In this issue

Thar desert ecosystem

After C. V. Raman held an annual meeting in Rajasthan at Udaipur more than 50 years ago in 1945, the Indian Academy of Sciences revisited the State for the 62nd annual meeting which was held at Jodhpur from November 1 to 3, 1996. Continuing a long-standing tradition, a highlight of the Jodhpur meeting was a symposium of local scientific interest devoted to 'Arid Ecosystem of the Thar desert of Western Rajasthan'. The symposium addressed Thar desert's unique characteristics in the light of modern day science and technology developments.

The Thar desert (drawing its name from a district in Pakistan's Sind province, Tharparkar) is also known as the Great Indian desert and spans an area of approximately 259,000 km^2 in the Indian subcontinent, 69% of which lies in our country's north-western region.

The Thar desert experienced several periodic climatic changes from arid to semi-arid, resulting in the dominance of either the fluvial or the aeolian processes. These processes have dictated much of the present topography. Historical data suggest that, several millennia ago, the total atmospheric precipitation in the Thar was 4 to 5 times higher than at present. The enhanced aridity is believed to be responsible for the decline of the Harappan civilization about four millennia ago. Famines of various kinds, namely Akal (great famine), Jalkal (water scarcity), Tinkal (fodder scarcity) and Trikal (water, fodder and grain scarcity) have been a frequent occurrence. Their dispersion in the Thar is emphasized in a local Rajasthani saying:

'Pug Poongal, Sar Merte, Udraj Bikaner, Bhoolo Chukyo Jodhpur, Thayo Jaisalmer.'

Translated:

'Famine keeps its legs standing in Poongal region in the heart of the desert, its head in Merta, stomach in Bikaner, may move to Jodhpur and stay forever in its home town of Jaisalmer'.

The Thar desert population is mostly rural. The Western Rajasthan population density is 84 persons/km^2 and accounts for 38% of the total State's population. Although the population density is low compared to the other parts of the country, it is relatively high by arid zone standards. The livestock is around 25 million! These figures make this arid zone one of the most densely populated deserts of the world which implies considerable pressure on the region's natural resources. Thus, management of the natural resources assumes great importance. George Joseph of the Space Applications Centre provided in the first lecture of this symposium an analysis of the role of remote sensing in the resource management with special reference to Western Rajasthan.

The climate of the Thar is characterized by high atmospheric temperatures, which often reach 46°C and a strong wind regime with wind speeds up to 30 km/h, leading to a high evaporative demand (1500–2200 mm/year) and frequently to dust-raising winds, dust storms and associated wind erosion. The mean annual rainfall in the Indian region of the Thar desert is 345 mm varying spatially from less than 100 mm in the extreme western part (Jaisalmer district) to over 400 mm along the eastern fringe (Pali, Sikar and Jhunjhunu districts). D. R. Sikka, formerly of India Meteorological Department and Indian Institute of Tropical Meteorology, spoke at the symposium on desert climate and its dynamics.

Hydrologically the Thar desert could be divided into: (i) a region which has its major water source in more humid regions such as the northern districts of Punjab and Haryana and north-western parts of Rajasthan, (ii) plain lands with a primitive (or none) network of streams. The inhabitants of this region are partly dependent on surface water, i.e. harnessing the run-off in the form of village ponds and underground cisterns and largely dependent on groundwater having total dissolved solids of over 3000 ppm at a depth of 40–100 m, and (iii) sloping regions with an integrated stream network (e.g Luni river, its tributaries and many ephemeral channels that remain dry for a large duration). Overall, surface water resources of the Thar desert are extremely unreliable. A considerable fraction of the drinking water demand by both humans and livestock has to be met by drawing groundwater. S. M. Rao of Bhabha Atomic Research Centre who has carried out isotope studies on groundwater in Western Rajasthan presented results of his work at the symposium.

Despite the scarce water resources, about 45% of the total land area of the Indian arid zone is brought under plough every year. Rain-fed agriculture is practical in most areas. Productivity of traditional agriculture on these lands is poor due to low and erratic precipitation, high solar incidence, high wind velocities and poor soil characteristics. These arid areas suffer from shortage of traditional energy sources. Hence it is important to consider development of alternative energy sources such as solar energy, wind power and bioenergetics. S. P. Sukhatme of the Indian Institute of Technology, Bombay, made a detailed presentation of the efforts made and presently underway for generating electricity through photovoltaic and thermal routes from solar energy taking advantage of the high solar incidence over the Thar with the mean annual global solar radiation in excess of 6 kwh/m^2. (Jodhpur, the venue of the Academy meeting is known as 'Sun city' and receives more than 7 kwh/m^2 per day of radiation during April–June.)

Life exists in several forms in the desert. Desert flora are mainly of four types: (i) drought escaping, (ii) drought evading, (iii) drought enduring and (iv) drought resisting. The many varieties of cacti are typical examples of drought resisting desert flora. A wide variety of insects, reptiles, amphibians, birds and mammals enrich the desert fauna. While Mohan Ram of Delhi University delivered, in a separate session, a special lecture on plant life under extreme conditions, Ishwar Prakash, now at the Zoological Survey of India, presented a fascinating account at the symposium on the ecology of the desert mammals.

The five symposium presentations, which appear in a special section of this issue, offer a glimpse of the range of perplexing features and issues pertaining to the Thar desert, in the sustained development of which resides a magnificent challenge to the scientific community.

A. R. Reddy

Essence of heavy hearts

The mammalian heart is a double pump. Each pump is provided with check valves to make it work in one direction and has a squeezable container, the ventricle and a filler, the atrium. William Harvey wrote in 1628: '... the blood in the animal body moves around in circle continuously and ... the action or the function of the heart is to accomplish this by pumping. This is the only reason for the motion and beat of the heart.' The pumping action of the heart results from shortening of muscle in its walls. The contraction of muscle produces the pressure that squeezes blood outward.

An incredible feature of this biological machine is that it is equipped with large factors of safety to meet the strains of every day life. A human heart pumps about 5–6 litres of blood per minute at rest. During strenuous muscular efforts such as running to catch a bus the output can go up to five times in a healthy adult. The heart does this by adjusting the rate of heart beat as well as increasing the volume of blood that comes out during one beat. From beat to beat, the output is regulated in response to muscle stretch. The more a cardiac muscle is stretched, the more vigorously it responds. This mechanism also helps in immediate adaptation when the valves of the heart become leaky due to disease processes. Leaky valves result in more blood in the ventricles, stretched muscles and more forceful contraction. However, continuous hyperfunction or sustained load needs other compensatory mechanisms to cope with the increased stress. Unlike other organs, heart is incapable of adding new units or multiplying its component cells. The basis of its growth is increase in the size of the muscle cells, i.e. hypertrophy. Hypertrophy is a phenomenon of normal growth of the heart. As body mass increases about 20 times from the time of birth to adulthood, there is proportionate increase in the cardiac muscle mass.

Both birth defects and acquired heart diseases can increase the load on the heart by either amplifying the resistance to cardiac output (pressure overload) or increasing the influx of blood into the heart (volume overload). In such situations, heart hypertrophies to increase the strength of contraction. A hypertrophied heart in some pathological conditions may weigh even one kilogram, 3–4 times the normal. Compensatory hypertrophy is a decisive factor for long term adaptation in a variety of heart diseases.

Though initially the hypertrophied heart is capable of meeting the increased work demands, during continuous hyperfunction, the reserves of the myocardial cells are successively mobilized until they are exhausted and function becomes severely impaired. Thus myocardial hypertrophy can be considered as an interface between normal and failing heart.

The hypertrophic response consists of not just an increase in muscle proteins. It is associated with re-expression of foetal genes and several proto-oncogenes. Significant increase also occurs in the number of non-myocyte cells, particularly the connective tissue cells, as well as collagen and other extra cellular matrix components.

Thanks to the use of cultured myocytes, transgenic animals in which hypertrophy is induced and application of recombinant DNA techniques, several questions regarding cardiac growth are being explored. Many questions have been answered and some remain to be elucidated.

What is the signal that transduces wall tension into cardiac growth? How is the signal from the cell surface mediated to the nucleus? What factors initiate and maintain protein synthesis? What is the role played by hormones and growth factors? These questions are addressed by D. S. Reddy in his review article **(page 13)**.

There are three reasons for the study of mechanisms of cardiac growth: (i) understanding the circumstances that lead adaptive cardiac growth to pathological hypertrophy and heart failure is expected to lead to a clinical cure for cardiac failure, (ii) knowledge gained on cardiac growth may provide clues to augment cardiac muscle growth in injured myocardium. If cardiac growth can be induced by use of growth factors, it will also be of benefit in modulating long term adaptation of the heart, (iii) the model of compensatory hyperfunction of the heart is viewed as an ideal one for the study of inter-relationship between function and the genetic apparatus, a key element of long term adaptation in physiological systems.

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