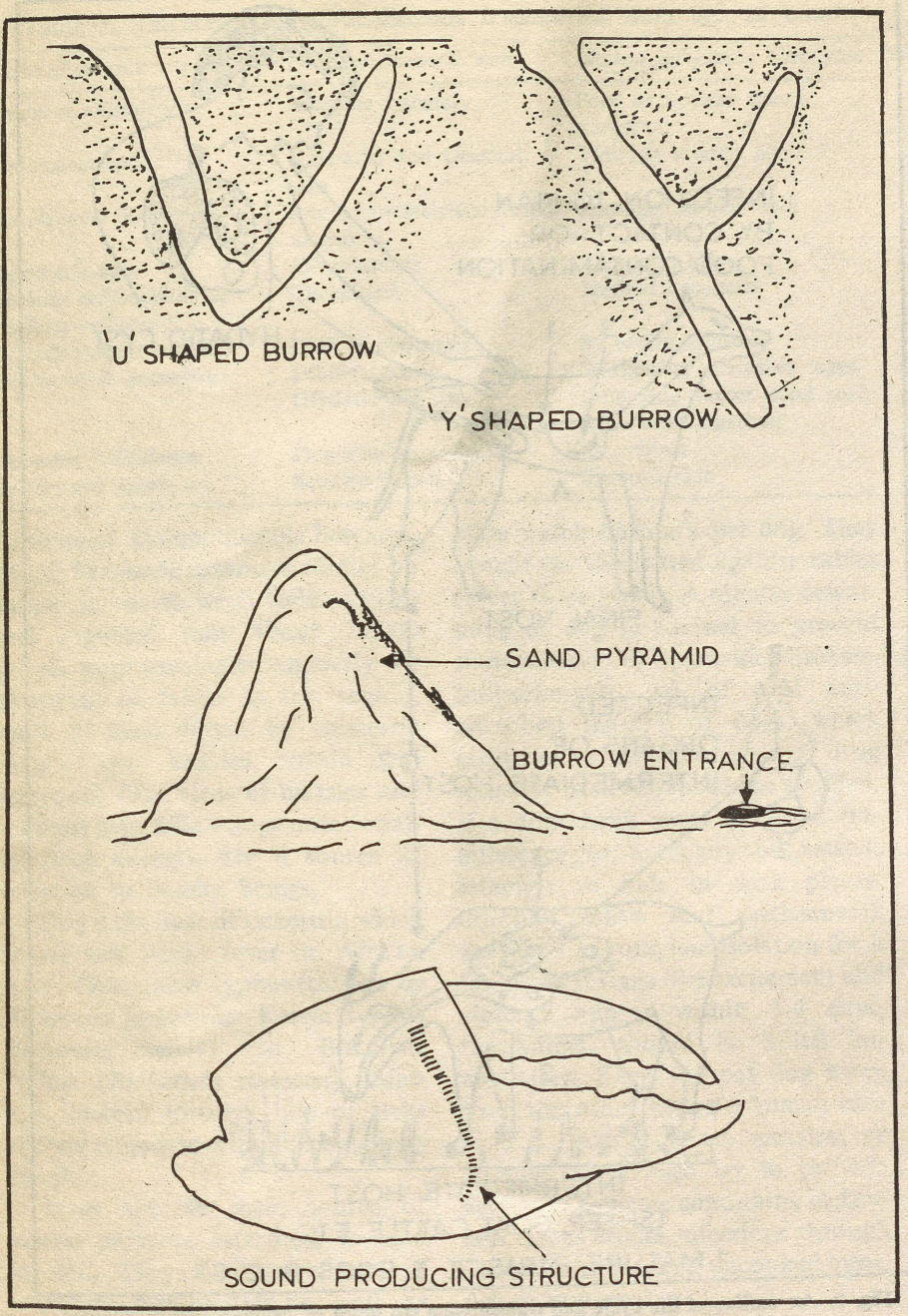


Fig. 1



Figs. 2, 3, 4

burrows are termed "copulation burrows" (Fig. 3).

The defence strategy of crabs is very interesting. When threatened, they raise their two chelate legs as if prepared to defend or attack (Fig. 1). If any predator or enemy catches hold of its leg, it escapes by simply shedding off the limb. This phenomenon, known as autotomy, is very common in crabs.

An exciting and unique feature of ghost crabs is their sound producing organ. They have a sound producing structure in the palm of their major *chela* (Fig. 4). The structure varies in different species. From the nature of the sound produced, different species are able to identify themselves from others. Even two sexes of the same species produce different sounds.

Although of little edible value because of their small size (maximum size 65 mm width), the local fishermen believe that its soup enhances milk secretion in lactating mothers.

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Dogs can be dangerous

DOG, a member of family *Canidae* of mammals, was the first animal domesticated by man; it was in the Mesolithic or probably in the late Palaeolithic period (11,000 B.C. - 9,000 B.C.). In India, during the Indus Valley civilization at Mohen-jo-Daro (3 millennium B.C.), dogs resembling the modern pariah dogs, lived in close association with man.

The early dogs were the half wild wolves or jackals and they were kept for hunting purpose by the prehistoric man (who was then a hunter and food collector). Later, dogs became useful to man in many other ways. Dogs have economic and emotional relationship with human society.

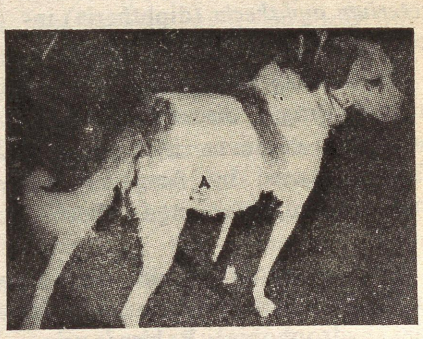

Fig. 1. A pet dog with lesion of Mange (A); such dogs are dangerous to human health

They have also been a source of danger under some conditions and could harm human population by biting and transmitting several bacterial, viral, parasitic, fungal and rickettsial diseases.

In India, no exact figure of dog bite victims is available, but it is estimated that nearly 15,000 people die annually on account of rabies which is predominantly (89%) attributed to dog bite.

The main problem of human health created by dogs is transmission of various infectious diseases. Bacterial diseases which can be transmitted by dogs are tuberculosis, brucellosis, anthrax (Splenic fever), salmonellosis, scarlet fever, diphtheria, plague, etc. Dogs are susceptible to *Mycobacterium tuberculosis* and *Myco. bovis*—the causative agents of tuberculosis in man (human and bovine type, respectively). Tuberculosis in dogs produces few symptoms that are characteristic of T.B. The tuberculin test (a diagnostic test for T.B. carriers) is not dependable in case of dogs. Carrier dogs may be a menace to human beings, especially children who play with them. Dogs carry *Salmonella enteritidis* and *S. typhinurium* pathogens which cause gastroenteritis and typhoid in man. Salmonellosis can be transmitted to man by food and water contaminated by infected dog's faeces. Dog is also responsible for the transmission of Streptococci (scarlet fever in man) and *Corynaebacterium diphtheria* (diphtheria) infection to man by direct contact.

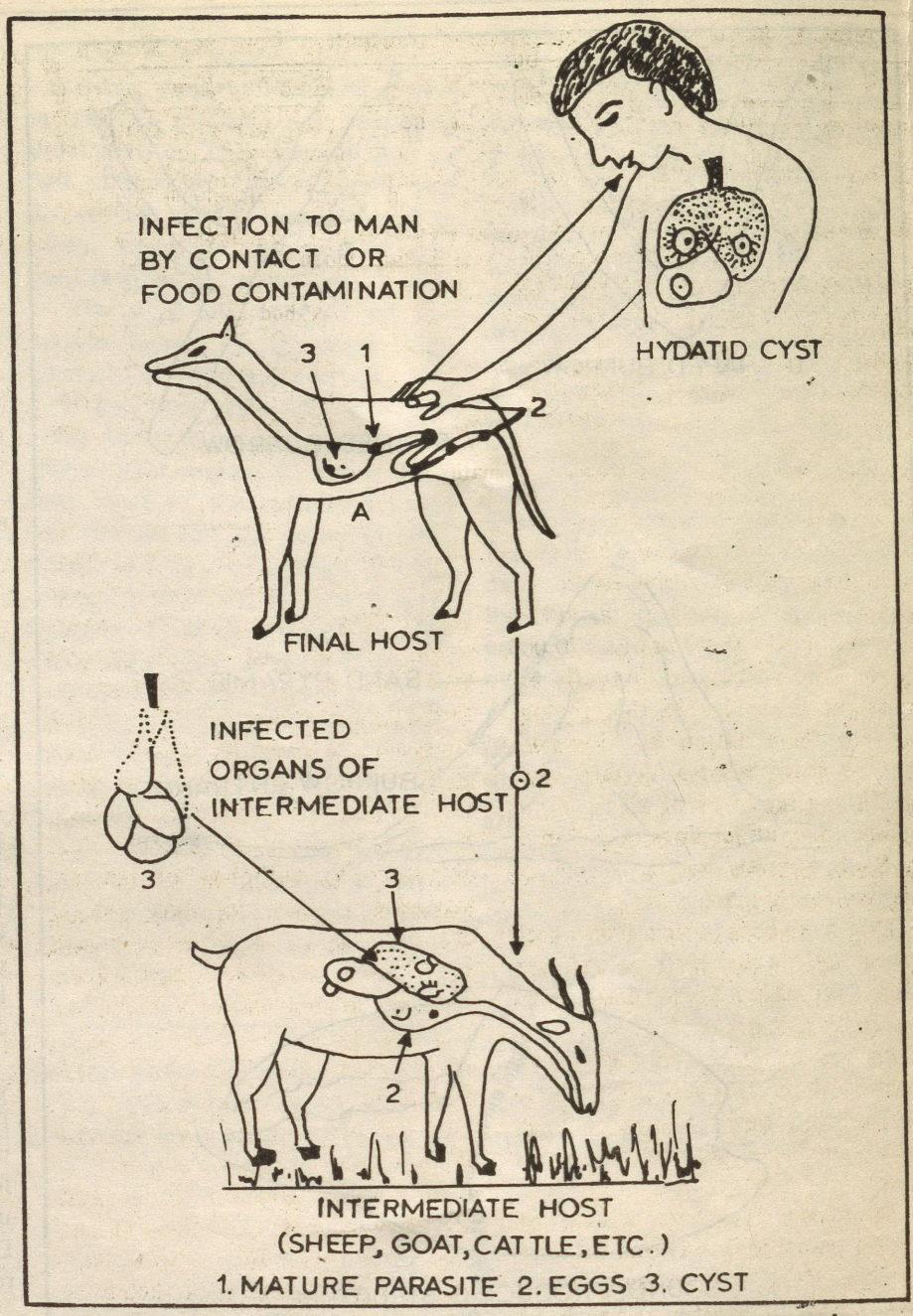

Fig. 2. An outline of life cycle and transmission (to man) of *Echinococcus granulosus*

Dogs along with other animals transmit fungal diseases to man. The most common is ringworm infection caused by fungi of the genus *Microsporum* and *Trichophyton*.

The most important viral disease transmitted from dogs to man is rabies (hydrophobia). Rabies is principally a disease of wild carnivores like jackals, foxs, cats, hyenas and stray dogs, but all warm-blooded animals including man are equally susceptible to it. According to a survey made by B. Bijorvatn and S.G. Gundersen of Norway (1980), among 296 Norwagian missioneries working abroad, risk of rabies was the highest in India, followed by Ethiopia, Bangladesh, Ecuador and Bolivia. The rabies is epidemidiogically divided into two types, viz., the wild cycle or sylvatics or wild life rabies and urban cycle.

The dog plays a key role in the urban cycle, being responsible for 80%-90% of total human exposure. Rabies virus is found in saliva of rabid dogs. They infect man by biting. A.N. Raichaudhuri (National

Table 1. Important parasitic diseases transmitted from dog to man

Name of parasite	*Name of disease in man*	*Method of human infestation*
Entamoeba histolytica	Amoebic dysentery	Food and water contamination
Leishmania spp.	Kala-azar and Oriental sore	Through sandfly bite
Ancylostoma ceylonicum	Ancylostomiasis (dog hook worm)	Through broken skin
Dirofilaria spp.	Dirofilariasis	Mosquito bite
Thelazia californiensis & *Thelazia callipaeda*	Thelaziasis	Method uncertain
Diphyllobothrium latum	Diphyllobothriasis	By eating raw fish
Echinococcus granulosus	Echinccoccosis (Hydatid disease)	Swallowing parasitic eggs from dog faeces food and water contamination
Domodex folliculorum	Dog-mite dermatits	By contact
Schistosoma japanicum	Schistosomiosis	Through skin

Institute of Communicable Diseases, Delhi) has made extensive studies on rabies in north-west India (1976) and reported that about 70,000 people were vaccinated annually for treatment of rabies in this region, most of them bitten by domestic dogs or cats. Besides, certain viral infections (like virus of measles and mumps) may afflict dogs occasionally. Such animals are a source of infection to human beings.

Dog is the host of rickettsia which causes tick borne fever or African fever, Colombian typhus (caused by *Rickettsia rickettsiae* Kenya typhus *Rickettsia conori*) and Brazilian typhus (*Rickettsia rickettsi*). Man gets infected through bite of ticks already engorged with infected dog's blood.

Dogs are the main source of several parasitic infections to man as well. They are transmitters of protozoan, helminthic as well as arthropod parasites to man, responsible for various ailments (Table 1 and Figs. 1 & 2).

To check the spread of these zoonotic diseases, one should have a close watch on one's pet dog. They should be vaccinated against rabies (every three years). A regular deworming of dog is advised to prevent transmission of parasitic diseases. Indiscriminate use of oral antimicrobial therapy of dogs, which gives rise to the occurrence of drug resistant bacteria, should be avoided. If a dog shows signs of rabies (indifference to authority of master, attempts to hide in dark places, drooling saliva and restlessness), keep him in complete isolation for a few days. If signs like excitement and violence appear within 3-4 days, the animal should be killed immediately. Keep the pet dog away from the room where a human case of T.B., scarlet fever, measles, or mumps exists. Also try to provide necessary hygienic conditions in kennels. Dogs aquire infections through contact with carriers, uncooked meat, fish or raw meal.

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And now selfish DNA

THE idea of selfish gene or deoxyribonucleic acid or in short selfish DNA is related with natural selection but here it acts at the molecular level, that is, at the level of DNA. It is most probably Dr Richard Dawkins of England who first described this idea in his book *The Selfish Gene*. Though Dawkins' definition included all surplus DNAs under the term 'selfish gene', L.E. Orgel and F.H.C. Crick of the Salk Institute, California (U.S.A.) defined the term in a wider sense to accommodate not only repetitive DNA (occurrence of multiple copies of similar DNA sequences) but also certain other DNA sequences which appear to have little or no function, for instance much of the DNA in the introns (the intervening segments between the coding sequences) of genes and parts of the DNA sequences between genes. In molecular genetics, natural selection is believed to operate upon the replicating units or replicons: In this process, the more efficient replicating units increase in number at the expense of their less efficient competitors. After a considerable period of time, only the most efficient replicons are in majority. This type of selection at the level of DNA also provides an explanation for the spread of useful genes or DNA sequences that contributes positively to fitness within a population. This tends to increase their representation at the cost of less useful ones. But, in the case of selfish DNA, the sequences which spread make no contribution to the phenotype of the organism. It is considered to be a slight burden on the cell that contains it or it is even better to suppose that it is a parasite or a harmless but useless passenger hitching a ride in the survival machines created by the other DNAs within the genome. This extra amount of the genetic material having little specificity is considered as junk. The designation "selfish" for this class of DNA is funny. However, these DNA sequences cannot be said to be selfish by themselves, it is the natural selection which makes it selfish.

Repetitive DNA

The occurrence of multiple copies of similar DNA sequences in chromosomes of higher organisms is a noteworthy discovery of the recent past. This property establishes a notable difference between the prokaryotes (organisms with simple DNA molecule) and eukaryotes (organisms having complex DNA molecule, chloroplast, mitochondria, etc.). The presence of repeated DNA sequences in varying amounts has been demonstrated in different organisms, including both higher plants and animals. Though the distribution of these sequences in chromosomes has been debated, its location at centromeres, secondary constrictions and at telomeres has been confirmed in addition to its occurrence in other parts of chromosomes, interspersed with the unique sequences of DNA (occurring only once in a genome).

The amount of DNA in relation to selfish gene

The presence of a large amount of DNA sequences in the chromosomes of the most eukaryotes has been a puzzle for a considerable period of time. It has also been well-known that the entire portion of the DNA, present in a particular organism, is not transcribed and only a minority of sequences has highly specific functions. The majority of the sequences does not code for protein since they do not occur at all in processed messenger ribonucleic acid (mRNA).

The phenomenon has somewhat been clarified by the discovery of *introns* in many genes. Introns are the intervening sequences found on stretches of DNA of almost all organisms which remain interspersed with unique sequences which code for proteins. These interspersed DNA may be needed for gene control. The tenable hypothesis is that they have little specific function and may be treated as junk. Nevertheless, various functions have been attributed to such repetitive DNAs, including their functions as spacer, control elements, etc. It is not unlikely that the introns and other repeated sequences represent different degrees of repetition necessary for the control of nuclear events as well as for inter-chromosomal control of metabolism. It is also not unlikely that in eukaryotic system, they act as buffer stock and may serve as store-house of additional genetic elements to be utilized by the organisms in need of adaptations, for example, the gene responsible for drought resistance.

Selfish gene and natural selection

Natural selection between genotypes provides a balancing force that attempts to maintain the total amount of selfish DNA at an equilibrium level. Organisms whose genome contain an excessive proportion of selfish DNA would be at a metabolic disadvantage relative to organisms with less selfish DNA and so would be eliminated by the normal mechanism of natural selection. Excessive spreading of functionless replicators may be considered as a cancer of the genome—the uncontrolled expansion of one segment of genome would ultimately lead to the extinction of the genotype that permits such expansion.

When the total amount of selfish DNA becomes comparable to or greater than that of useful DNA, it seems likely that the selective disadvantage would be significant. One may, therefore, expect that the mechanism of the formation and deletion of nonspecific DNA will adjust in each organism so that the load of DNA is sufficiently small and it can be accommodated without producing a large selective disadvantage.

The elimination of disadvantaged organisms from a population by their more favoured competitors takes several generations. For typical higher organisms, this is a very long time, so the elimination of a particular stretch of selfish DNA may be a very slow process even on a geological time scale. Secondly, mechanisms for the deletion of short sequences of DNA may be inefficient, as there is a strong selective pressure for the development of corrective measures when the fault carries a relatively small selective penalty. Taken together, these arguments suggest that the elimination of a particular piece of junk from the genome may be a very slow process.

This, in turn, suggests that the amount of useless DNA in the genome is a consequence of a dynamic balance. The organism attempts to limit the spread of selfish DNA by controlling the mechanism for gene duplication, but is constrained by imperfections in genetic process and/or by the need to permit some duplication of advantageous genes. Selfish DNA sequences attempt to subvert these mechanisms and may be able to do so comparatively rapidly because mutation will affect them directly.

For any particular type of selfish DNA, there is no reason that a steady state should be reached in evolution. The situation would be continually changing. Random mutations in the selfish DNA might make it more like ordinary DNA or so, perhaps, less easy to remove. On the other hand, it may also lead to the elimination of a normal DNA sequence. Eventually, these sequences, possibly by now rather remote from those originally introduced, may cease to spread and be slowly eliminated. Meanwhile other types of selfish DNA may originate, expand and evolve in a similar way.

In other words, it can be said

that a kind of molecular struggle for existence within the chromosomal DNA is always operating, through the usual process of natural selection. Simultaneously, it is reasonable to believe that such nonspecific genes may rise to levels which are acceptable or even advantageous to an organism depending upon certain features of its life style.

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Milk test to know pregnancy in dairy animals

MILK contains, besides necessary nutrients, about 20 enzymes, some proteins and steroid hormones. Although a number of proteins and steroid hormones have been detected in the milk of dairy animals, only progesterone (also called hormone of pregnancy) has been studied extensively, in particular its application to pregnancy diagnosis. The importance of the hormone lies in its diagnostic value and in aiding husbandrymen to manage reproduction.

Source of progesterone

Unlike some primates including humans, female dairy animals show sexual inclination towards the opposite sex only during a particular period called 'Oestrus'. Oestrus differs from the menstrus in that there is no bleeding in the former. Ovulation (shedding of the female gamete from Graafian follicle) takes place around oestrus and the Graafian follicle is transformed into corpus luteum. The granulosa cells (internal layer) of the Graafian follicle are transformed by hypertrophy and hyperplasia into lutein cells of corpus luteum. The lutein cells of corpus luteum secrete progesterone into blood stream.

Pattern of progesterone secretion

In case of pregnancy setting in, the corpus luteum is maintained and so is progesterone secretion. However, if pregnancy does not settle, the corpus luteum regresses and progesterone secretion stops (Fig. 1). The animal comes to heat again, repeating the cycle. The length of menstrual cycle is about 30 days, which is longer than oestrous cycle (about 20 days). Normally, if an animal does not return to oestrus after the stipulated period, it is thought to be pregnant. However, some animals show poor symptoms of heat, go undetected and are mistaken as being pregnant. Pregnancy is not confirmed until 60 days after artificial insemination or breeding.

Progesterone and pregnancy diagnosis

With increase in human population and proportionate increase in milk consumption, the herd size is also enlarging. Increase in herd size poses managerial problems. One major problem is to ascertain if pregnancy has set in the animal. The traditional methods of non-return to oestrus and rectal palpation are tedious and not wholly reliable. Inability to ascertain pregnancy at a proper time leads to a longer calving interval. Consequently, it reduces milk production and loss to the dairyman.

In order to overcome this problem, one solution was to estimate progesterone in blood plasma because of its typical pattern during oestrous cycle and early pregnancy. If progesterone concentration is found to be above the value at oestrus at the time when the animal is expected to cycle, the animal can be regarded as pregnant. Because of the likely variation in the length of

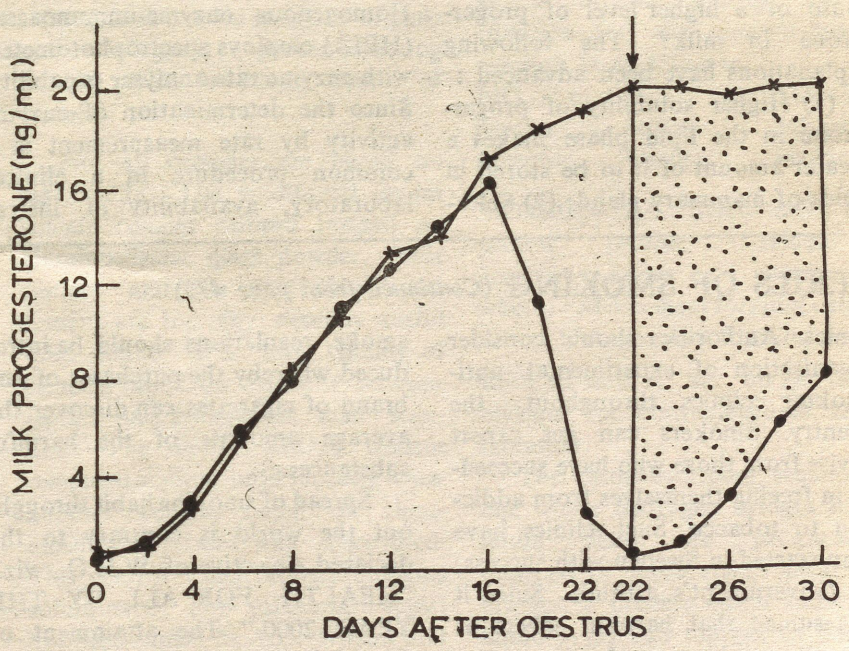

Fig. 1

oestrous cycle, a few samples collected after the stipulated length have greatly improved the success rate of pregnancy diagnosis. This test gave a fairly high success rate (70 %-80 %). The use of highly sensitive and specific technique of radioimmunoassay has made it possible to detect the hormone level even to the extent of picograms (10^{-12} gram). The results are available within a day. The main problem faced in blood progesterone test is the cumbersome job of blood collection and its processing. Besides, it was not practicable in field conditions.

One possibility was to measure the hormone in milk and to see if it could serve as an index of pregnancy. Milk progesterone test yielded satisfactory results. Surprisingly its concentration in milk was found to be 2-4 times high than in plasma. It was possible to measure the hormone directly in the milk samples, and skip the usual procedure of extraction. This not only simplified the assay procedure but also reduced time and cost. The question that naturally arises is: What could be the cause of a higher level of progesterone in milk? The following explanations have been advanced :

(1) Higher solubility of progesterone in the lipid phase makes a greater amount of it to be stored in lipids of mammary gland; (2) Selective uptake by the mammary gland; (3) 'Concentration' in the mammary gland; and (4) Presence of its metabolites in milk.

The milk progesterone test is now being increasingly used as a routine test for diagnosis of pregnancy in some European countries. As mentioned earlier, progesterone is lipid soluble and therefore any variation in the fat content is likely to influence results. However, estimation of progesterone directly in fat or skim milk can eliminate the error due to variation in fat content.

One of the limitations of the test is its application in non-lactating animals. The chief hurdle hampering the popularisation of this test is the high cost involved in the assay and the use of costly and imported instruments. The use of enzyme-immunoassay, instead of radioimmunoassay, has to a great extent overcome some of these problems. The use of the former method has reduced the reagent cost and technician's time required for the assay; the process employed is simple and the instrument easily available. Homogenous enzyme-immunoassay (HEIA) employs spectrophotometers with enzyme rate analyser capability. Since the determination of enzyme activity by rate measurement is a common procedure in a clinical laboratory, availability of instrumentation for HEIA is usually not a problem. Moreover, by the use of this technique one escapes potential health hazards associated with the use of radioactive materials and the problems associated with the disposal of radioactivity in the environment.

Is progesterone in milk a health hazard?

A dairy cow or buffalo generally spends three-fourths of its reproductive life in pregnancy. So, in a herd three-fourths of the animals will usually be pregnant. Progesterone is secreted during pregnancy. A question therefore arises: Does the presence of progesterone in milk pose any health threat? Possibly not, because progesterone given by mouth is much less effective than that administered by injection. Moreover, relatively large doses (300 mg-1000 mg) are required to evoke contraceptive response in a woman whereas the concentration found in milk is not more than 10^{-9} gm. Such low levels of progesterone in milk and milk product would not have any significant biological effect.

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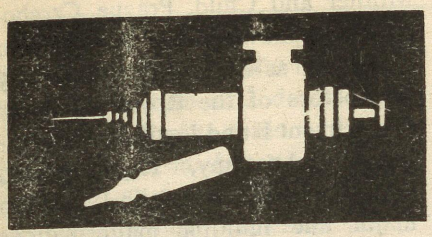
PERILS OF SMOKING (*Continued from page 475*)

clinics. Authorities should consider organisation of experimental anti-smoking clinics throughout the country. Smokers can get expert advise from those who have succeeded in freeing themselves from addiction to tobacco. Such clinics have been started in Sweden with success; (4) Government's attitude. Since it is assumed that harmful effects of cigarette smoking may be due to tar, volatile irritants and nicotine in the smoke, regulations should be introduced whereby the purchaser of any brand of cigarettes can discover the average amounts of the harmful substances.

Spread of smoking habit throughout the world is contrary to the declared objective of W.H.O., viz., "HEALTH FOR ALL BY THE YEAR 2000." The attainment of this goal will be seriously hampered if smoking-related diseases are allowed to reach epidemic proportions in the developing world.

Further reading

1. Wodehouse, J. Henry, *The Smoking Habit* (*Its Dangers & Cure*).
2. *Smoking and Health*—A Report of the Royal College of Physicans of London on smoking in relation to cancer of the lung and other diseases.
3. Chesser, Eustace, *When And How To Stop Smoking*.



MEDICAL NOTES

Dental cements

THE art of dentistry such as exodontics, the extraction of teeth, and prosthetics, the complete replacement of teeth is as old as civilisation. Modern dentistry is concerned with the restoration of the function and appearance of teeth following lesions caused by caries. Besides prosthetics (a form of restoration), the conservation of natural dentition is called conservative dentistry. The latter restores the eroded teeth by using a filling material or a cemented inlay or crown.

The subject of dental materials forms an essential part of restorative dentistry. Since they are prepared by clinicians in the surgery, they must have good manipulative properties and adequate working time allied to the ability to set and harden rapidy once placed in position. They should, ideally, adhere to tooth material. Moreover, dental restorative materials are required to function in the sensitive but hostile environment of the mouth. They should be bland towards living tissues, yet be able to withstand the aggressive action of acid generated from sugars by micro-organisms. No one material meets all these requirements and all have limitations of peformance and application. For this reason a wide variety of restorative materials have been formulated.

Common dental cements

One of the most important classes of materials used in dentistry is that of the dental cements. These materials, which are prepared directly in surgery, are used for many purposes. Depending on their formulation they may be used to attach prefabricated crowns and inlays to teeth, to line cavities for the protection of dental pulp against chemical and thermal insult, and even for direct filling of cavities.

All dental cements are based on hardening reaction between a powdered solid and a viscous hydrogen-bonded liquid. The plastic pastes formed by mixing these components set rapidly to hard salt-like gels. The liquids, which may be waterbased or organic, act as acids or proton donors. Cement powders are essentially amphoteric or slightly basic substances which act as proton acceptors in the cement forming reaction. They may be simple oxides such as zinc oxide, or complex aminosilicate glasses containing appreciable amounts of fluorides. The most versatile powder for cement formation is zinc oxide which when treated with a wide range of organic and inorganic proton-donating liquids yields a whole family of cements.

Not all cements are based on zinc oxide. The traditional dental silicate cement utilised instead an aluminosilicate glass powder. This cement and the zinc phosphated cement are the only dentally useful ones found in a large family of cements based on reactions between oxides and phosphoric acid solution. The dental silicate cement remained unique until recently when another cement based on aluminosilicate glasses was discovered. This cement which utilises aqueous solutions of poly (alkenoic acids) has been named by A.D. Wilson and B.E. Kent (1971-75) a glass-ionomer or ASPA cement; ASPA is an acronym of alumino-silicate poly acrylic acid.

Undoubtedly the most important recent development in dental cement technology has been the emergence of a new class of cement, the ionic polymer cement system where anionic polyelectrolytes are employed as cement forming liquids. The ionic polymer cements are at present represented by zinc polycarboxylate cement (D.C. Smith, 1968) (which uses a zinc oxide powder) and the glass-ionomer cement of Wilson and Kent. This field of dental science is one where further developments are to be expected.

Dental cements may be more closely defined as acid-base reaction cements. The cement forming liquids are acidic, viscous hydrogen-bonded liquids capable of donating protons, exemplified by eugenol and phosphoric acid. The powders are amphoteric oxides, either zinc oxide or aluminosilicate glass, which act as proton acceptors. The cement-forming reaction is essentially an acid-base interaction between these two components, the gel-salt formed, in the liquid phase acting as a binding matrix. General equation for the cement-forming reaction is as follows:

MO	+	H_2A	=	$MA+H_2O$
proton acceptor		proton donor		salt-gel matrix

$$MOxSiO_2 + H_2A = MA + xSiO + H_2O$$

proton acceptor	proton donor	salt-gel matrix

where, M=cement forming cation
A=cement forming anion

Both M and A are taken to be bivalent for convenience of representation.

The cement-forming reaction is one where hydrogen bridges in the liquid phase are progressively replaced by more rigid metal ion bridges, a process which causes the liquid to gel and the gel to harden. The matrices of all the dental cements are amorphous.

Phosphate bonded cements

Cements based on the hardening reaction between a metal oxide or silicate and a concentrated solution of phosphoric acid can be formulated to set within a few minutes and to develop strength rapidly. This property makes them suitable for dentistry. There are two main types: the dental zinc phosphate cement employed for luting crowns and inlays, and the dental silicate cement used for the aesthetic filling of front teeth. Until quite recently, they remained the materials of choice for these applications, but the advent of the composite resins and ionomer cements has greatly reduced their usage.

Ion polymer cements

The ionic polymer cements which include the most recent dental cements, are based on acid-base reactions between aqueous solutions of poly (alkenoic acids) (40% to 50% w/w) and certain acid-decomposible metal oxides, aminosilico glasses, and minerals. In the setting reaction, liberated cations become bound to poly anions in the aqueous phase to form a hard polysalt gel. These materials are of importance as they are intermediates between a filled organic polymer and an inorganic cement. They are novel in that the gel-matrix contains both covalent C-C and ionic bonds and so can properly be termed ionic polymer (or ionomer) cements.

Many cements are weak, hydrolytically unstable and of little practical utility. However, hydrolytically stable cements are formed from zinc and copper oxides, special aluminosilicate (ASPA) glasses, and the minerals willemite and muscovite. Of these cements those of zinc oxide, the so called zinc polycarboxylate cements and of calcium alumino silicate glasses, the ASPA (or glass ionomer) cements, are important as they find practical applications in dentistry. These cements are notable for being bland towards living tissues and adhesive towards enamel, dentine and base materials. Stainless steel orthodontic buttons can be directly attached to teeth.

Development of restorative dentistry has been related to the availability of suitable materials.

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Insulin and congenital malformations

THE human embryo lies safe within the mother's womb, protected by the amniotic fluid, foetal membranes and the placenta. Normally, the foetal surrounding is stable. Sometimes, however, the intra-uterine milieu is disturbed by factors both intrinsic like the genetic, or, extrinsic such as radiations, physical injury, infections, hypoxia, dyes and drugs. Such factors make their effect felt by causing distortions in the foetal development. Approximately, 10% of all known human malformations are caused by genetic factors, another 10% by environmental factors and the remaining 80% result from an intricate interplay of genetic and environmental agents.

A familiar disease which induces detectable congenital malformations is diabetes. The World Health Organization has put the figures of diabetes-attributed malformations at 1.65%, whereas a study by J. Kucera in 1971 at the Institute for Care of Mother and Child, Prague, Czechoslovakia, showed their incidence to be as high as 4.8%. In another study by doctors of the Royal Maternity Department B and Institute of Pathological Anatomy, Rigshospitalet, Copenhagen, Denmark, in 1964, both major and multiple malformations were found higher in infants of diabetic mothers than in a control series. The more advanced the diabetes in the mother (especially if linked with complications like vascular disease), the more severe are the malformations in her offsprings. The malformations usually produced are: the non-formation or underdevelopment of the femurs and absence of the lower vertebrae. In extreme cases it may lead to foetal wastage, or still-births.

Now, which aspect of diabetes is responsible for such malformations? Is it hypoglycemia, hyperglycemia, vascular disease or other complications in the diabetic mother? Or is it exclusively due to insulin imbalance, either maternal or foetal?

Spotlight has been on insulin. Experiments have been conducted on mice, rats, rabbits and chickens to demonstrate the possible role of insulin as a teratogen. In 1945 it was reported that insulin produced ruplessness and abnormalities of the beak, extremities and eyes in chicken embryos. In 1950, P.K. Duraiswami, an Indian, working at the Department of Orthopaedic Surgery, University of Liverpool, U.K. observed that insulin induced a number of skeletal abnormalities in chicks namely those of the vertebral column, claws, limbs, beak, hip and bone-formation. The severity of deformities increased with increase in insulin dose. In the following year, a group of Americans, H. Lichtenstein, G.M. Guest and J. Warkany, of the Children's Hospital Research Foundation and the Department of Pediatrics, University of Cincinnati College of Medicine, Cincinnati,

U.S.A., produced mild skeletal abnormalities such as a decrease in number, or complete absence of ossification centres in the sternum and irregularities in shape of ribs and long bones in rats. However, later, in 1966, K. Horri, G. Watanabe and T.H. Ingalls of the Department of Public Health and Preventive Medicine, University of Pennsylvania School of Medicine, Philadelphia and the Department of Hygiene, University of Niigata, Japan by their collaborative work, found a decrease in malformations with the administration of insulin in mice.

Does insulin have a teratogenic action on human embryos? The critical period when it could possibly affect is between 4 to 7 weeks of gestation (Mills *et al.*, 1979). A.A. Like and L. Orci, in 1972, found differentiated B-cells at about 10.5 weeks of gestational age, while an earlier study by J. Steinke and S.G. Driscoll, both Americans reported demonstrable insulin in the pancreas at about the 8th week of gestation. Both these reports rule out foetal insulin as a possible teratogen, as it is secreted after the critical period. Maternal insulin too is ruled out as a possible source of malformation, because the placenta is an effective barrier to maternal insulin. So it may be concluded that insulin, whether maternal or foetal, is not teratogenic to human embryos and that some other aspect of diabetes must be the contributory factor.

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Solutions to brain teasers:

1. The problem can be easily solved using a Venn diagram (see Fig. 2). Fill in the diagram as shown. Then you will see that there are 70–29 or 41 who drink coffee only and 60-29 or 31 who drink tea only. Thus the total should be 41 + 31 + 29 or 101, but Edward interviewed only 100 ministers.

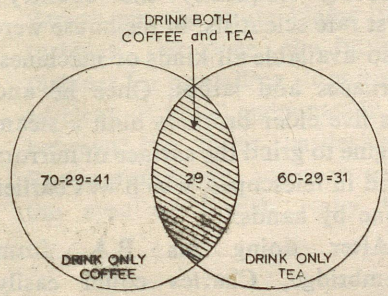


Fig. 2

2. Starting on the coast cross bridge 1, go to the island A; then cross bridge 2 and after passing through B cross bridge 3 and come to the coast. Again cross bridge 8, go to the island D and so on. The whole sequence of crossing the bridges and passing through the islands is as follows: 1–A–2–B–3- coast-8-D-7-C-9-E-5-coast–6-C-4-B (end).

3. Assume that Faqira is guilty. Then Abdul's statement is true and Kishan's is also true. so Faqira's is untrue. Fill in the table (Fig. 3) with tick (if true) or crosses (if untrue) against the initials of the three criminals. Next assume Kishan to be guilty. Follow the same procedure. You will have to find the column containing one tick only because only one of the criminals is telling the truth. Abdul turns out to be the guilty man.

Faqira guilty	Kishan guilty	Abdul guilty
A ✓	A ✓	A X
F X	F ✓	F X
K ✓	K X	K ✓

Fig. 3

4. Since the cube of ab has four digits it is clear that ab cannot exceed 21, for the cube of 22 has five digits. Further, as the cube of ab ends in b, the value of b can be only 1, 4, 5, 6 or 9. Possible values for ab are thus 11, 14, 15, 16, 19 and 21. Of these 21 alone fits the equation, so that $(ab)^3=(21)^3=9261$

It is clear that a = 2, b = 1, c=9 and d=6. These values also satisfy the equation $(cd)^2=cabd$, as $(96)^2=9216$.



SCIENCE FOR THE YOUNG

He opened the gates of power

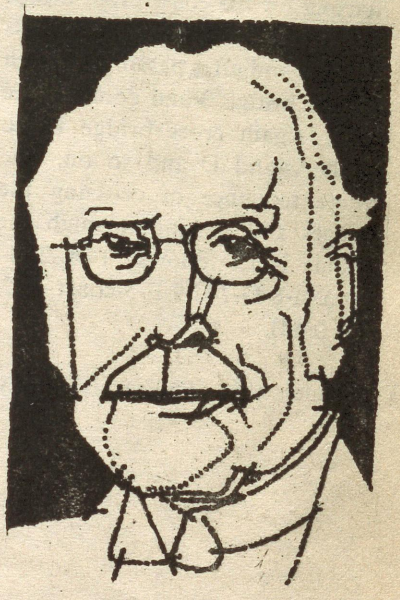
WITH their colourful flags on masts fluttering in the wind, an array of battleships lined the port at Spithead, England in 1897. It was the naval review in honour of Queen Victoria's Diamond Jubilee. Suddenly, a small boat appeared and sailed fast through the colourful ranks of the battleships. The astonished Commander-in-Chief of the Navy opened his eyes wide, swore and ordered a picket-boat to give a chase to the intruding boat. But the picket-boat could not catch up with the speed of the intruding boat let alone capture it! When the Commander-in-Chief examined the flag of the speeding boat through binoculars, he read *Turbinia*. That reminded him of turbines. He wondered whether the boat was not being run by that crazy invention. He was not wrong. The 44 ton *Turbinia* was the first boat to run on a steam turbine. The inventor of the turbine was Charles A. Parson, who used it not only for driving ships but also for generating electricity. Within 20 years he brought the development of steam turbines to such a stage that even in these days of diesel engines and electric motors, they are used for many purposes.

Born on June 13, 1854, in London, Charles A. Parson was the son of an eminent astronomer, who was also a member of the British Parliament and President of the prestigious Royal Society, London. From an early age young Charles had an inventive bent of mind, which blossomed in the atmosphere that prevailed in his house. Besides meeting frequently the country's first rate scientists, in his house were also available all kinds of machines, furnaces and lathes. Once he and his five elder brothers built a steam engine to grind the surface of mirrors used in telescopes, which was earlier done by hands.

After doing his B.A. from Cambridge, Charles could easily have got the job of a Professor in a university. But he opted for the hard path of becoming an engineer, and not an ordinary one at that. He always dreamt of engines and wanted to build a new type of engine himself.

Parson joined as an apprentice to an engineering firm, where, apart from improving the steam engine, he wanted to invent rocket-driven torpedoes for sinking ships. But those were the days when the world needed not torpedoes but suitable steam engines to drive dynamos for generating electricity. The steam engines then in use were highly inefficient. Only 12 per cent of the heat of coal in form of steam was converted into mechanical work. This was because the linear to and fro movement of the steam engine's pistons had to be converted into the rotating motion of the rotor of a dynamo. Parson thought, why not build an engine which would directly produce circular motion needed for dynamo? He observed that some inventors had built steam turbines for producing circular motion, which were, however, highly inefficient and were not used.

A steam turbine works just like a water wheel or a windmill. A jet of high pressure steam is allowed to strike at an angle blades attached to the rim of a wheel, as a result of which the wheel is set into circular motion. Parson made a fundamental change in the design of turbines which made them two to three times more efficient than a steam engine. Instead of having one wheel in the turbine, he introduced a large number of wheels turning on one shaft. The jet of steam moved these wheels one after another till it was exhausted of its energy. In earlier designs, most of the energy contained in the steam was wasted. Of course, Parson did not arrive at this final solution all at once. He first built small cardboard models of turbines, made them of iron and brass, and thereafter made small improvements



Charles A. Parson

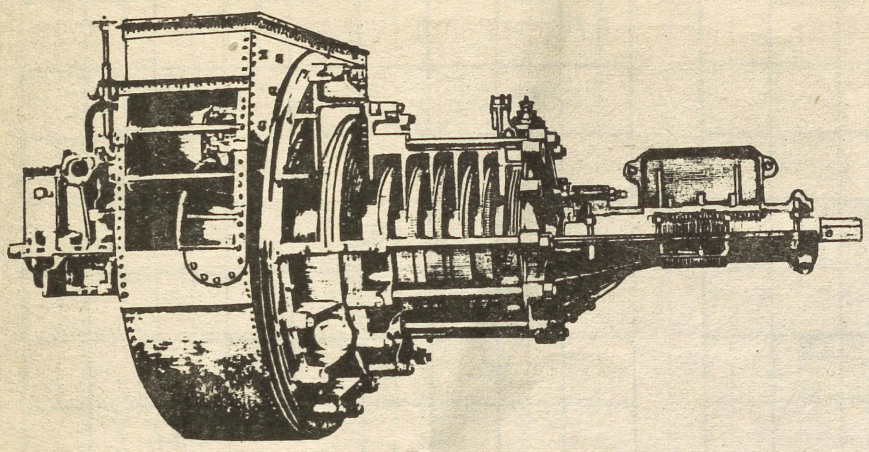


Fig. 1. Radial-flow turbine from the *Turbinia, 1894*

over them to increase their efficiency—a method of inventing things he had acquired from his childhood. His first turbine-driven dynamo generated about 7.5 kilowatts (kw) of electricity.

Parson's turbine came to the notice of the public when an organiser of a skating show, after reading a small news item about it in a daily paper, asked him to install it for lighting the show. His turbine became so popular that an order was placed for a big turbine to generate electricity for a small town. He even received orders from Germany for his turbines. In the meanwhile, Parson started his own firm to manufacture turbines on a large-scale to meet the rising demands. It was at this time that a friend reminded Parson of his age-old desire of building turbine-driven ships. After making some modifications in the turbine and the screw-propeller, Parson was able to launch *Turbinia* in 1897. It could cruise at the speed of 35 knots—the fastest in the world. It was the most popular exhibit at the International Exhibition held in Paris in 1900.

The mischievous manner in which Parson brought the attention of the Commander-in-Chief of the British Navy to *Turbinia* did bear fruit. A few months later, the British Navy placed an order for building two turbine-driven cruisers. Unfortunately, both the cruisers met with accidents within a few weeks of their launch. The opponents of Parson put the entire blame on his turbines. For once, the future of turbines for propelling ships appeared bleak. A naval encounter in 1904 between the faster battleships of Russia and Japan, however, opened the eyes of British Navy Commanders. An order was immediately placed for building a big turbine-run battleship *H.M.S. Dreadnought,* which, when launched in 1906, created naval history. Subsequently, merchant and passenger liners followed suit. The 38,000 ton passenger liner *Mauretania,* which was built by Parson's firm won the "Blue Ribbon of the Atlantic" and remained the fastest ship for no less than 20 years.

Few inventors have realised all their dreams during their life-time as had Parson before he passed away quietly in 1931 while aboard a ship. During his life-time all the major power generating plants had replaced their piston engines by his steam turbines. The power generating capacity of his turbines had risen from the initial 7.5 kw to 200,000 kw!

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Magic squares—a novel method of construction

A magic square of nth order is a square array of n^2 different positive integers with the property that the sum of the numbers in any row or column and the two main diagonals is always the same. The constant sum is called the Magic constant. Depending on the number of cells in the rows or columns being odd or even, a Magic square is called an odd or even order Magic square. Basic Magic squares of order 'n' are generally constructed with consecutive numbers from 1 to n^2 and the Magic constant of such a square is given by the equation $\frac{1}{2}n\ (n^2 + 1)$.

History of Magic squares is very interesting and a few methods are available for constructing them. The existing methods are cumbersome and involve arranging the numbers 1 to n^2 in some regular fashion. This new method makes use of the relationship among the various numbers to build up the magic square. A fundamental knowledge of arithmetical progression is sufficient to understand and construct a square by this method. The following definitions would be helpful:

(a) Each of the n^2 smaller squares in a Magic square is called a cell.

(b) Common difference (c.d.) is

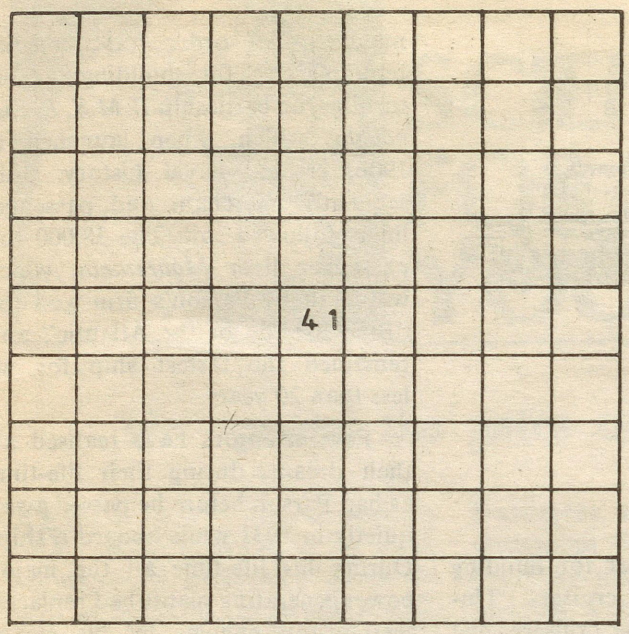

Fig. 1.

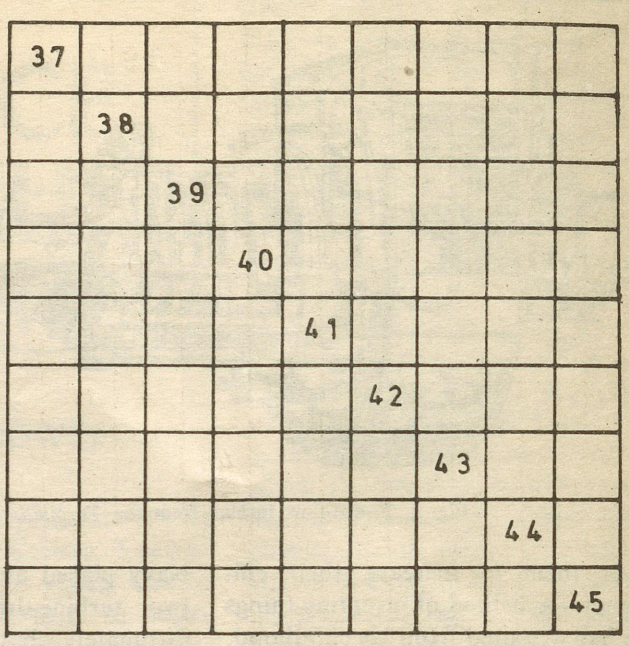

Fig. 2.

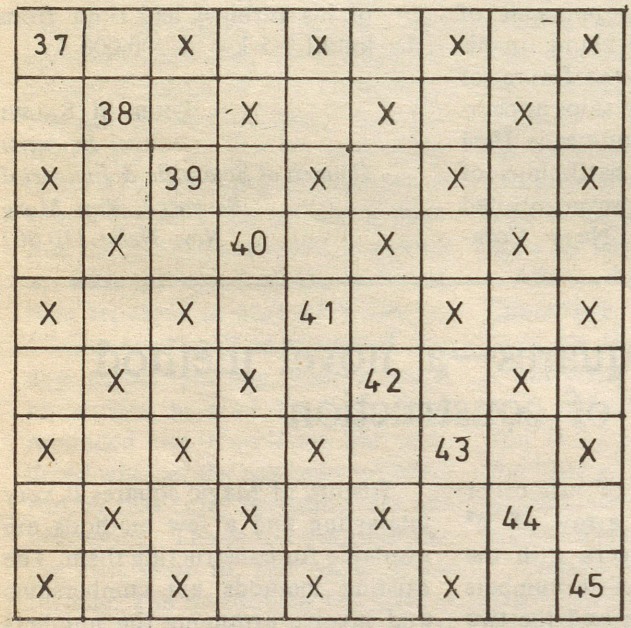

Fig. 3.

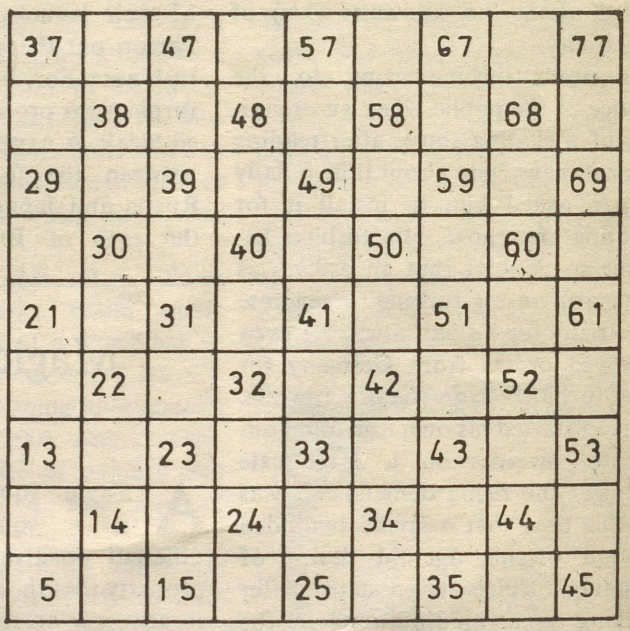

Fig. 4.

Fig. 1. Centre cell; Fig. 2. Descending from *L* to *R*; Fig. 3. Vacant diagonal cells; Fig. 4. Filled diagonal cells

the constant, observed between two successive numbers in a row or column.

(c) Border squares are sets of squares engulfing the immediate centre square. An nth order Magic square will have $\frac{n-2}{2}$ border squares.

The method outlined here is applicable only to odd Magic squares. The rules observed in this process are as follows:

(i) Enter in the central cell, the number $\frac{n^2+1}{2}$ where n is the order of the square (Fig. 1).

(ii) Fill in one of the main diagonals with successive and preceding numbers so that the numbers are either ascending or descending in a given direction (Fig. 2).

(iii) There will now be vacant diagonal cells on either side of the above cells as shown marked 'X' in

37	6	47	16	57	26	67	36	77
78	38	7	48	17	58	27	68	28
29	79	39		49		59	19	69
70	30		40		50		60	20
21	71	31		41		51	11	61
62	22		32		42		52	12
13	63	23		33		43	3	53
54	14	55	24	65	34	75	44	4
5	46	15	56	25	66	35	76	45

Fig.5.

37	6	47	16	57	26	67	36	77
78	38	7	48	17	58	27	68	28
29	79	39	8	49	18	59	19	69
70	30	80	40	9	50	10	60	20
21	71	31	81	41	1	51	11	61
62	22	72	32	73	42	2	52	12
13	63	23	64	33	74	43	3	53
54	14	55	24	65	34	75	44	4
5	46	15	56	25	66	35	76	45

Fig.6.

Fig. 5. n × n border filled, (n-2) × (n-2) filled., Fig. 6. (n-4) × (n-4) filled followed by (n-6) × (n-6)

Fig. 3. Each of these vacant cells are filled with numbers, so that each group of cells in diagonals perpendicular to the diagonal filled in earlier, forms an arithmetic progression with a constant difference equal to the order of the square. In Fig. 4, for example, the order is 9. So we have diagonals with numbers (from lower right hand corner), 35, 44, 53; 25, 34, 43, 52, 61; 15, 24, 33, 42, 51, 60, 69 ... and so on.

(iv) Next step is to fill up the vacant cells in the border squares. You can observe that the numbers in the orthogonals (i.e., rows or columns) are in an arithmetic progression with a c.d. equal to (n —1) or (n+1). Select the orthogonals in such a way that they have a pair of vacant cells at their ends. Add the corresponding c.d. to the largest number in any orthogonal and enter it in the corresponding farthest vacant cell. Similarly deduct the c.d. from the smallest number and enter it in the farthest cell. Complete all the vacant cells in the n × n border square and then proceed to the (n — 2) × (n — 2) border squares. For example, in Fig. 5, the c.d. in the rows is 10, i.e. (n + 1), and that in the columns is 8, i.e. (n — 1). To fill the end cells in the 2nd row from top add 10 to 68 and put the sum, viz., 78 in the left hand vacant cell. Again substract 10 from 38 and put the difference, viz., 28, in the right hand vacant cell. And so on.

(v) From the $(n - 4)^{th}$ border square onwards. (for squares of order 7 and above), rule (iv) is slightly modified. The progressive numbers obtained from rule (iv) are entered in the adjacent and not the farthest vacant cell of the corresponding row or column.

The example shown is for a 9th order Magic square with a Magic constant of 369. You may try it out on a odd-magic square of any order.

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Brain teasers

1. The careless marketing surveyor

Edward got some job in a market research agency. The agency boss asked him to do a survey on ministers to study their perferences for tea and coffee. Edward did the survey and told his boss: "I interviewed 100 ministers. Of them 60 drink tea, 70 drink coffee and 29 drink both tea and coffee."

"You are fired!" boomed the boss. But why did he fire Edward?

2. Over the bridges and the islands

In Fig. 1 are shown five islands A, B, C, D and E. They are linked by nine bridges to each other and to the coast as shown. Starting on the coast can you cross all nine bridges once only, going through all the

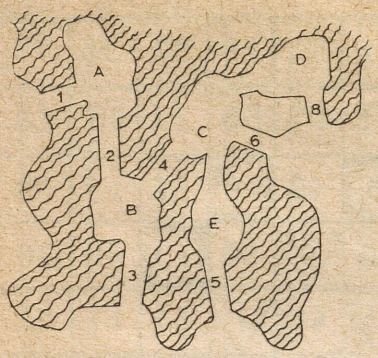

Fig. 1

islands (but any island can be crossed maximum twice) and end on island B ? You are not allowed to go to the islands B and E crossing bridges 3 and 5, but you can cross these bridges and come to the coast.

3. Figure out the criminal

The judge eyed the three criminals in the dock, Kishan, Faqira and Abdul. One of them was guilty of a robbery. When questioned they spoke up in turn :

Abdul : I did not do it, your Honour.
Faqira : Kishan did it sir.
Kishan : I'm innocent me Lord ! Faqira is lying.

The judge knew the criminals of old. He also knew that only one of them was telling the truth. Who did he convict ?

4. A puzzle with digits and letters

In the equations below the letters a, b, c, and d represent four different digits. Can you find the numerical equivalents of a, b, c and d ?

$(ab)^3 = cadb$
$(cd)^2 = cabd$

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(Solutions on page 495)

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Herbal hair dressing

HAIR dressing constitutes a very important product category in the cosmetic toilet industry. Hair dressings are best defined as oil based preparations applied to hair to hold it in place and to improve its luster and condition. Included in this category are various oils, emulsion creams, cream oil liquids, hydroalcoholic hair dressing and hair tonics. Women's hair preparation differ from men's in having gums mucilages, resins and fixed oils which make hair easier to comb and style and enhance its luster.

Hair washes

Many plants exhibit soap like activity and are actively used as soap alternatives e.g., pods of shikakai (*Acacia concinna*) pericarp of soapnut fruit (*Sapindus*), *Agave* leaf juice, soapwort (*Saponaria officinalis*) leaves and soapweed (*Yucca*). Amla (*Emblica officinalis*) being an acidic substance serves as a detergent shampoo. Spikenard (*Nardostachys jatamansi*), mint (*mentha*), milfoil (*Achillea millefolium*), jayaphal (*Myristica fragrans*), pepper (*Capsicum*), chamomile (Roman and German), rose, henna and sandal are some examples of plants which are or can be used as fragrant substances in shampoos. Aromatic substances added to hair washes serve two purposes; firstly they improve the acceptibility of the products by imparting to them good natural fragrance, and secondly, they exhibit good antifungal and antibacterial activity and thus protect the hair and scalp from many diseases.

Hair massaging

The performance of herbal messages can be improved by the addition of many essential oils. Some of them have specific effects. For example, cypress (*Cupressus*), lavender (*Lavandula vera*) and rosemary (*Rosmarinus officinalis*) soothe nerves thyme (*Thymus serpyllum*) and chamomile (*Matricaria chamomilla*), have selctive effect, and mint (*Mentha piperita*), sage (*Salvia officinalis*), fennel (*Foeniculum vulgare*), lemon (*Citruslimon*), and assafras (*S. Officinale*) are stimulating. A large range of therapeutic effects can be obtained with the use of essential oils.

Besides, these, Brahmi (*Bacopa monieri*), amla (*Emblica officinalis*), Behrangraj (*Eclipta prostrata*), jaba kusum (*Hibiscus rosa sinensis*) and til (*Sesamum indicum*) are extremely useful as hair managing agents. One who applies til oil regularly does not suffer from baldness, greying of hair, hair fall. The hair becomes black, long and deep rooted. Palm oil as an extremely rich source of carotene and appears to be the only oil of vegetable origin which can serve as a potent source of vitamin A.

Hair dyeing

Many naturally occurring hair dyes have been used since long. The first plant hair dye probably was henna (*Lawsonia alba*) and indigo (*Indigofera*). For fine black hair the use of henna and indigo (each two parts) and of dried myrtle leaves and emblic myrobalans (each one part) mixed with water to the consistency of soft poultice is beneficial. This composition is said to stimulate the growth of hair, blacken grey hair and prevent splitting. Elderly women use a decoction of Behrangraj (*Eclipta erecta*) to rinse hair, the plant possesses a bluish black dye. The flowers of chamomile (*Matricaria chamomilla*) yield a yellow dye The leaves and juice of *Wedelia calendulacea* are used to dye grey hair.

Hair tonics

A hair tonic is used to improve the general condition of the hair. Numerous home remedies are used for washing and conditioning hair which contain a foamy saponin or a volatile oil. To brighten, strengthen and stimulate hair a rinse made of chamomile (*Matricaria chamomilla*) and yarrow (*Achillea millefolium*) is said to be most effective. For brunettes, a mixture of rosemary (*Rosmarinus officinalis*) reputedly maintains a dark sheen and also strengthens and stimulates hair growth. An infusion of rosemary mixed with a little borax and massaged into root hairs is considered to be effective against dandruff. The volatile oil from spikenard (*Nardostachys jatamansi*) and the leaf decoction of *Pithecellobium bigerminum* are often used to improve hair growth. The juice from fresh leaves of *Eclipta prostrata* mixed with neem oil is applied to promote hair growth.

Hair sprays and setting fluids

Many plants, such as *Kikar Babul* (*Acacia*), and quince (*Cydonia*) yield a mucilage whch is more effective than water in converting straight hair into desired curls. A typical wave setting fluid contains a vegetable mucilage, a mild alkali, and a preservative. The gum is soaked in hot or cold water and strained. Karaya gum (*Sterculia urens*) makes a clear solution and causes relatively less flaking of hair. Most hair sprays do not contain plant products though some do contain rosin as a hair lacquer and castor oil to impart a thin film.

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BOOK REVIEWS

NUTRITION AND HEALTH, The Institute of Biology's Studies in Biology No. 141 by T. Geoffrey Taylor, *Edward Arnold (Publishers) Limited,* 41, Bedford Square, London WC1 3 D Q. Pp 59 £ 2.50.

NEW findings in every discipline keep pouring in at such a high rate that text book writers find it difficult to keep pace with them. The Institute of Biology has solved this problem somewhat by producing a series namely, 'Studies in Biology'. A topic in Biology is taken up and treated extensively. And when significant researches pile up in the field, they are treated in sequels to these main books. The book under review, for instance, is a sequel to book no. 94 in this series, *Principles of Human Nutrition.* The present one deals with practical issues involved in the subject and presupposes knowledge of the fundamental concepts. For, if the author were to go into basic definitions, it would not be possible for him to include any new material.

In writing this book, the main objective of the author has been to bring out clearly the relationship between nutrition and health. He has emphasised time and again, the fact that individual nutrients for example, vitamins, proteins or fats are not too important by themselves—the proportion in which they are taken in a diet is the most crucial factor. From the very beginning, the author maintains that it is the concept of optimum *ranges* of intake of nutrients which is crucial.

Each physiological state in the life of an individual has been treated exhaustively in the light of recent studies. Descriptions of the how and why of nutritional requirements in infants, pregnant women and the aged, make this book meaningful to anybody with a background of Biology. Many common notions, for instance, that the human body's protein requirements go down with increasing age, have been refuted. Rather a good production both in form and content.

RATNABALI MITRA

WORLD LITERATURE ON RECLAMATION AND MANAGEMENT ON SALT-AFFECTED SOILS—1950–1981 *by* K.N. Pahwa and I.C. Gupta, 1982, *Associated Publishing Company,* 8763, Shidipura, Karol Bagh, New Delhi-110005, Pp. 352, Rs. 180.00 (US $ 50.00; UK £ 25.00).

GLOBAL problem of water-logging, salinization and alkalinization covers 950 million hectares of the land. The saline and alkali (sodic) soil conditions considerably reduce the land productivity value. Thus, the reclamation and management of salt-affected soils offers an opportunity for enhanced crop yields.

More than 800 abstracts, covering primary and original research papers, review articles, books, bulletins, monographs and bibliographies on reclamation and management of salt-affected soils of last three decades have been compiled. It contains important and interesting subjects of land development, hydrological aspects, irrigation practices, drainage, leaching, chemical amendments, electrical, thermal and other methods, agronomic cultural practices, crop production and economic aspects of reclmation. Author, subject, source and geographical indices have been provided at the end of the bibliography to facilitate reader usability.

This annotated bibliography covering available world literature survey, is likely to enrich knowledge on the subject and prove useful for scientists, agriculturists and planners as well.

TAPAN K. MUKHERJEE

FUNGAL PARASITISM (Second Edition, 1981) *by* Brian J. Deverall, *Edward Arnold* (Publishers) *Ltd.,* 41, Bedford Square, London, WC$_1$ B$_3$ D$_Q$ Pp. 66; £ 2.40.

SINCE quite a long time Institute o Biology, 41 Queen's Gate, Londo SW7 5HU is bringing out the *Studies i Biology* series as it is not possible for on text book to cover the whole field o biology with up-to-date information. I this series they have already covered b publishing about 134 topics of biology This is 2nd edition of the 17th booklet o the series having changes in its chapter 1, 5 and 6 in order to accommodat advances in understanding the physiolog and biochemistry of those interaction which result in either successful coloni zation by the parasites or resistance by the plant. This information in the bookle may be useful because of the fact tha without the knowledge of interactior between a fungus and a plant it may no be possible to take proper useful steps for controling the probable damage done by fungal parasites.

It is a well-known fact that parasitism is the mode of life of an organism which derives its food from another living organism. Many fungi obtain their food as parasites of plants and animals. In doing so they cause disease in the host organism. Giving the causes of some of the best known diseases of the plants parasitism of the fungi on plants have been dealt with in this booklet. Recent advances concerning the role of enzymes and toxins in prasitic attack and of phytoalexins and other chemical factors in resistance have also been described.

For the benefit of readers the information about fungal parasitism (in this booklet) has been divided into six chapters, namely, Ecology and Nutrition of Fungi; Isolation, Culture and Germination of Parasitic Fungi; Types of Parasitic Fungi; Spread of Parasitic Fungi; Colonization of the Host; and Resistance to Parasitic Attack, etc. At the end of the publication relevant references of books for further reading and subject index have been provided. Those who want to understand the subject in any easy manner will find its neat and clean illustrations and diagrams befitting the subject matter. Written in simple language, this booklet may be useful for those who want to have some knowledge on fungal parasitism on plants.

T.P. PATHAK

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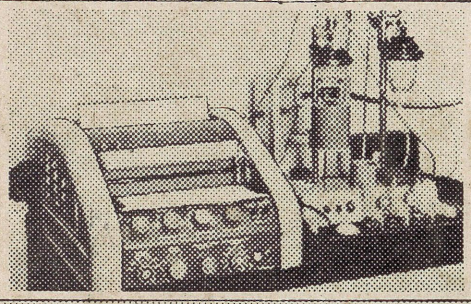

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