EVERYMAN'S SCIENCE

Vol. XLII No. 1 (April '07 – May '07)

COVER PHOTOGRAPHS *(Left to Right)*

Past General Presidents of ISCA

1. Dr. D. N. Wadia (1942, 1943)

2. Prof. S. N. Bose (1944)

3. Sir S. S. Bhatnagar (1945)

4. Prof. M. Afzal Husain (1946)

5. Pandit Jawaharlal Nehru (1947)

Printed and published by Prof. S. P. Mukherjee on behalf of Indian Science Congress Association and printed at Seva Mudran, 43, Kailash Bose Street, Kolkata-700 006 and published at Indian Science Congress Association, 14, Dr. Biresh Guha Street, Kolkata-700 017, with Prof. S. P. Mukherjee as Editor.

Annual Subscription : **(6 issues)**
Institutional Rs. 200/- ; Individual Rs. 50/-
Price : Rs. 10/- per issue

CONTENTS

EDITORIAL

ARE WE ON THE RIGHT TRACK ?

Effectiveness, Efficiency and Excellence are positive attributes which are associated with or are assigned to various organizations at different levels. These apply to manufacturing houses, service providers, academic institutions, R and D set-ups and even to associations or societies engaged in promoting Science and Technology. Every organization desires to achieve and sustain some degree of excellence in managing its activities and realizing its goals and objectives. It can be argued that the three E's which drive organizations in their search for Excellence are eventually captured by the phrase 'doing right things right'.

The big question now is what do we mean by 'right' ? Before we beget a good answer, we first suggest that 'right' is something relative and we face the next question 'relative to what'. Well, talking of ourselves–within the Indian Science Congress Association—one way to interpret 'right' will take us to the objects of the Association that were envisaged some time back and that are incorporated in the Memorandum of Association. One may point out that these objects are not adequately spelt out to provide a framework against which one can find out whether or not the Association is currently effective and efficient, keeping the question of excellence on hold for the time being.

The Memorandum gives out–in very broad terms—several objects, of which the most important one is : to advance and promote the cause of Science in India. To be fussy about words, one can point out that this object does not enjoin on us the task of advancing or promoting Science as such. It may be pointed out here that the fraternal organization in Great Britain goes by the name of British Association for the Advancement of Science. (The difference between Science as such and the cause of Science cannot be unnecessarily blown up.) In a sense, the statement of ISCA's objective is more relevant for a government-supported democratic set-up that provides an umbrella for scientists, engineers and technologists of all shades and statures.

To advance and promote the cause of Science, we need to plan and execute various activities like holding debates and discussions on contemporary issues in Science, publishing and circulating—as widely as possible—documents incorporating outcomes of such debates and discussions, encouraging and enabling research workers in keeping themselves abreast of current developments in their respective fields, creating a scientific temper among the masses, attracting young minds—I mean students in schools and colleges—to take up studies in Science and, subsequently, careers in Science. (Science here includes Technology.) The memorandum itself provides ideas for such activities like holding an annual Congress at a suitable place in India, publishing such proceedings, transactions and other publications as may be considered desirable. For this purpose, the Association should secure funds and endowments for the promotion of Science. Lastly, the Association should do and perform any or all other acts, matters and things as are conducive to, or necessary for, the above objects.

Starting from the penultimate clause to proceed backward, we—in the Association—can claim that we have been achieving our objectives literally, without talking necessarily about our efficiency or even the extent to which our objectives are met—quantitatively as well as qualitatively.

We secure funds (essentially through a grant from the Department of Science and Technology, Government of India) and we have a Finance committee to look after our funds and endowments (which we occasionally receive from munificient individuals and institutions). Well, 'management'

may be a nasty word for some scientists or tecnologists. If one scans the pattern of expenditure, one has a feeling that a lot more should have been spent on exercises to promote the cause of Science throughout India and at least to some extent, advance the frontiers of scientific knowledge.

We do publish a bi-monthly volume viz. Everyman's Science that is circulated to all members besides a few subscribers, but is not seen by all of them, and surely not read by quite a few. Contents of this periodical are sometimes extolled and occasionally snubbed as not-so-good. We also publish from time to time some special volumes containing platinum jubliee lectures, special lectures, endowment lectures and their likes. Editors and referees sometimes point out that, though treated as 'special', some of these articles reflect lack of contemporaneity and of erudition.

We unfailingly organize an annual Congress, marked by a splendid (better to avoid the term pompous) inauguration, graced by the presence of our Prime Minister and sometimes of our President also, attended by a large all-India gathering of scientists of all sorts besides a handful of foreign scientists, and covered in various ways by the media. Not too unoften voices can be heard to denounce the manner in which people—not all scientists—are invited to address the plenary sessions or panel discussions or the more glorified 'summits'. Some of the invitees are only dilettantes. Sincere attempts to involve serious scientific workers in different fields in the session for fruitful interactions and exchanges among the participants are not always evident and we continue to hear the same old tunes in the somewhat unimaginatively formed sections.

The Indian Science Congress Association is an esteemed organization started nearly a centurey back with some noble ideas and it continues to play a major role in the development of Science and Technology in India. Given a foresighted and competent leadership, it has the potential to provide an umbrella over different local and regional organisations actively engaged in promoting the cause of Science, to collaborate with fraternal bodies in other countries in establishing co-operation for scientific programmes in emerging areas that call for multi-country involvement, to organize national dialogues and debates on Science policies and plans and even to mould the latter appropriately, and to ensure that Science and Technology lead to better quality of life for a much larger segment of our population.

Let the Council of the Association ponder over some of these issues and let the Executive Committee initiate appropriate moves to see that we are on the right track.

S. P. Mukherjee

"Becoming number one is easier than remaining number one."

—Bill Bradley

PRESIDENTIAL ADDRESS

THE MAKING OF INDIA—A REVIEW OF SOME ASPECTS OF THE GEOLOGICAL STRUCTURE OF INDIA

DR. D. N. WADIA, M.A., B.SC., F.G.S., F.R.G.S., F.R.A.S.B., F.N.I.

The 29th Session of the Indian Science Congress meets today at a centre which possesses a distinguished record as one of the pioneers of Science education in India. As far back as 1882, the Baroda College was launched on its beneficent career of providing higher education to the people of North Bombay Presidency. Very soon it emerged with well-equipped departments of Physics, Biology and Agriculture, which included fully-appointed laboratories, a botanical garden, experimental farm and, later, a science museum. The vision and munificence of that Prince of many pioneering institutions, Maharaja Sayaji Rao Gaikwar, endowed Baroda with institutions for the teaching of Science on a scale of liberality equalled, at that date, by few centres in India.

On behalf of the Indian Science Congress Association, I tender our sincere acknowledgments to the Government of His Highness the Gaikwar for the cordial invitation extended to the Congress last June, under circumstances that make our appreciation of His Highness's courtesy all the keener. This meeting looks forward to a pleasant and profitable week in this progressive capital of a premier State Containing, as it does, many landmarks reminiscent of its early leadership in Science education and of its industrial and technical developments of later date.

Indian scientists have celebrated in August last the 8th anniversary of the birthday of one who is, in every sense, their *doyen*—Sir Prafulla Chandra Ray. His has been a singular example of a life dedicated to the service of his fellow-beings, as founder of the Calcutta Chemistry school, author, industrialist and public benefactor. Another remarkable octogenarian anniversary was celebrated about the same time during the year, that of Sir M. Visvesvaraya, eminent engineer and scientist whose labours during the last two decades have materially helped in building the industrial structure of India. The Science Congress, over which they presided in 1920 and 1923 respectively, is proud to claim the privilege of their continued membership.

On behalf of the delegates of the Congress I offer our felicitations to Rai Bahadur T. S. Venkataraman on the honour of Knighthood bestowed upon him by His Majesty in recognition of his meritorious researches of high scientific and economic importance.

It is my sad duty to refer to the grave loss Indian Science has suffered by the untimely death of Sir Shah Mohammad Sulaiman, Judge of the Federal Court of India. A noted jurist, scientist and educationist. Sir Shah Mohammad's activities and interests were many-sided and they shed light on several spheres outside the ambit of his official duties.

SCIENCE AND THE WORLD OF TODAY

The events of the last two or three decades have served to bring Science under a cloud. Its amazing

* General President, Twenty-Nineth Indian Science Congress held during 31st January to 5th February, 1942 at Baroda.

achievements are at times forgotten in the wreckage of civilization that, it is feared, its misuse may bring about. What can be claimed as the finest flowering of human genius and the culmination of the heritage of man has begun to be looked upon with growing suspicion and uneasiness. Some time ago, a group of distinguished divines in Europe pleaded for a ten-year holiday for Science asking that all the laboratories and academies of Science of the world may be put in cold storage for this time. The implication was that this cessation of scientific activities will mean no real loss to knowledge, but may possibly result in more worth-while knowledge : Today, after a century of Science, during which it has explored vast vistas of Nature, supervened Time and Space, conquered many plagues and diseases, probed truths about God's creation and is near making an approach to absolute Truth, Science is facing the charge of helping with its inventions and discoveries man's lower instincts and lust for power, possession and aggrandizement. But for the aid of Science, it is thought, his animal instincts and desires would have been infinitely less and the tempo of resulting suffering and destruction greatly reduced. But Science repudiates the indictment. The ulterior end of Science is search for truths of Nature and of the universe, and Truth always builds and integrates. The wreckage made possible by the abuse of Science is an evanescent phase in the history of nations, and is to be compared to the havoc by earthquakes and tornadoes. Science will, without doubt, rebuild the damaged world on better foundations and reintegrate the stricken people to a new and more secure life; and the tempo of the resulting reconstruction will be no less striking.

Science pools knowledge from every quarter and offers to the man of today a vast accumulation of well-ascertained facts drawn from its many branches of discovery. It strives to seek absolute Truth, not utopian theories. But till the goal is reached in the interim, in a world torn by conflicting ideas and 'isms, Truth is true only in isolation to its contexts. The precision tools, the alloys, the specialized steels perfected by scientific research, can be used equally well in the making of surgical instruments, in improved ploughshares, in drills for cutting the hardest rock as well as in the making of a super edge sword, a *messerschmitt* engine, or in the internal mechanism of a death-dealing bomb. To check this perversion of Science, it is time the hierarchy of Pure Science asserted its patent rights on the common pool of Strategic Science and, backed by its $1\frac{1}{2}$ centuries of resolute strivings for the betterment of mankind, claim a determining share in the governments of the world. An intenational directorate of scientists, containing a due proportion of economists, engineers and industrialists, will, by adopting the technique and temper of Science, govern the countries of the world better than the chancellors, diplomats and politicians who for the past 5,000 years have failed to bring harmony in human relations, but have signally succeeded in making history one record of recurrent wars.

We live today in a quick-changing world. Signs of a new world order are dimly apparent on the horizon. A new democracy—the democracy of Science and altruistic knowledge—is emerging, pledged to do away with the "war potential" from human society. Success may not be immediate, but there is no doubt that Man, with his centuries of struggle and conflict, is evolving. Conflict has a place in the working of the physical universe, but it is a passing phase and out of conflict comes order and evolution both in the organic and inorganic world. The poet's dream

> "In the Parliament of man, the Federation of world"—
>
> "when war drums throb no longer and the battle flags are furl'd"

is perhaps nearer realization than it ever was in the past.

SCIENCE AND THE CHANGED OUTLOOK IN INDIA

The progress of Science in India is reflected in the growth of the Indian Science Congress during the last 28 years, since its inception in 1914, through the prophetic vision of the Royal Asiatic Society, Bengal, and its active foster-mothering. In the history of the Congress, we have a fit criterion of the growth of scientific spirit in India, and an index to a remarkable change of outlook from an amorphous desire for scientific progress to a definite, though still inadequate, provision for advanced Science teaching, technology and research at a number of centres. In 1914-16, its membership was a few scores of Government officials, mostly of the scientific departments and surveys, with a sprinkling of university men drawn from the Province in which the meetings were held. The papers contributed numbered a couple of dozen, read at five or six sections. In 25 years, fourteen well-attended sections were meeting with a total all-India membership of, at times, over 1,000, handling in the aggregate about 700 to 800 papers, doubtless, not all of equal merit, but coming from young men versed in laboratory method of investigation, and keen on producing something original, a faculty not cultivated before and, according to some critics, foreign to Indian mind. A very welcome development of recent years is the addition of sections of Entomology, Physiology and Engineering, in each of which fruitful work has already been done, and in which the scope for productive research is still immense. The recent establishment of the Sub-Committee on Science and Social Relations by the Congress is a timely move for reviewing the progress of Science in the country and appraising the extent to which it has promoted, or is capable of promoting, the real welfare of the populace. In a country whose social structure is based on traditional religion and custom it is inevitable that there should be some time-lag between the march of Science and its ultimate effect on the popular welfare. This is the gap between the static India that is passing, and the dynamic India that is visualized by the scientists, but the small advances that are already visible ought to fill us with new hope and encouragement. We are awaiting the committee's report with eager interest.

The progress, though small, is however the more gratifying for it is not a forced march, the outcome of a regimentation from an outside agency, but to all appearance, is the natural and spontaneous development of the Indian intellect that had lain in hybernation during five or six centuries of the dark age in India. Although it can scarcely be said that Science has begun to occupy a considerable place in the general life of the masses of the people, or even the educated middle classes, one welcomes the attempts of some voluntary organization, municipal and civic bodies through the publicity of the radio and the press, to bring the benefits of Elementary Science home to people at large. The infiltration of Everyday Science thus to the 600,000 villages, which harbour 78% of our population, is sure to bring results in improved agriculture and husbandry, health and housing, sanitation and nutrition. Here it is a pleasure to note that the advancement of Higher Science in India has been accelerated in the last decade by, what may fitly be called, evangelistic work of the two journals to name them in the order of their coming–*Current Science* (1931) and *Science and Culture* (1935). These papers through the unflagging missionary efforts of their editors have already reached a high standard of scientific journalism and are filling two important needs of the country–bringing together isolated workers in the different branches of general and specialized Sciences and helping to mould public mind and Governmental policies on such major issues as Science education, national economic development and State aid to research. The vigorous espousal by *Science and Culture* of a policy of National Planning, creation of a *Department of Scientific* and Technical Research and hydroelectric development has, it seems, reached

the right parlors while the more academic bias of the editor of *Current Science* has done no less service for the spread of Applied Science, scientific thought and the cultural benefits of Science.

But the time is not yet for a complacent self-satisfaction for Science workers in India. The disproportion between the task looming ahead and the work accomplished is vast and the outstanding basic needs of national economy, such as literacy, sanitation, nutrition and improved standards of living, are reminders of our yet unliquidated liabilities. Workers in the cause of Pure and Applied Sciences will have to multiply a hundred-fold and their efforts redoubled in order to eliminate these big debit factors from the national balance sheet.

A serious handicap to industrial progress in India was lack of planned *liaison* between industry and science. In the Board of Scientific and Industrial Research, inaugurated last year under the directorship of Sir S. S. Bhatnagar, we see the promise of a new era of planned aid to India's industry. Already the activities of the Board, through its fifteen committees, cover a wide field of research calculated to assist a variety of new manufactures. Although the services of the Board are channelized today to further India's war production through *ad hoc research*, with the return of peace and the withdrawal of the stimulus of war premia and priorities, there will be a greater demand on these services for domestic aid to the nascent industries it has itself sponsored, as well as to those launched by private enterprise in recent years, particularly the heavy-chemicals, engineering and metallurgical industries. The country will then need a central agency for integrating the scientific effort of the different units today functioning under handicaps, financial and others, and improving the defective industrial machinery of the country at present working with many emergency joints, if there is to be no setback to the hard-won industrial progress of pre-war years. This need is nowhere greater than in the mineral industries, where for the last three or four decades the raw produce of the mines, the ores and industrially vital minerals have been allowed to leave the country in ever-increasing tonnages, at ridiculously low prices, simply because of lack of technical guidance in the processing of minerals or their part manufacture before export.

The coordination of Material Science with productive industry and the marshalling of the productive resources of the country was, for long, a *lacuna* which is now being filled by the National Planning Committee, under the chairmanship of Pandit Jawaharlal Nehru. Twenty-nine sub-committees have been set up and their labours cover almost every field of the country's life and activity, cultural, productive and distributive as well as organizational.

It is pity that this work has had almost to be cold-storaged, because of the exigencies of war. But the material already collected, and the thought bestowed upon the several aspects of national reconstruction on a comprehensive scale, cannot but prove of the utmost utility when the moment for constructive efforts arrives.

The commencement of the functioning of the Eastern Group Supply Conference at Delhi during the year is another event which the Indian Science Congress welcomes. The participants with India in this Conference–Britain, Australasia, South and East Africa, Burma, Ceylon and Malaya—have never before thought of industrial cooperation, and this step, made imperative by the exigencies of a world war, ought to augur a new era of international coordination in the field of commerce. When the crisis of war is over, the contacts established by this Conference should make for greater collaboration and interdependence of these nations in place of the ignoble jealousies and racial barriers that have marred international relations so far.

THE STRUCTURE OF INDIA

I have reviewed affairs and events as they affect Indian scientists. This is one part of the duty of the person called upon to preside over this assembly. I shall now present before you some investigations on the subject on which I have worked for years and on which my last three year's work in Ceylon has thrown some welcome light.

In the making of the Indian sub-continent two distinct crust-blocks of the earth's circumference, of totally different nature and constitution, have taken part. How they came to be together to build the geographic entity we call India is one of the live problems of Geology. One school of geologists denies the Asiatic parentage of India. It suggests that the peninsulas of Asia have wandered far away from an ancient southern parental continent, of which Africa is the surviving nucleus, and fused along the southern edge of Asia, only during a comparatively late date in the geological history of our earth. The impact of these drifting fragements of the southern continent with the shores of Eurasia is held to have ridged up the submerged continental shelf into the imposing chain of mountains which girdle India's Asiatic front all along its West, North and East.

The impact further necessitated the underthrusting of a considerable selvage of North India beneath Turkistan and Tibet, while a still wider marginal belt has buckled under the strain of the northerly pressures into a wide and deep trough, stretching from North-West Punjab to the Arakan ranges. Madagascar, which undoubtedly has some consanguinity both with India and East Africa in its rock-groups and in their structural relations, is held to have started in the wake of India, but broke away from it early in the north-easterly drift. The parallel rocks and structures of Madagascar, Africa and Indo-Ceylon are cited as evidence of their pristine unity in one integral land-mass.

The orthodox school of geologists, believing in the fundamental doctrine that the present forces and agencies of earth supply a key to the past, while admitting some undoubted merits of this theory in explaining some perplexing problems of stratigraphy and climatology, have questioned such unknown and revolutionary forces in earth-dynamics. It finds no adequate force or agency in the earth's sphere to effect a congregation of continents and their fragmentation and drifting over vast sections of the earth's circumference and is inclined to the belief in the permanence of the great ocean deeps and of the essential framework of the major continents. According to these geologists, the making of India has been an evolutionary process, the two component crust-blocks being always integral and adjacent parts, though pursuing quite distinct geographical course of events—the one a stable land-mass composed of some of the most ancient rocks of the earth and never submerged underneath the oceans; the other a flexible and comparatively weak belt of the earth's crust, for long submerged under the waters of the oceans and loaded with thousands of feet of marine sediments during this submergence. The ridging up of this sedimentary pile into the great mountain wall of India is explained as due to tangential pressures acting on this overloaded and consequently weakened zone of the crust. In contrast with the unpuckered and generally horizontally bedded rocks of the former crust-block of India, the Himalyan segment of India has undergone colossal flexuring and crumpling of strata, sheets of rock being overfolded, disrupted and thrust bodily over the severed members for miles. In these earth pileations, masses of crystalline igneous rocks, granites, from the depths of the earth, have been pushed up through the sedimentary cover and now occupy the central zone of highest elevations. The sublime snow-capped peaks of the Himalayas, from Mt. Everest to Nanga Parbat, all are built of this axial granite core, which has risen five to six miles from the earth's interior breaking its way through

the sedimentary crust. While the architecture of the crust lies mostly hidden beneath the surface of the rest of India, in the corrugations of the Himalayas over six miles depth of the outer lining of the earth's sphere is laid bare for the geologist' study.

The Himalyan orogeny is not an isolated unit in the mountain system of Asia, but is a part of, and stratigraphically related to, the great mountain girdle of the earth which starts from the Atlantic coast of Europe and traverses the earth along the Alps, the Caucasus, the Iranian arc, and after two or three sharp bends in its passage through India, terminates at the eastern end of the Malayan arc.

On either of the two hypothesis, the sub-continent of India consists of two, crustblocks of different nature and constitution, the rigid Archaean shield of Deccan and the 1,600 miles long folded belt of younger rocks (the Himalayas). Their interaction has produced the thrity physiographic division of India—the North Indian Plains—built by the alluvial deposits of rivers of the Indo-Gangetic system. These great plains of India cover a trough or depression in front of the earth-waves of the Himalayas pressing from Tibet against the immobile crust segment of the Deccan.

THE THREE STRUCTURAL UNITS

The unravelling of the structural features of these three units of earth-body, integrated into one sub-continent, has been India's contribution to the world of Science—the branches of Geophysics, Isostasy and Geodesy deriving their earlier and more vital data from these regions from the labours, since 1860, of the pioneer workers in the departments of the Great Trigonometrical Survey and the Geological Survey of India.

As stated earlier, there is the most striking geographical antithesis between North and South India—between peninsular and the extra-peninsular India. The one is a much-folded and contorted pile of sea-deposited sediments, thousands of feet in thickness; the other a non-flexible, obviously impassive block composed of ancient, crystalline rocks, which has, since the dawn of geological history, acted as a peg in the earth's crust. The latter circumstance has led to a belief in the absolute immovability or immunity of the Deccan from earth-disturbances of any kind whatever.

In the structure of India, the folded zone has played a comparatively minor part and that also during the last one or two chapters of its history, having but lately emerged from a central eurasian sea. Regionally it is in part extra-Indian and builds the lofty north frontiers, which though they have barricaded India from the rest of Asia geographically, have knit India structurally with the Iranian ranges to the west, Tian Shan on the north and the Burma Malay arc of mountains on the South-East. This folded zone bears evidence of great compression whereby the country between Tibet and the Ganges valley has been shortened by 60-80 miles. Only a small part of the thickening of this belt arising from the compression forms the visible mass of the Himalayas, a considerably larger part being pushed down as the roots of the mountains into the sub-crustal, semi-plastic magma which acts, through its buoyancy, as the support of the Himalayas. The visible excess of mass above the surface is thus compensated underground by a displacement of the heavier and denser sub-stratum of rock (*sima*), which underlies the surface crust of the earth.

But the fold-zone of North India is of great interest in the dynamics of the earth's crust. It has profoundly modified and superseded the old trend-lines of Southern Asia. The festooning and curves of the Himalayan arc are caused by the obstructions of the rigid Indian table-land reacting against the plastic earth-folds pressing from the north and moulding their shape on its promontories and bays. Large slices of the mountains have thus slid bodily for miles over the peneplained edge of the Indian foreland, whose broad front has imposed on the

mountain range its main trend-lines. The orientation of the Alai—Kuen Lun system of chains in the north, that of the Hindu Kush—Karakoram arc in the middle and of the deeply reflexed Himalayan arc in the south are broadly alike, fusing together in the Pamir vertex or knot. The Pamir is a nuclear point of Asia's mountain system and it is in axial continuity with the Punjab wedge—the pivotal point of the Indian foreland that has guided the main Himalayan syntaxis. The Pamir-Punjab crustal wedge or knot is thus of critical importance in the orography of Asia and will take a key position in future work on orogenesis and mechanics of crustal motion in mountain-building.

The structure of the extra-peninsula is thus explained in a broad and general sense. The labours of the Geological Survey of India during the last 70 years have explored the outline of this plan and future work will add to and perfect the details. When the structure of the Himalayas is finally worked out from Kashmir to Assam, Indian Geology will have made another important contribution to the world of Science.

The third division of India—the Indo-Gangetic Plains—is the newest part to be added to the edifice of India and is still not complete. It has grown almost wholly within the Human Era by the extension of the flood-plains and deltas of the river systems belonging to the Ganges on the east and to the Indus on the west. The dust of the Himalayas, in the technical language of Geology—products of erosion of the Himalayas—brought down by these rivers and their thousands of tributaries, has filled up a hollow at the foot of the Himalayas, variously computed by different authors to be from 6,000 to 15,000 feet deep. Though of great interest from human viewpoint as the source of great agricultural wealth, as an underground reservoir of freshwater and as the principal theatre of India's chequered history since the advent of the Aryans (when the Aryans came to India, probably this section of Aryavarta was not complete for habitation—for large parts, especially of Bengal, were still under the tidal waters of the Bay of Bengal) its importance as a geological unit is only secondary.

The southern limit of the Punjab—Bengal plains possesses a great significance in the sub-structure of India. Along this line gravimetric observations carried out by the Survey of India have revealed a sharply-marked zone of abnormally dense and heavy matter hidden under the alluvium at an unknown depth, roughly along the parallel of 23°N. Experiments with the plumb-line carried out in the middle of the plains show no deflections towards the Himalayas, as one might expect from their great visible mass, but towards a curved line underneath the plains running from Karachi towards Orissa, thus denoting some invisible excess of matter in the south counteracting the gravitative pull of the Himalayas. Similar observations carried out to the south of this line show deflections towards it, their amount gradually diminishing with distance. After repeated observations, the Survey of India has mapped out this subterraean chain of density and named it the "hidden range".

The South Indian highlands have not made the same appeal to geologists, mountaineers and naturalists as the snowy ranges of the Himalayas, and thus have attracted much less attention to their framework or sub-structure. Indian geologists, especially of late, however, have demurred to accept the simple viewpoint of the earlier workers dismissing the mountains of Deccan, South Deccan in particular, as not true mountains of uplift, but as mere relics, or residual stumps, of an old plateau left standing by the denudation of the country around, in the age-long and ceaseless waste of the land exposed to the atmosphere. Gravimetric data too suggest axes of warping and a more complicated sub-structure for these topographic prominences than is implied by mere remnants of a peneplained table-land. Professor Bailey Willis, the noted

American geomorphologist, during a tour in 1936 expecially devoted to this study, pointedly drew attention to the existence of definite upwarps and downwarps in Southern Deccan.

Although it is beyond doubt that the segment of India south of the Aravali-Hazaribath line has never been submerged, *en masse*, under the sea since in Cambrian era, or wrinkled into mountain-chains, it bears scars of several periods of earth-movements, though of a kind quite different from the mountain-building movements. Recent geological work I have been able to do in the last three years in Ceylon has greatly strengthened the new belief. The admirably lucid physiography of Ceylon, exposed in three terrace-like platforms or peneplains, of which this island is built, throws much fresh light on the origin and constitution of the highlands of South Deccan—the Niligiri and Palni groups of mountains. In some respects, the structure of Ceylon furnishes the key to the tectonics of South India.

FAULT MOUNTAINS OF CEYLON AND SOUTH DECCAN

Here we may turn briefly to review the structure of Ceylon, which, though an island today, is an integral portion of the Carnatic gnessic terrain only recently severed from the mainland, and still connected by Adam's Bridge spanning a shallow strait, only five fathoms deep. Outside the Indo-Ceylon strait, the coastal shelf plunges to 1,000–2,000 fathoms depth.

The accompanying diagrammatic section

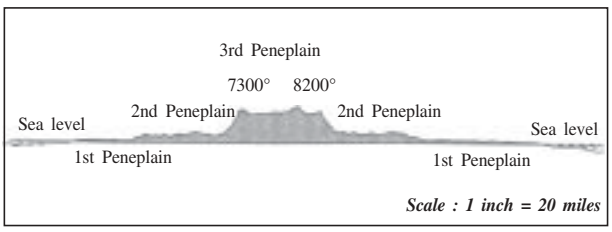


Fig. 1 *Profile Section across centre of Ceylon*

(Fig. 1) across the middle of Ceylon illustrates the profile of the country. The Ceylon rocks consist of a thick series of granulites, quartzites, crystalline limestones and sillimanite-garnet rocks (Khondalites), most probably metamorphosed sediments of Dharwar age. The extreme degree of pressure metamorphism, to which these rocks have been subjected during the orogenic revolutions of the Archaean era, is indicated by the wide prevalence and relative abundance of such small-volume minerals of condensed molecular packing as garnet, ilmenite, zircon, monazite, graphite, sillimanite, coroundum (sapphire), thorianite, spinel, forsterite, pyrrhotite. The Khondalite group of rocks is thrown into a synclinorium, centrally resting on basal, finely foliated gneisses. Both the gneiss and the Khondalite group are extensively permeated by intrusions of Charnockite granites identical with the Madras Charnockites. The meteoric denudation, to which this island has been exposed since its Archean origin, has cut the synclinorium forming the high-country and its gneissic platform, forming the lowlands, into three more or less deeply eroded terraces or peneplains rising from the sea, one above the other, in three tiers. These three terraces rise from the sea in two sharply cut steps or escarpments, the lower step about 1,000 feet above the coastal peneplain (which is very nearly a plain of marine denudation) and the second step 3,000-4,000 feet above the latter to the third the highest peneplain. Though fairly deeply dissected by branching river-valleys, the summits of the hills, ridges and other erosion remnants of all the three terraces show a general accordance of level, denoting three successive stages of base-levelling of the island. To one standing on the brim of the highest escarpment, overlooking the distant sea, the three terraces incised out of the island are as clearly apparent in the actual scene as they are in a diagram section.

Now the second fact in the physiography of Ceylon which arrests attention is the number of waterfalls precipitating from these escarpments to the valleys below in single leaps of from 100 to 10,000 feet. There are no less than 20 major

waterfalls, besides a large number of smaller ones. The waterfalls occur along the southern, western and eastern edge of the escarpment of the third and highest peneplain, defining a broad semicircle or crescent in the centre of the island. The significance of these vigorous young waterfalls in a land whose rocks definitely fix its age at of hoary geological antiquity (pre-Cambrian) and which should, ages ago, have attained a base-levelled topography and uniform drainage system is obvious. It suggests recent block uplift of the Ceylon highlands, relatively to the lower ground surrounding it, through powerful dislocations or block-faults of the normal type. My field observations of these stupendous mural scarps, the lower of 800-1,800 feet, the higher of 2,000-4,000 feet altitude, have led me to the conclusion that they are not produced by ordinary denudation of dip-slopes as stated by F. D. Adams, but they are of the nature of fault-scarps, produced by nearly vertical normal faults. The rocks of the whole region are too closely and complicately folded to give rise to the long and wide dipslopes demanded by Adam's explanation, except locally at a few spots, e.g. around Madulsima near Badula.

The mural scarp effect, though commonly very striking, is at some places subdued by multiple, intersecting, or step faults; sub-aerial denudation also has tempered the abruptness of some of the precipices and indented them by profound gorges and canyons. In an address before a general audience, I need not enter into geographical or technical details. I have dealt with the tectonic significance of the Ceylon waterfalls in a separate paper before this Congress and the detailed Geology will be published later. Here, I would emphasize the horst nature of the central Ceylon *massif*—a block of special uplift composed of crystalline Archaean rocks of 6,000 feet mean elevation, 3,000 square miles in extent, and bounded by faults on its West, South and East, but tilting sharply to its North, due to a northerly pitch of the axis of uplift.

The field geological work so far carried out in this area indicates, beyond doubt, that the Ceylon mountains are not the undenuded passive remants left out of an old table-land, but have been "created" by positive earth-movements, lifting them vertically in two intermittent, widely separated stages. They are what are known as "fault mountains" in contrast to the folded, laterally compressed mountains of the Alps and Himalaya type.

The tectonic strike of Ceylon, the main grain of the country, is that of the well-defined central synclinorium, which covers three-fourths of the crystalline area of the island. If prolonged, it will continue the strike of the Khondalite basin of the Madras coast. The strike of the basal gneisses (the *fundamental gneiss* of Ceylon), though locally inconstant, is regionally consistent, and is in conformity with the north-west strike of the gneisses along the west coast of India, north of Cape Comorin.

On purely physiographic grounds, Adams made a very suggestive observation in his paper on Geology of Ceylon (1929), that the Deccan plateau represents a continuation of the second peneplain of Ceylon and that the third peneplain of Ceylon might be found in the uplands of the Nilgris whose highest peaks have approximately the same elevation as the culminating point of Ceylon. (Dodabetta, 8,700 feet, of the Niligiris corresponding to Pidurutalagala, 8,300 feet, of Ceylon; the 8,000 feet peaks of the Palni escarpment correspond to 7,000 feet peaks of the great southern escarpment of Ceylon.)

To revert to the structure of South Deccan, a remarkable parallelism of many of the Ceylon phenomena is detected in the Nilgiri-Palni hills, and their southern extension, the Cardamom hills, which for hundreds of miles have their western, and still more prominently, their south-eastern sides bounded by gigantic precipices. The Niligiri *massif* on its south-eastern face presents cliffs of 6,000

feet height rising above the peneplain of Coimbatore. Standing on the brow of Pykara precipice of 3,500 feet sheer fall, one cannot but ascribe such extraordinarily abrupt inquality of the ground in the ancient Archaean terrain to mechanical dislocation and recent block uplift. The waterfalls of this region, again, are reminders that the topography has not attained maturity, and that some recent great disruption of the river courses have taken place. The fault-scarp nature of the precipices bounding the south-east face of the Palni block of hills is no less apparent to one looking down on the plains of Madura, 4,000 feet below, from Kodaikanal. As in the Ceylon mountains, the steep scarp may not be due to single fractures, but to a system of faults, more or less vertical, in their inclination. Although modified by atmospheric wear and tear of ages they form, in many cases, most striking features of the South Indian landscapes.

That the Nilgiri and Palni escarpments are of different nature from the table-topped square-cut hills of the Deccan trap plateau is at once apparent from their difference in geological structure. In the latter, the vertical stair-like faces of the hills arise from the weathering of rectangularly jointed horizontal lava-beds, while in the former, the cliff faces, thousands of feet high, built of closely folded and contorted strata are best explained as due to mechanical disruption, followed by relative movement along the walls of the fissure. These hills are not the residual stumps of an eroded plateau, but are upraised mountains with an orographic axis, formed during a late period of earth-deformation, rejuvenating the ancient well-graded drainage-lines of the country.

THE ROLE OF VERTICAL UPLIFT IN MOUNTAIN BUILDING

Positive upward movements of portions of the earth's crust, formerly not recognized as an important agency in mountain-building, has now been emphasized by geophysicists. Mountains formed primarily by faults, through vertical or nearly vertical uplift, are found in many parts of the world, and have been the subject of morphological study by Blackweder and Lauderback, notably in the Basin Range Province of North America. William Bowie, J. Barrell and other high authorities regard vertical movements of great amplitude as largely responsible for much of the visible crustal deformation. Barrell recognizes vertical movements of horsts as constituting a distinct orogenic feature and goes so far as to say that the linear mountain systems originating from geosynclinal troughs of sediments have come to be recognized as but one of several classes of mountains. He further states that the great plateau areas of folded as well as unfolded rocks have been bodily lifted one or two miles, or more, above their earlier levels. They may be broad geanticlinal arches or bounded by the walls of profound fractures.

The actual mechanism of this vertical uplift of large land-masses is to be sought in the adjustments brought about by isostasy and in the thermal expansion of the dense basaltic sub-stratum (*sima*) underlying the continents, through the effects of radioactive heating of the rocks. Joly has formulated a working hypothesis of cyclical volume changes of the sima, causing periodic earth-deformations by alternate liquefaction of the sima through accumulation of heat and its solidification through loss of that heat in long intervals of geological time.

In the absence of sedimentary formations, there are no reliable criteria for determining the age of the post-Archaean uplift of Ceylon mountains. There is, however, no doubt that there were two distinct period of diastrophism, separated by wide intervals of time, resulting in the uplift of the two fault-bounded terraces. The lower terrace is far more worn and graded and is, therefore, clearly much older than the upper and more abruptly scarped terrace. Here the river-valleys with their numerous rapids, cascades and 1,000 feet waterfalls have a

more juvenile aspect. Provisionally we may accept a late Tertiary age for the uplift of the upper terrace—an event contemporaneous with one of the two or three periods of intense diastrophic activity following the Deccan volcanic cycle, which upheaved the Himalayas and other mountains of Southern Asia. The South Deccan orogeny must be considered as coeval with these and with the last period of Ceylon's earth-movements. For the date of the earlier deforamation, which elevated the second peneplain, we have somewhat more exact data. The topography and drainage of this are of a more advanced type and clearly prove its relatively greater age and a small patch of Jurassic sediments containing Upper Gondwana fossil plants, near Tabbowa on the western coast—the most important documented geological record in Ceylon—helps to fix the lower limit. The complex faulting witnessed in this small Tabbowa basin, lying in the gneissic lowlands of the first peneplain, is probably a consequence of the older epeirogenic movement in Ceylon, where detritus is definitely dated as post-Jurassic.

THE DECCAN, A MUCH FAULTED LAND-MASS

The faults, bounding the mountains of South India are only a part of the system of faults traversing the inflexible peninsular shield in many directions. Several systems of longitudinal fractures intersect this one-million-mile gneissic terrain, producing a series of sunken basins, which have acted as receptacles of the detritus of the old inland drainage. Chains of such fault-bounded depressions, filled with sediments of Gondwana age, are found a long the ancestral valleys of the present Godavery, Mahanadi and Damodar rivers, which form a valuable economic asset because of the important coal measures locked up in them. The straight and steep contours of the Malabar coast have been known since the early days of the Indian Geological Survey to be shaped by one or more dislocation; while a prominent line of fractures defines the smooth coastline of the Makran coast of Baluchistan. The basaltic lavas of the Bombay coast, which are sub-aerially erupted flows, are known to extend down to a depth of at least 2,000 feet below the sea, indicating that the coast has faulted down to that extent since their eruption. Two more fracture plains, parallel with the Makran coast fault, remain to be noted. These have given rise to the two prominent lines of steeps in the central Indian landscapes—the Vindhya and the Satpura ranges and at the same time guided the channels of the Narbada and the Tapti along these tectonic lines. The latter rivers are peculiar in their being the only west-flowing streams of South India, a fact which finds explanation in this accidental circumstance providing them with their valleys.

The westerly courses of the Narbada and the Tapti, in sharp contrast with the rest of the Deccan rivers flowing eastwards into the Bay of Bengal, almost from within sight of the Arabian Sea, demonstrate a singularly interesting structural feature. The easterly drainage is probably the result of an easterly tilt given to the Deccan block at the time of origin of the great Malabar coast fault, the transverse Tapti and Narbada dislocations acting as release lines. The eminent naturalist, Blanford, has dated these displacements of the western coast as Pliocene to post-Pliocene—a date which brings these momentous transformations in the figure of India within the Human Era of geological history. The former date appears to be more in conformity with physical and geological facts.

The severence of Ceylon from India took place at a somewhat earlier date, by the subsidence of south-east Carnatic under the sea. By the middle of the Pliocene, however, the connection was for the most part restored by the uplift of the Jaffna limestone beds laid down on the Miocene sea-bed to form the dry land of North-West Ceylon.

The Indian Peninsula, thus, though still a rigid shield, is not an unbroken unit. Perhaps it is owing to this circumstance of multiple basin-faulting that

it has attained equilibrium and isostatic adjustment as a whole and the remarkable immunity of this part of India from seismic disturbance is also to be credited to the absence of any tension between its several parts. Few earthquakes of any intensity have shaken the Deccan Peninsula, while those that have been recorded in extra-peninsular India form a long catalogue of tragedies.

The block-mountain and fault-basin structure of the Deccan is responsible for some highly beneficial features in the exploitation of the economic mineral resources of South India. To it we owe the uncrumpled and generally undisturbed underground disposition of the coal seams accessible to simple mining in our coal fields. The presence of large sheets of commercially valuable mica free from buckling and crushing and the wide stretches of richly aluminous laterite, capping the table-lands, also arise from this circumstance. The waterfalls of the peninsula—potential power-resources in coal-less provinces—are also the direct outcome of the same structural peculiarity. Large volumes of water, falling down fault-scarped highlands, provide a source of energy more lasting and economical than that obtained from a coal field. The surface or near-surface occurrences of iron and manganese ores, rendering these two most valuable metallic assets of the country susceptible to comparatively simple mining operations, are also indirectly ascribable to this cause.

The remaining orography of peninsular India is represented by the tectonic chains of Aravalli and the Eastern Ghats, all but worn away and now existing mainly in their roots. Once of a size comparable with the Himalayas of today, these mountain ranges have played a large part in the succession of geological ages and their detrital waste has furnished the raw material of the principal rock-systems of India.

The Vindhya and Satpura chains, which form the main divide of North and South India today, are not of as great geological antiquity. There is some evidence that in the early Eocene they were non-existent and that a north drainage flowed across their site to central Deccan. These prominent lines of steep south-facing cliffs, like the cliffs of the Western Ghats in the Konkan, have been produced, as stated before, by parallel linear faults, now usruped by the valleys of the Narbada and the Tapti, Though of tectonic origin, these ranges have no axis of folding or compression.

The mountains of the Assam ranges and those of the Salt Range in North-Western Punjab are two unique and rather aberrant structural features of India. Though so near to the Himalayas, their orography is unrelated and independent and the folds, faults and thrust structures present problems that have aroused the keenest interest of geological workers in India.

THE VOLCANIC PLATEAU OF NORTH DECCAN

A large section of the Deccan, so far left out of the above description, now claims attention, portions of Bombay-Deccan extending from Kathiawar to Nagpur, and from Malwa to Dharwar. This part of India possesses the simplest geological structure possible, for these 200,000 miles tract is built up of flat-reposing sheets of lava, forming a pile from 2,000 to 6,000 feet high, completely burying the ancient Geography of the land. Time has sculptured this lava plateau into imposing hills, valleys and plains, but these high hills are only the few outstanding portions of the plateau that have withstood weathering, and have no pretensions to be classed as mountains of elevations. They have no orographic axes of foldings, but have remained in their original position and attitude. At the time of its completion, this volcanic formation, known as the Deccan trap, must have covered a much wider extent both in area and altitude and it will not be far wide of the mark to say that 400,000 cubic miles of molten rock was poured out from the bowels of the earth during this volcanic period—

a volume of rock exceeding both in bulk and mass that represented by the entire body of the Himalayas, and of an average density one-tenth higher than that of the Himalayan rocks. The transfer of so much heavy matter from the interior of the earth to the exterior must have had reactions on the isostatic adjustments of the neighbouring sections of the crust. Relief would be sought in the downwarp of large tracts whereby the relatively lighter rocks of the upper crust would be depressed and condensed. We might see in this a predisposing cause for the sinking of the long and wide tract of the Indo-Gangetic plains to a depth of some thousands of feet in front of the Himalayas. The completion of the gigantic volcanic discharge of the Deccan trap may be considered as pene-contemporaneous with the first uplift of the Himalayas in Mid-Eocene to Post-Eocene time. No satisfactory theoretical explanation has yet been found for the hidden chain of dense matter detected by gravimetric survey, referred to before, under the southern edge of the plains. A suggestion may be advanced that the upwelling of the basaltic magma forced up, along the north periphery of the Deccan trap reservoir, masses of ultra-basic, dunitic rocks from the deeper levels of the reservoir to a position in the upper crust near enough to affect the plumb-line and the pendulum. A concentration of masses of heavy rock along this chain was suggested as long ago as 1914 by Sir Thomas Holland as a matter needing further attention of geologists and geodesists. The parallelism of the hidden range with the Himalayan protaxis cannot be entirely accidental and may have a structural significance suggesting sub-crustal redistribution of heavy and light rocks—an upwarp of the sima preeded, or caused by, the downwarp of the Gangetic tract.

THE SCULPTURE OF TIME

But in the making of India the constructive geological processes that we have hitherto considered have only given the broad outlines of the country; the shape of figure of India, as we see it today, is determined essentially by the destructive processes of Nature. The sea, rain, rivers and other atmospheric agencies of change, by their ceaseless action have cut deep into the profile of India and have removed thousands of feet of matter from off the surface, producing the existing sculpture of the land. The 6,000 to 15,000 feet thick beds of clay, sand and silt, laid down in the Indo-Gangetic plains, are all derived from the decay of the Himalayas. They are only a small measure of the waste of these mountains. The dissection of the originally two miles high volcanic plateau of Malwa—Deccan to the depth of over a mile into the picturesque alternation of plains, valleys and hills is another visual demonstration of the power of surface natural agencies in shaping the surface features of the continents, while constantly lowering their level to the mean sea-level. These base-levelling processes have in the past, repeatedly peneplained vast tracts of India, but the geological cycle was not allowed to be completed by the supervening earth movements which restored topographic youth. Rajputana and Madras have thus been levelled and peneplained and rejuvenated by timely earth-movements reversing the geological cycle time and again.

Ladies and Gentlemen, the above is manifestly an incomplete summary of the structure of India. It has dwelt mainly on those aspects which have received some additional facts from the work on which I have been lately engaged. I have refrained from giving a review on recent work in the Geological Sciences done in India, as this account was presented before the Congress in a long paper, published as late as in 1938, at its Jubilee Session held at Calcutta.

BIBLIOGRAPHY

1. Adams, F. D., Geology of Ceylon, *Canadian Jour Res.* Montreal, 1929.
2. Auden, J. B., Geological Structure of the

Garhwal Himalaya, *Rec. Geol. Sur. Ind.,* **71** (4), 1937.

3. Blackwelder, E., Recognition of Fault Scarps, *Jour. Geol.*, **36**, 1928.
4. Burrard, S., Origin of the Indo-Gangetic Trough, *Proc. Roy. Soc.*, X-C, 1-A, 1925.
5. Daly, R. A., *Our Mobile Earth,* New York, 1923.
6. De Terra, H. Himalayan and Alpine Orogeny, *XVI-Intern. Geol. Cong.,* Washington, 1934.
7. Du Toit, A. L., *Our Wandering Continents.* Oliver and Boyd, 1937.
8. Evans, P., The Assam Ranges, *Trans. Min. Geol. Inst. Ind.,* **27**, 1932.
9. Fermor, L. L., Garnets and their Role in Nature, *Ind. Ass. Cult. Sc.,* Calcutta, 1938.
10. Fox, C. S., Gondwans System of India, *Mem. Geol. Sur. Ind.,* **58**, 1931.
11. Glennie, E. A., Gravity Anomalies and Structure of the Earth's Crust, *Prof. Pap.* **27**, *Survey of India,* 1932.
12. Gregory, J. W., *The Structure of Asia (Metheun),* London, 1920.
13. Hayden, H. H. Relation of the Himalaya to the Gangetic Plains, *Rec. Geol, Sur. Ind.,* **43** (1), 1913.
14. Heron, A. M., Geology of Rajputana, *Mem. Geol. Sur. Ind.,* **45**; 68(1), 1936, 1917-22.
15. Hora, S. L., Fossil Fish Remains from the Deccan Intertrappeans, *Rec. Geol. Sur. Ind.,* **73** (2), 1938.
16. Joly, J. *The Surface History of the Earth*, Clarendon Press, Oxford, 1925.
17. Lauderback, G. D., Morphological Features of the Basin Range, *Bull. Univ. Calif,* **16,** 1926.
18. Oldham, R. D., The Structure of the Gangetic Plains, *Mem. Geol. Sur. Ind.,* **42**(2), 1917.
19. Pilgrim, G. E. Stratigraphy of Simla Rocks, *Mem. Geol, Sur. Ind.,* **53**, 1928.
20. Pithawala, M. B. Physiographic Divisions of India, *Proc. Sc. Cong.,* **26**, 1939.
21. Sahni, B., Wegener's Theory in Light of Palaenantical Evidence, *Jour. Ind. Bot. Sol.,* **15**(5), 1936.
22. Schuchert, C., Gondwana Land Bridges, *Bull Geol. Soc. Amer.,* **43**, 1932.
23. Sewell, R. B. S., The Murray Expedition, the Arabian Sea, *Nature,* **133** and **134**, 1934.
24. Wadia, D. N., Syntaxis of the North-West Himalaya, *Rec. Geol. Sur. Ind.,* **65**, 2, 1931.
25. ——, Structure of the Himalayas and the North Indian Foreland, *Proc. Ind. Sc. Cong.,* **25**, 1938.
26. West, W. D., Stratigraphy and Structure of Simla Rocks, *Mem. Geol. Sur. Ind.,* **53**. 1928.
27. Weyland, E. J., The Tabbowa Series (Gondwanas of Ceylon), *Cey. Jour. Sc.,* **13**, Pt. 2, 1915.
28. Willis, B. Isthmian Links, *Bull. Geol. Soc. Amer.,* **43**, 1932.
29. —— The Great Bihar Earthquake–Structural Features of, *Mem. Geol. Sur. Ind.,* **73**, 1939.

TECHNOLOGIES IN REMOVING POLLUTANTS FROM WASTEWATER

Ajay S. Ghatbandhe*

The removal of organic pollutants in aqueous solution needs one or various basic treatment techniques. Depending on the compounds present in solution, the method to use can be destructive or nondestructure. Examples of destructive methods are chemical oxidation and incineration or degradation, which allow the efficient elimination of the pollutants. Non-destructive method include liquid-liquid extraction and absorption, that allow recuperation of the pollutant. It is necessary to choose an adequate method according to the characteristic of the nature and concentration of the pollutants. The final choice basically depends on the cost of the process and other factors like the concentration and volume flow of the effluent to be treated.

INTRODUCTION

One of the fundamental requirements for life on earth water comprises two thirds of the earth surface and arround 65 percent of human bodies. Dehydration with loss of about 2.7 liter of water from human body can be fatal. The total water existing on earth (oceans, lakes, rivers, polar regions, glaciers, underground water, water of the biosphere and atmosphere) is around 1.4×10^9 km^3 of which only ~0.8 – 1.0% (i.e., ~1.3×10^7 km^3) corresponds to total drinking water[1]. World is suffering from growing health and hygienic problems and a high percentage of diseases in developing countries is caused by deficient water supply. In this context contaminants from industrial waste streams, that seriously threaten human health and the environment, has assumed growing importance in recent years. Reduction, if not elimination, of such pollutants can be achieved through a combination of resource management, product reformulation, process modification, and some form of end-of-pipe treatment. The established technologies are based on incineration, biological treatment, condensation, absorption, and adsorption processes[2].

* Department of Chemical Technology, Laxminarayan Institute of Technology, R T M Nagpur University, Nagpur. Email : ajay_gbandhe@rediffmail.com

The most widely used methods of treatment of pollutants are described next.

REMOVAL OF POLLUTANTS FROM WASTEWATER

Treatment processes for different types of effluents should ensure elimination or recuperation of the pollutant in order to reach the strict authorized levels for the discharge of these effluents. The levels of pollutants allowed in discharge waters, are directly related with the type of pollutant present. In general, elimination of organic pollutants in aqueous solution needs one or more basic treatment techniques. The technique can be destructive as for example, chemical oxidation, incineration or degradation, which destroys the pollutants on non-destructive such as those employing liquid-liquid extraction and absorption, that allow recuperation of the pollutants. The choice of the methods depends on the nature and the concentration of the effluent. It is necessary to choose the appropriate method according to the characteristic of the affluent stream. For high concentrations of pollutants, incineration or some chemical oxidation may be suitable. For low concentrations of pollutants, generally one employs adsorption, membrane techniques and some chemical oxidation

methods as well. The cost of the process and other factors like the concentration and volume flow of the effluent to be treated influence the final choice.

The most widely used treatment methods are as follows.

COAGULATION FLOCULATION AND FILTRATION

The physical state of pollutants present in wastewater, often calls for a suitable method for its treatment. For example, about 80% of the COD in raw domestic sewage is due to materials which are colloidal or larger in size. Coagulation and sedimentation can efficiently remove these materials. These pre-treatment processes reduce operational difficulties in subsequent operations such as filtration, adsorption and disinfection. Filtration is mostly employed for removal of solids and precipitated compounds from lime softened water and precipitated iron or magnesium present in well water. Direct filtration of wastewater without flocculation is very ineffective for turbidity removal. The most common and successful process has been the high rate filtration through a bed of granular media such as sand, coal or activated carbon. Such filtration is usually carried out in open beds, which operate under the gravitational influence of a static head of water over the bed. Pressure filtration in closed vessels is an alternative design used more frequently for industrial waste treatment. Filtration performance, significantly depend on the nature of the solids, the type of filter media used and the frequency and efficiency of back washing.

INCINERATION

Incineration is a useful method for small quantities of wastewater with high pollutant concentration. However, it presents the disadvantage of requiring big investments and high energy cost as well. Incinerators normally used for this process are similar to those for sludge or industrial residues, and they can be horizontal, vertical or fluidized bed. A fundamental economic aspect in the incineration of organic solutions is the auxiliary fuel needed to maintain combustion. Incineration can also be used to minimize wastewater quantity prior to application of other treatment processes.

AIR STRIPPING

Air stripping involves the transfer of volatile organics from liquid phase to the air phase by greatly increasing air/water contact area. Typical aeration methods include packed towers, diffusers, trays, and spray aeration. This is more established and a more widely understood technology than chemical oxidation. If air emissions are not regulated, air stripping is by far the simplest and cheapest solution for the removal of volatile compounds from water. The treatment of phenolic and nitro aromatic effluents by means of air stripping has not been reported. Air stripping has been used in the treatment of trichloroethylene (TCE), dichloromethane (DCM), 1,2-dichloroethylene (DCE), 1,2-dichloroethane (DCA), chlorobenzene (Cl-Bz), and dichloroethyl ether (DCEE) and the results showed that they could be removed easily from water solutions except DCEE[3].

WET OXIDATION

In the wet oxidation processes, organic and inorganic compounds are oxidized in the aqueous phase, with oxygen or air, under high pressure and high temperature conditions. The temperature depends on the nature of the compounds to be destroyed. However generally the range is 150 to 350°C. Pressurevaries from 20 to 200 bar. COD removal ranges from 75 to 90%[4]. The mechanism of wet oxidation has been deeply studied and seems to take place by means of a free radical process. Among the compounds that have been catalogued as readily oxidizable by means of wet oxidation are aliphatic, aliphatic chlorides and

aromatic, which do not contain halogenated functional groups, such as phenols or anilines. Experimental results indicate that over 90% removal of phenol or phenolic compounds can be achieved in the wet oxidation wastewater treatment.

ELECTROCHEMICAL OXIDATION

The use of electrochemical oxidation for the destruction of organic compounds in water solutions has been tried on bench and pilot plant scale, but is not yet used commercially because of high operating cost. One of the main advantages of the electrochemical processes is that electrons given or consumed by the electrodes imply a clean reactant, which does not increase the number of chemical molecules involved in the process. Electrochemical oxidation of organic compounds is thermodynamically favored against the competitive reaction of oxygen production by electrolysis of water. The mechanism of the electrochemical processes involves three stages; electrocoagulation, electroflotation and electro oxidation. The anodic oxidation is generally considered to be a direct technique involving direct transfer of an electron from the organic molecule to the electrode and generation of a cationic radical. In the direct way, the cationic radical, the pH and the nature of the electrodes influence the nature of products formed. It has been also used in combination with coagulation to remove colour, turbidity and COD[5].

PHOTOCHEMICAL PROCESSES

Addition of energy as radiation to a chemical compound is the principle of the photochemical processes. Molecules absorb this energy and reach excited states to be able to carry out chemical reactions Medium and high-pressure lamps, with a broader emission spectrum, have been more frequently used for the degradation of contaminants. Medium-pressure Hg lamps emit particularly strong light in the spectral region between 254 and 400 nm and they generate hydroxyl radicals from e.g. hydrogen peroxide or ozone, but also cause electronic transitions in a large number of organic molecules.

Photolysis involves interaction of light with molecules to bring about their dissociation into fragments. This reaction is a poor source of radicals and, in the reaction, medium large quantity of reaction intermediates that absorb part of the radiation are generated. This decreases considerably the photo oxidation kinetics of the contaminants. This fact makes the process valid only for effluents with low concentration of pollutants. The photochemical treatment, although partially suitable for the problem of refractory compounds, has some negative aspects in practice e.g. as the high cost of UV radiation production. Furthermore, of all the emitted radiation only the absorbed radiation is used and only a fraction of this radiation produces chemical changes. Thus, some photodegradation reactions have very low yields and slow kinetics. To accelerate the process, other oxidants like hydrogen peroxide and / or ozone, metallic salts or semiconductors like TiO_2 can be added. Instead of UV lamps, solar light could be used as radiation energy for degradation of some compounds.

BIOLOGICAL OXIDATION

Bio treatment is effective for dissolved and suspended organics (BOD, COD, VOC's and SVOC's), and inorganics (nitrites, phosphate, cyanide, and hydrogen sulphide), as well as bio solids. It is also ineffective for some organics, such as halogenated solvents and aliphatic compounds. In recent years, with the development in third generation bioreactor systems, the activated sludge process is gaining popularity. It is preferred because of its reliability and suitablity for handling large volumes of wastewater and because of the high degree of treatment achieved.

Concentration of biodegradable organics can be reduced by more than 90% by this process. However, the biological treatment processes have number of disadvantages such as the requirement

of large ground area, ever increasing volumes of sewage causing secondary pollution, foul smell and unhygienic conditions. Biological treatment, generally by means of activated sludge in adequate conditions has unquestionable advantages for the destruction of organic compounds. However, its application to the treatment of effluents with phenols, nitro aromatic, ether and aliphatic compounds is quite restricted because of the high toxicity inherent in these wastes, the need to adjust the pH to an adequate value and add food and oxygen in adequate quantities for the transforming microorganisms, as the viability of the process depends fundamentally on the health and activity of the latter. There are two kinds of processes in the biological treatment of biological compounds : aerobic and anaerobic. The aerobic process are used more because of their efficiency and operational simplicity.

CHEMICAL OXIDATION

Chemical oxidation methods are used since long for purification of wastewater and conversion of undersirable chemicals into non-hazardous products. Aeration was one of the first methods utilised in water purification. Common oxidants include air, chlorine, chlorine dioxide, hydrogen peroxide, ozone and potassium permanganate. Advanced oxidation processes generate OH free radicals that oxidise the contaminants. It has been found that chlorination of waters containing natural organic materials produces a series of organohalides such as trihalomethanes (THM), which are more toxic in nature.

Ozonation is an advanced oxidation process (AOPs) with applications in the fields of wastewater and drinking water treatments. These processes are all characterized by the production of OH radicals (.OH), an extraordinarily reactive species, which attacks most of the organic molecules with rate constants in the order of 106-109 $M^{-1}s^{-1}$. According to the literature, the oxidative degradation with these treatments may ensure complete mineralization of the organic contaminants. Ozonation treatment is economically advantageous when organic compounds are present in trace amounts. The direct reaction with molecular ozone is selective while indirect reaction with hydroxyl radical is rather non-selective and faster. The combination of these two different pathways depends on the pollutants, the solution pH and the ozone dose fed. One of the disadvantage of this treatment is oxidation product may be more harmful than original one.

MEMBRANE PROCESSES

Membrane processes employ a semi-permeable (selective) membrane and a driving force (pressure difference, gradients in concentrations, electrical potential and / or temperature) across the membrane to separate target constituents from a feed liquid. Different types of membrane processes can remove dissolved and colloidal constituents in the size range 0.0001 to 1 microns. The membrane has three layers. The first is a 500 to 2000 A° polymer layer that does actual separation. The second layer is made up of porous polysulfone of 50 μm thickness. The third layer used for tear resistance and strength is made up of polyester with thickness of 125 μm. The membrances can withstand pH in the range 2-12 and temperature up to 60°C. One of the most important physico-chemical criteria governing membrane separation of organic solute is the polar effect of the solute molecule which includes both the functional group and substituted groups for phenol and nitrophenols. The commercially available membrane processes include, microfiltration, ultrafiltration, reverse osmosis, membrane electrodialysis and diffusion dialysis. Microfiltration and ultrafiltration are variations of cross-flow microfiltration (CMF). In CMF, the fluid to be filtered flows parallel to the filtration surface-that is, cross flow with respect to the flow of the filtrate. The cross-flow generates shearing forces and turbulence across the filtration medium and limits the thickness of the particle deposits on the filtration surface. Because of the nature of flows within a tubular

surface, a gradient in the particle concentration perpendicular to the surface is established. Microfiltration removes constituents between approximately 0.05 and 2 microns, while ultrafiltration removes constituents between approximately 0.005 micron and 0.1 microns. The disadvantages of membrane processes are high cost of equipment and difficulty with the separation of highly polar compounds.

REVERSE OSMOSIS

The term "osmosis" describes the interaction between weakly concentrated aqueous solution and a more highly concentrated solution, separated by a semipermeable membrane. The membrane which is permeable to water molecules permits the diffusion of water from the lower concentration to higher concentration. If this natural process is reversed, say by raising the side with the higher concentration to a higher pressure, the flow of water will be in the opposite direction. Reverse osmosis (RO) is thus a pressure driven membrane process used generally to remove constituents with molecular weights above 200. It has become a common method for the treatment of household drinking water supplies. Effectiveness of RO units depends on initial levels of contamination and water pressure. The treatment may be used to reduce the levels of various contaminants as listed such as naturally occurring substances that cause water supplies to be unhealthy or unappealing (foul tastes, smells or colors) and substances that have contaminated the water supply resulting in possible adverse health effects.

RO systems are typically used to reduce the levels of total dissolved solids and suspended matter. In Minnesota and the Dakotas, reverse osmosis is principally used for the reduction of high levels of nitrate, sulfate, sodium and total dissolved solids. RO units with carbon filters may also reduce the level of some SOCs (soluble organic compounds) like pesticides, dioxins and VOCs (volatile organic compounds like chloroform and petrochemicals).

Application of the process includes purification of water for use as make-up water, desalination of seawater, concentration of milk in the dairy industries, and dehydration of the liquid food. The separating capacity of the membrane is reliable. Salts and organic contaminants of water can penetrate the membrane to a very small degree but the bacteria and viruses are incapable of penetrating it. Thus the reverse osmosis process is used as a reliable process for the production of extremely pure water. RO systems, normally used to treat only drinking and cooking water supplies, may not be preferred where larger supplies are being treated. They are not appropriate for treating water supplies that are contaminated by coliform bacteria.

ADSORPTION

Adsorption, an important technique in separation and purification processes, is used in water and wastewater industry for removal of colour, odor, and organic pollution. Adsorption on solid substrates such as soils, clays, microorganisms or activated carbon is a well-establised and powerful technique for removing organics from wastewaters. Various kinds of activated carbons are known to have the potential to remove organics to very low concentrations and to accumulate large amounts of these hazardous organics. Carbon and other adsorbents in various forms have been used for the treatment of water and as detoxifying pharmaceutical agents in medicine for many centuries. Drinking water regulations list numerous constituents that can be extracted from raw water, preferably by adsorption. Some of these are as follows :

● Polycyclic aromatic hydrocarbons ● Chlorine and chlorination by-products ● Color, odor and taste ● Surfactants ● Lead, Arsenic, Nickel ● Petroleum / gasoline by-products ● Radon ● Volatile organic chemicals (VOCs) ● Bacteria, viruses Cysts (*Cryptosporidium, Giardia lamblia*)

Adsorption is not always a single process and often a combination of interactions is responsible

for the association between a particular chemical (sorbate) and solid (sorbent). Activated carbon is the most widely and effectively used adsorbent used for removal of organics from water owing to its large surface area, porosity and surface chemistry. A typical activated carbon particle, whether in a powdered or granular form, has a porous structure consisting of a network of interconnected macro pores, meso pores, and micro pores that provide a good capacity for the adsorption of organic molecules due to its high surface area.

The surface chemistry of activated carbon such as the kind and concentration of adsorbent surface groups as well as its point of zero charge, the chemical characteristics of adsorbate such as polarity, ionic nature, functional groups and solubility and the properties of adsorption solution such as pH, concentration of adsorbate, the presence of other species etc. determine the nature of bonding mechanisms as well as the extent and strength of adsorption. Electrostatic and van der Waals forces, H-binding, dipole-dipole interactions, ion exchange, covalent bonding, cation bridging and water bridging can be responsible for adsorption of organic compounds on activated carbon.

Ion exchange resins : These are cross-linked polyelectrolytes that are capable of removing ionic species via an ion exchange process. However, they may also function as adsorbents in removing organics or metal chelates. These structures may be formed from cross-linked polymers derived from styrene, acrylates, phenols, and pyridines. Synthetic zeolites have been widely used as porous ion exchange materials where the compensating or charge balancing zeolitic cations (normally alkali metal ions) readily exchange with heavy metal ions in solution.

Nonionic polymeric adsorbents : These adsorbents are nonionic, high-surface-area, cross-linked copolymers of styrene, phenol, or acrylate. Some are hydrophobic; others are hydrophilic. In essence, the macroreticular particle is composed of microspheres that are linked together, creating a continuous network of fine or large pores.

Of the different technologies used for the control of water pollution, depending upon the nature of pollutants present in the wastewater, one or more technologies can be applied. In several countries across the world different technologies in combination or individually are being applied for water pollution control depending upon the operation conditions and cost effectiveness of the process. Thus, among the above mentioned technologies, one or combination of them can be applied to control the pollutants present in wastewater.

REFERENCES

1. S. Malato, Photo Catalysis and Advanced Oxidation Technologies Applied to Water Treatment. In Workshop on "*Catalytic process for clean chemistry and water and air pollution*". Hammamet–Tunisia, 2000.

2. R. E. Hester and R. M. Harrison. *Royal Chem. Soc.*, London, 1995.

3. K. Li, S. Chang and C. Yu. "Treatment of cholorohydrocarbon contaminated groundwater by air stripping". Proc. International Conference on Remediation of Chlorinated and Recalcitrant Compounds, 2nd, Monterey, CA, United States, May **22-25**: 293-300, 2000.

4. L. Li, C. Peishi and F. Earnest. *AIChE J.*, **37** : 1687-1697, 1991.

5. S. Lin and M. Chen. *Wa. t Res.*, **31** : 868-876, 1997.

APPLICATION OF BIOTECHNOLOGY IN MARINE BACTERIA

Mousumi Debnath* and A. K. Paul**

With the development of marine biotechnology, marine bacteria from unique and extreme environment are attracting attention as new biological resources. Many kinds of bioproducts derived from marine bacteria have been used as pharmaceutical compounds (antibacterial, bacteriocins, antifungal, antiviral, antitumour, anticancer compounds), single cell protein, vaccine, enzymes, biosurfactant and for food production.

INTRODUCTION

Undoubtedly, the soil has contributed to the overwhelming majority of commercialy useful strains of microorganisms till date. Yet, marine environment is also a vast reservoir of bioactive compounds of pharmaceutical interest. Marine biotechnology encompasses the search and collection of marine organisms as well as the discovery and utilisation of special functions and useful substances from them. Marine bacteria produce chemicals for their own use in a diverse array of functions including defence, offence and signaling. The enormous and diverse chemical arsenal evolved for these purposes is the raw material for many potential pharmaceutical and biotechnology products. These bacteria have wide application as biosurfactant in polymer production and biodegradation of pollutants. They have also gained notoriety for their role in biodetoriation of useful objects and biofouling[1].

In recent years, novel chemotherapeutic products from marine bacteria with regard to antibiotics[2], antitumour agents, antiviral insecticide, enzymes, polymers, drugs, quinolinols, toxins and antibiosis, have been reported. Their metabolic functions have developed during evolutionary process for adapting to diversified marine environment[3]. Some marine bacteria by direct antibiosis technique was found to inhibit the growth of some bacteria. A few examples mentioned below illustrate an immense potential of biotechnology for marine bacteria.

MARINE DRUGS

Marine bacteria comprise a comparatively untapped reservoir of commercially valuable compounds. Many of these compounds were found to have inhibiting effect on other microorganisms like bacteria, fungi, viruses, etc and hence are termed as antibacterial, antifungal and antiviral compounds respectively. The antibacterial antibiotics showed inhibitory action against most Gram positive non-marine bacteria. Notable among them are Istamycin, Altemicidin, Aplasmomycin, and Nocardicin A. Due to their low toxicity and effectiveness against antibiotic resistant bacteria, its use as a drug is immense. *Streptomyces tenjimariensis*, a marine bacterium has been recently reported to produce the antibiotic istamycin even under laboratory culture, presumably these compounds serve an ecological role in countering competitive species[2]. Pluramycin, Xanthomycin and Ansamitocins are some antifungal antibiotics from

* Seeding Academy of Design, Technology and Management College, Jagatpura, Jaipur.
** Department of Botany, University of Calcutta, Kolkata-19, e-mail : subir_debnath@indiatimes.com

marine bacteria. A marine cyanobacterium *Hormothamnin entermor*phoides with a weak cancer activity has also been reported[4].

The most exciting discovery was a new vasodilator from extracts of *Moraxella*, marine bacteria. A marine bacterium SCRC-2738 similar to *Shewanella putrefaciens*, isolated from intestinal content of pacific mackeral produced eicosapentaenoic acid, a polysaturated fatty acid. This is found to be effective for prevention and cure of thrombosis, arteriosclerosis and blood circulating diseases. Researchers at Scripps Institution of Oceanography at the University of California, San Diego (UCSD), have produced evidence that bacteria living inside a small marine animal may be the source of a new drug compound being developed to fight cancer. The anticancer drug Bryostatin 1 can be extracted from colonies of *Bugula neritina*, a marine invertebrate. Many bioactive substances from the marine environment already have been isolated and characterized, several with great promise for the treatment of human diseases.

ENZYMES

The commercial value for enzymes has increased substantially with the uses including confectionary, detergents, industry etc. Marine bacteria also serve as sources of improved enzymes. Xylanase isolated from *Clostridium stercorarium*, thermophilic bacteria plays a role in the enzymatic bleaching of pulp in the manufacture of paper. The alginate lyase producing bacteria may be useful for conversion of brown algal biomass to methane. A unique glucanase isolated from *Bacillus circulans* has the potential for liquifying the insoluable glucan adhering to the surface of the teeth causing dental carries[5]. Hence they can be incorporated into toothpastes to prevent dental carries.

Thermostable enzymes are required for a number of industrial processes. α-amylase, β-amylase, glucoamylase and pullalanase are some of the main amylolytic enzymes used in starch industry. The production of these enzymes and the formation of fermentative products by thermoplilic *Clostridium* sp. are important for their commercial application in textile, paper industry, starch liquefaction, food, adhesive and sugar production[6]. Asparginase, glutaminase and urease play an important role in biocycling of carbon and nitrogen in natural water and sediments. L-asparginase produced by *Vibrio harveyi* showed clinical trails for antitumour, antilueukaemic treatment and high activity against *E. coli, Citrobacter freundii*.

Thermostable DNA-modifying enzymes, such as polymerases, ligases, and restriction endonucleases, enzymes offer distinct advantages in research and industrial processes. The only commercially available thermostable DNA ligase is derived from *Thermus thermophilus* and expressed in *E. coli*. The ligase amplification reaction has potential application in the identification of gene defects. Hot springs in Yellowstone National Park provided the first archaeon (*Thermus aquaticus*) from which thermostable DNA polymerases were isolated. These novel enzymes (the *Taq* polymerases) became the basis for the polymerase chain reaction (PCR), a useful technique for studying genetic material.

POLYMER PRODUCTION

An active polysaccharide named "marinactan" was isolated and purified from *Flavobacterium uliginosum*. It is a heteroglycan consisting of glucose, mannose and fucose. This polysaccharide has antitumour activity with immunopotentiating activity. Several of the halophilic bacteria, in particular *Haloferax mediterranei* produce quantities of intracellular poly β-hydroxy-butyrate (PHB) and poly β-hydroxy-valerate (PHV)[6]. Copolymers of PHB and PHV are produced as biodegradable

bioplastics and are attractive oil-derived thermoplastic. Agarolytic enzymes have been detected in *Alteromonas* sp.

BIOSURFACTANT

Biosurfactant are the surface active molecules produced by living cells. The industrial demand for surfactant is high for their use in soap and detergents, food, beverage industries. *Acinetobacter calcoaceticus* RAG-1 is a marine bacterium, which can utilize the hydrocarbons in oil as a source of carbon. This isolate produced a surfactant, which has been exploited commercially as the product "EMULSAN"-a polysaccharide that will emulsify oil. Emulsan accumulates on RAG 1 cell surfaces as minicapsules and is released into the media as an active emulsifier, as the cell growth approaches the stationary phase[7]. The absence of a carbon nutrient source accelerates the release of emulsans. When these bacteria are grown in a carbon minimal medium, they will breakdown hydrocarbons. The product has been marketed with great success as a cleansing agent for oil tankers and oil storage tanks. Emulsion can form complex with Uranium and thus may also be useful for recovery of Uranium from waste material.

BIODEGRADATION OF POLLUTANTS

Marine microorganism have a marked ability to degrade complex molecules including napthalene pesticides, wood pulp and petroleum. *Acinetobacter, Arthrobacter, Micrococcus, Mycobacterium* are some of the marine bacteria found to degrade a range of hydrocarbon. A large oil spill is one of the most dramatic and terrible environmental disasters. Some of this oil is degraded by marine bacteria, which degrades the hydrocarbon in oil for use as a carbon source. Scientists have been experimenting with the use of oil degrading marine bacteria in oil spill clean ups. Marine bacteria, which naturally degrade oil, grow much more slowly than other bacteria strains. *E. coli* bacteria used in biotechnology labs divides every twenty minutes and is a vigorous and hardy species. If the gene, which enables marine species to degrade oil, can be isolated and inserted into *E. coli* bacteria, the ability to use bioremediation to clean up oil spills might be enhanced. A genetically engineered "superbug" was synthesized that could aid in clearing the oil spills occurring in coastal areas and oceans.

BIODETERIORATION AND BIOFOULING

Marine microorganisms have also gained notoriety for their role in biodeterioration of useful objects such as wooden dockyard piling, cotton fishing nets or ropes. This attachment of microorganism is known as fouling. Biofouling of ship undersurfaces by *Achromobacter marinoglutinosus*, marine bacteria reduces the speed of fouled ships as compared to their unfouled counterparts[8].

Biomaterials also hold promise for counteracting biofouling, which long has been recognized as an extensive and costly problem. Bacterial biofilms form slime layers that increase drag on moving ships, interfere with transfer on heat exchangers, block pipelines, and contribute to corrosion on metal sufaces. Bacterial and microalgal colonization of surfaces is accompanied by settlement of invertebrate larvae and algal spores, eventually leading to "hard fouling" and the need for costly cleaning.

The most effective anti-fouling coatings have utilized toxic chemicals, such as copper. There is an urgent need for non-toxic biofouling control strategies, due to heightened recognition of the impact that toxic coatings can have on the environment. Research is needed on the attachment mechanisms of marine organisms and the natural products they employ to prevent fouling of their own surfaces.

Molecular approaches to characterizing biofilm structure and development offer considerable potential for finding novel biofouling prevention strategies. It is now possible to determine the genes and pathways involved in regulation and synthesis of bacterial adhesive polymers. Considerable progress has been made in understanding the nature and expression of surface polymers produced by microorganisms such as the nitrogen-fixing *Rhizobium* species and the opportunistic pathogen *Pseudomonas aeruginosa*. Similar approaches can be applied to marine biofilm bacteria, to find the genetic determinants of adhesive production and the environmental factors that regulate synthesis.

BIOMONITORS

Marine organisms can provide the basis for development of biosensors, bio-indicators and diagnostic devices for medicine, aquaculture, and environmental monitoring. One type of biosensor employs the enzymes responsible for bioluminescence. The *lux* genes, which encode these enzymes, have been cloned from marine bacteria such as *Vibrio fischeri* and transferred sucessfully to a variety of plants and other bacteria. The *lux* genes typically are inserted into a gene sequence, or operon, that is functional only when stimulated by a defined environmental feature. The enzymes responsible for toluene degradation, for example, are synthesized only in the presence of toluene. When *lux* genes are inserted into a toluene operon, the engineered bacterium glows yellow-green in the presence of toluene. Like *Vibrio fischeri, another marine bacteria vibrio harveyi* (*Photobackterium phosoporeum*) is also capable of producing light.

Another type of biomonitor that holds great promise is the gene probe, which can be used to identify organisms that pose health hazards or may be useful in research. Specific gene probes can be employed, for example, to detect human pathogens in seafood and recreational waters; fish pathogens in aquaculture systems; microorganisms capable of mediating desired chemical transformations (e.g., toxic chemical degradation, CO_2 assimilation, and metal reduction) and specific fish stocks in fish migration and recruitment studies.

FERMENTED FOOD PRODUCTS

In Eastern countries, many fermented foods result from microbial activity. For e.g. a products "shoyu" and fish sauce in Japan has been produced by thermophilic bacteria, *Staphylothermus* marinus[9]. A squid meat product known as "Ika-Shiokara" involves *Rhodotorulla mucilaginosa, R. minuta* and *Cryptococcus* in the ripening process.

CONCLUSION

The oceans offer abundant resources for research and development, yet the potential of this domain, as the basis for new application of biotechnology remains largely unexplored. Predicting the future is an uncertain affair, with the development in one area greatly influencing other apparently distant disciplines. One can predict an increasing effort being placed on the search and discovery of pharmacologically active substances, notably antimicrobial and antineoplastic agents. Indeed, the vast majority of marine organisms (primarily microorganisms) have yet to be identified. Even for known organisms, there is insufficient knowledge to permit their intelligent management and application. The application of bioprocess intensification method to the production of antibiotics and other metabolites from marine bacteria will become an important strategy for improving supply of natural products in order to assess their suitability as chemotherapeutic drugs. Thus, marine microbiology offers considerable promise for biotechnology.

REFERENCES

1. A. S. Clare. *J. Mar. Biotechnol*. **6**, 3-6, 1998.
2. M. Slattery, I. Rajbhandari and K. Wesson. *Microbial Ecology* DOI : **10**. 1007/ s002480000084, 2001.
3. J. D. Marvick, P. C. Wright, and J. G. Burgess. *Mar. Biotechnol.* **1**, 495-507, 1999.
4. W. H. Gerwick, Z. D. Jiang, S. K. Agarwal and B. T. Farmer. *Tetrahedron*. **48**, 2313-2324, 1992.
5. Y. Okami, S. Kurasawa, Y. Hirose, *J. Antibiot.* **44**, 1191-1192, 1988.
6. D. A. Cowan. *Trends in Biotech*. **10**, 315-323, 1992.
7. Z. Zosin, D. Gutnick and E. Rosenberg. *Biotech. and Bioeng*. **25**, 1725-1735, 1983.
8. R. R. Colwell, *J. Shell Fish Res.* **7**, 552-553, 1988.
9. G. BarBier and D. Prieur. *Biofutur*. **106**, 41-46, 1991.

DO YOU KNOW ?

Q1. Which is the world's only flying animal?

Q2. What is a sonic boom and what causes it?

Q3. Which country has 3 capitals?

EPIDEMIC SCENARIO OF HIV / AIDS IN INDIA

Kailash Choubey*

HIV/AIDS is a social reality rooted in human behaviour. It is a product of human actions in social contexts. Although it is a biological phenomenon, some people are more vulnerable to this infection due to their social, cultural and economic environment. According to *NACO*, about 5.34 million people of the country were living with HIV/AIDS in Dec. 2004. Present study is basically based on the figures and facts of NACO, News-papers and other resources. India is a major epi-centre of the ADIS Epidemic which is spreading too fast thereby becoming a major threat to the country. More than 35 percent of the total cases of AIDS occur among the young people and unprotected sex is the major cause of the HIV-infection. Migrants, Truck-Drivers, sex workers, hotel and tourist-industry people are the main sensitive risk-groups. Now no group is immune to HIV-infection. The only way to check the dance of death is by stepping up awareness programmes and strict preventive intervention.

AIDS (Acquired Immuno Deficiency Syndrome) is called 'Acquired', because it is always 'caught' from someone else, immuno deficiency, because the virus destroys the body's protection mechanism. HIV/AIDS is not only a biomedical phenomenon, but a social reality rooted in human behaviour. It is a product of human actions in social contexts. The actions and their circumstances are shaped by longer cultural and social structures. HIV is a human immuno deficiency virus that cause AIDS and it can take 8-10 yrs to develop after infection with HIV and infected prople can live without symptoms for years. Virus live in the body fluids of the infected person, such as semen, vaginal secretion, blood, etc. In India, sexual contact is the predominant way of transmission in most of the states. It has emerged as a very serious socio-economic health hazard and it is one of the challenging task for the country to provide support to the people living with AIDS. This section of the society continues to be stigmatised due to various misconceptions prevailing in the society. Beyond biological reality, some people are more vulnerable to HIV infection due to their social, cultural and economic environment. It is estimated that 5.34 million people (NACO) were living with HIV/AIDS by the end of Dec 2004. But experts believe these cases represent only a small portion of the actual cases of HIV/AIDS in the country.

* Deptt. of Applied Geography, Dr. H. S. Gour University, Sagar-470 003.

PROFILE OF THE REGION

The geographical area of the study unit is 3287263 sq.km with a population of 10.27 Billions, according to 2001 census. The density of the population is 324 persons per sq. km, but it is not even throughout the country, while the sex-ratio of the area is 933 females per 1000 males. The educational level (literates) of the country is about

65 percent and the working population is only 24.5 percent. It is also significant that only 28 percent persons of the unit under study live in urban areas. The total number of urban towns in the country are 5161, while 35 metropolitan cities, 6 mega cities and 423 other cities provide the residential facilities to the people of the country.

Mumbai is the bigest city, where 16.3 millions people live, while Calcutta (13.2 m) and Delhi (12.8 m) are the other major cities of the country. More than 40 millions (14 percent) of the total population of the state of Maharashtra get their shelter in Mumbai slums, while 26 percent of the total population of the country are living still below poverty line.

India is the birth place of many religions, but 'Hinduism' is the oldest and predominant religion. India has a heterogenous population predominantly rural in character and mostly depend on agriculture, but now it is increasingly turning towards industrialization. Considerable differences are also found in their ecology and living environment. **Education level** among women is also not up to the mark. Women usually are the provider of primary healthcare and motivators of healthy behaviours at home. Contaminated drinking water, and deficient dietary intakes are also the other major problems of the country, which reduce the resistance power of the body and increase possibilities for infection. Changes in life style, behaviour, cultural and social values are also behind the emergence of many health disorder including HIV in the country. Travel, including tourism, internal and international movements of population including refugees and migrants, haphazard and uncontrolled urbanization are some of the causes for the emergence of many health disorders including AIDS.

SOURCE OF THE STUDY

Present study is basically based on the figures and facts of the NACO, reports from News papers, magazines, etc. The available data are believed to be underestimates, because mostly patients suffering from HIV infection do not come forward to disclose it.

INDIAN SCENARIO

India is a major epicentre of the AIDS epidemic and it is spreading very fast which poses a major public health and developmental threat to the country. If unchecked, AIDS can wipe out a large proportion of productive population of the nation. Southern and western states are the most affected areas in the country. Cases are also reported from urban as well as rural areas. It is believed that they are mostly due to hetrosexual risky attitudes. The N. E. states, being in geographical proximity to the 'Golden Triangle' of the S. E. Asia, initially experienced HIV among the injecting drug users.

Basically, HIV was introduced in India, much later than the other parts of the world, but it is spreading with unprecedented rapidity and is becoming a public health problem with enormous social and economic implications. The risky behaviour and practices associated with a higher risk of HIV transmission in India, are mostly due to unprotected sexual intercourse. Reasonable causes which affect the sexual transmission of HIV in the country include the presence of ulcerative STD's, irregular use of condoms, frequency of sexual contact and the age of sexual initiation, accommodation facilitics at the time of sexual contact, attitude and belief about sexual practices; low literacy and economic conditions also affect high risk behaviors in the country.

GEOGRAPHICAL EXTENT

AIDS/HIV epidemic in India has entered in the third phase, where significant transmission is occurring through perinatal route. At present, it is believed that about six million people in the country are suffering with this infection. Now the epidemic

is moving from high risk groups and urban centres to general mass with normal life style and the rural hinterland. Tamil Nadu, Maharashtra, Andhra Pradesh, Karnataka, Manipur, etc are the high prevalence states. But the cases are being reported throughout the country and are rising continuosly. Out of the total cases, 41.43 percent belongs to urban areas and rest 58.47 percent patients belong to rural areas. Officially recorded cases are very few in the country, which are as follows.

Table–1

STATEWISE REPORTED CASES (NACO-END 2003)

Sl. No.	State	No of recorded case	S. No.	State	No of recorded case
1.	Andhra Pradesh	43339	12.	Maharashtra	11829
2.	Assam	171	13.	Mumbai	2595
3.	Bihar	155	14.	Manipur	1238
4.	Delhi	821	15.	Orissa	128
5.	Goa	308	16.	Punjab	248
6.	Gujarat	3562	18.	Tamil Nadu	24667
7.	Haryana	313	19.	Uttar Pradesh	1083
8.	Himachal	114	20.	West Bengal	930
9.	Karnataka	1790	21.	Chandigarh	750
10.	Kerala	267	22.	Pondicherry	157
11.	Madhya Pradesh	1027			

N. B. : Experts believe that these reported cases are much less than the actual cases.

STATEWISE PATTERN

HIV/AIDS cases are primarily concentrated in Chennai and Mumbai, but such cases are also being reported from other regions, mainly spreading through major highways and migrant peoples. Tamil Nadu had more then 40 percent of the total reported AIDS cases by the end of 2003. Now Mumbai, together with rest of the Maharashtra, have about 20 percent of the total reported cases. The recent sharp rise in the people living with HIV/AIDS clearly indicates that the disease has taken root deeply in the country. NACO, considers six states as high prevalent states. (Table–1) Among these, Tamil Nadu continues to account for the maximum number of cases, followed by Maharashtra, while about 10 percent of the total cases were reported from Andhra Pradesh. Altogether, the six highly prevalent states have 80 percent of the reported cases. The latest study of various states (NACO) confirm that no group is immune to HIV/AIDS in the country. In some states, such as Tamil Nadu, Karnataka, Andhra and Maharashtra, the epidemic is in advanced phase while in other states the problem is only in early stage.

SOME IMPORTANT OBSERVATIONS ARE

1. More than 35 percent of the total reported cases of AIDS occur among young people in the age group of 18-24 years.
2. Unprotected sex is the major cause of the HIV-infection.
3. Main vulnerable groups of HIV infection are unemployed, under-employed, mobile migrant, youth and street children.
4. Vulnerable group often faces the repeated risks of HIV infection through sexual exposure by coercion or while selling sex in order to survive.
5. Most of the young people become sexually active during teenage and are more likely to have sex with risky partners or multiple partners.
6. The vulnerability of young women and adolescent girls is hightened because they are less likely to access information on HIV and have limited ability and power to exercise control over their sexual lives.
7. In case where the comparative poverty levels are high and females have less alternative work opportunities, they may turn easily to prostitution and become a source of infection.

CASE STUDIES

From the information and data collected from daily newspapers, it was revealed that the Indian states viz. Maharashtra, Tamil Nadu, Karnataka, Goa, Pondicherry, West Bengal, North Eastern states, and a few big towns of the North India are the major nucleus from where most of the HIV infection spread.

PONDICHERRY

Pondicherry Bars play 'Host to AIDS to pleasure seekers. Cocktail of wine and women comes increasingly spiked with a deadly third ingredient. The ubiquitious bars in union territory, which attract a large floating population in search of cheap liquor, have become breeding grounds for the HIV infection. In Pondicherry, nexus between liquor, sex worker and AIDS, prevails almost openly. Partial prohibition in Tamil Nadu, results in many people visiting Pondicherry to relatively inexpensive and freely available liquor, the evening out often includes sex workers. On an average, the town attracts a floating population of around 30000 every day. A byproduct is Pondicherry's flourishing sex trade. One survey report says that about 40 percent of sex workers are from out side. (Indian Express, 12th March 1997).

WEST BENGAL

HIV was catching up in West Bengal, according to School of Tropical Medicine, Kolkata, almost 18-20 people were found HIV positive during medical examination everyday. Unofficial sources confirm higher prevalence of HIV infection in the state. Places like, Kolkata, Siliguri, 24 Paraganas, Midnapore and Haldia are reportedly giving them sleepless night. Kolkata and Haldia are especially more susceptible because of their close proximity to migratory labour forces and are potential carriers of infection. Beside this, red light areas in urban and rural places pose a potential threat, alleging that rural areas have been converted into breeding group for sex workers. Their rehabilitation programmes have also failed because of high monetary expectations of the girls. (Indian Express, 12th March 1997).

ARMY AND PARAMILITARY FORCES

The spectre of AIDS looms large over the Army and Para-military forces normally on the borders with Bangla Desh, where prostitution is thriving in sprawing red light districts.

The villages around Army and para-military bases are teeming with sex workers. Military persons frequently turn up for recreation at the nearest sex-shop, with the barest idea about AIDS. Girls travel huge distance from their homes to join this lucrative trade, in this strategically important region which has three international boundaries. Travelling around these parts one finds countless little villages in southern Sikkim, East Nepal and of course, North Bengal where "Small Huts" are being used by sex workers for their trade.

These flying sex workers are most dangerous as far as HIV spread is concern. (Indian Express, 12th March 1997).

MADHYA PRADESH

About 1400 cases of HIV/AIDS have been reported officially in the state during last 17 yrs. In this state, it has an exogenous origin being first reported in an African student in M. P. in 1988. It has its endogenous origin in 1991. In Indore the highest number 396 AIDS cases have been reported by May 2005, followed by 258 cases in Ujjain and 109 in Jabalpur. In Khargone and Dewas, the reported cases are 78 and 68 respectively. From time to time, the AIDS cases are also reported from other parts of the state which appears in daily newspapers. According to one report, 77 percent of AIDS cases were reported from the age group of 21-24 yrs and 64 percent HIV infection had been

caused by the sexual route. Another salient feature of the report is that 75 percent cases have been reported from the districts which are on two major national highways. (Hindustan Times Sept. 25, 2005)

EASTERN-UTTAR PRADESH

In eastern Uttar Pradesh, this deadly disease had been reported from Sultanpur, Banaras, Kusinagar, etc. which are the major centres of the epidemic. A large number of the people of this region has been employed in various cities e.g. Mumbai, Kolkata, Chennai, etc. It is believed that they become HIV Positive after they migrate to towns and when they come back to their native place they may infect their spouses. In recent years, it is estimated that about 2 lakh 71 thousands and 600 peoples of the region are infected by HIV. The WHO centre of AIDS at Banaras, has reported 618 cases in six months (after March '05). The Pendra block of the Banaras is the main affected region, where 14 people reportedly died due to AIDS, and it is a place from where a large number of people are working in Mumbai. (Bhaskar 25 Sept 2005)

TOURIST SPOTS

Major risk places of India are "Tourist Places" from 'Kashmir to Kanya-Kumari', where 'Sex and Pleasure' are synonymous. Tourist industry is also responsible for the sex related activities in the tourist spots and these are also one of the main 'nucleus' of HIV epidemic of the country.

It is estimated that about 1200 effective red-light areas are in the country where a large number of sex workers are involved. Only in Mumbai, there are about 15 red light areas where sex workers provide their services to visiting clients. The sex workers are finding Delhi, Bangalore, Kolkata and Hyderabad the most attractive places for them.

Table–2
Percent of HIV Positive By Occupation in a Few States (NACO–2001)

Sl.No.	Occupation	Andhra	Karnataka	Maharashtra	Tamil Nadu
1.	Businessman	37.0	17.0	16.0	11.0
2.	Driver	32.0	22.0	23.0	20.0
3.	Hotel staff	26.0	17.0	27.0	40.0
4.	Industry/ Factory Workers	24.0	18.0	14.0	10.0
5.	Service class	16.0	23.0	16.0	10.0
6.	Unskilled labour	31.0	20.0	19.0	9.0
7.	Housewives	29.0	13.0	8.0	12.0
8.	Unemployed persons	35	17.0	21.0	13.0

Source : NACO 2001

RISK GROUPS

The common way by which HIV spreads is from high risk group such as sex workers, who transfer their infection to their married clients, who in turn infect their spouses. Highest prevalence are also reported among the workers of hotels and tourist industry. Truck drivers are another group of high prevalence, they often travel long distances to many different places bringing the infection with them to areas where the disease has not yet begun. The unemployed people are also a sensitive group, they often become HIV positive after migrating to towns and cities, in search of employment.

According to one report of M. P., the possible infection rate in migrant labours due to commercial sex workers had risen to 27 percent in 2004. These labourers initiate thousands of infection chains. As a large number of youth aged between 18-40 yrs migrate to cities and metros for various types of work in search of employment and often associate themselves with the commercial sex workers, most of whom are infected. This type of contact is very serious and leads to a deadly chain of infection, as the infected labours go back home and spread infection among their spouses.

In the same way, increased incidences (NACO) among housewives and pregnant women signal serious expansion of the HIV infection. Business class/service class people are also found HIV infected which also causes expansion of the infection among the general mass.

EDUCATION AND PREVENTION

Knowledge about the modes of transmission of the virus and the various outcome of the infection, is the only measure to control the disease. Misconception and baseless fears must be eliminated by a nationwide education programme in schools, health clinics and community groups. Although the awareness of HIV/AIDS has increased, but not so uniformly throughout the country. According to the behavioural survilence survey (B.S.S.), 70 percent of the people living in rural areas have ever heard about the HIV/AIDS. In the same way, three out of four rural women in most of the states never heard about the disease.

The involvement and co-operation among government, society and sex workers are needed ultimately before any significant stride could be made. Care should also be taken to select the communication channels, which must reach the rural and urban communities. The message must be culturally specific and it must begin in understandable local languages. It is also desirable that the messages, at the initial stage may be centred on factual information i.e. (i) What is AIDS? (ii) How does it spread? (iii) How to modify the life style and behaviour which would help protect people from HIV/AIDS.

There is urgent need to utilize all avenues of mass media, education and communication channels to reach all the segments of population. AIDS education should motivate to change the behaviour of the people and adopt healthy life styles to ensure that all keep in mind two important precautions :

1. Faithful relationship with one partner.
2. Infected women should avoid pregnancy.

Awareness through special educational programmes will also be necessary for specific risk behaviour people, such as drug users, sex workers, truck drivers, hotel and industrial workers, slum dwellers, etc. The young people can play a vital role in the prevention and control of HIV infection. Young people have the enthusiasm, energy and idealism that can be harnessed for spreading the message of HIV/AIDS awareness.

The socio-cultural stigma attached with the disease must be removed, because it is one of the main obstacles in the campaign against HIV/AIDS. The epidemic is growing in an unsuspecting general population. The only way to check the dance of death is by stepping up awareness programmes and strict preventive intervention.

DO YOU KNOW ?

Q4. The United Nations declared which year as the International year of Freshwater?

Q5. What is a spa?

Q6. How many persons died during Second World War?

STUDIES ON THE EFFICACY OF THE WASTEWATER TREATMENT USING BIOLOGICAL MATERIALS

G. Gunasekaran* and P. T. Palaniswamy

This article describes a preliminary investigation on the coagulative ability, pH & BOD/COD consequence of seed of *Moringa oleifera* (Drumstick), pulp of *Moringa oleifera* (Drumstick), leaves of *Azadirachta indica* (Neem) & *Ficus religiosa* (Peepul tree) and Alum (Aluminium sulphate) on the wastewater samples from a pharmaceutical industry, Alathur. Varying weights (3g to 10g) of dried pulverized plant materials and Alum were treated with 200ml of wastewater samples and kept for 24h. *Moringa oleifera* seeds exhibited coagulative effect comparable to Alum and Moringa pulp reduces the BOD/COD significantly. *Azadirachta indica* leaves also exhibited appreciable effect in the pH comparable to Alum. *Moringa oleifera* seeds & *Azadirachta idica* leaves also reduce the BOD/COD appreciably. These preliminary studies not only suggest alternative and cheaper wastewater purification methods for the pharmaceutical industries but also suggest good starting materials for the synthesis of environment friendly natural coagulants.

INTRODUCTION

The World Health Organization (WHO) has estimated that up to 80% of all diseases and sickness in the World is caused by inadequate sanitation, polluted water or unavailability of water. About 1.6 million people are forced to use contaminated water[1], which are polluted with either industrial waste like pharmaceutical wastes or domestic waste.

The pollutants can broadly be classified as organic and inorganic pollutants. The main source of organic pollutants are the waste water from industries like pharmaceutical industry, textile dye industry, paper board industry, petrochemical industry, sugar industry, breweries, etc., and the main source of inorganic pollutants are the waste water from industries involving mining and metallurgy, metal finishing, automobile, etc.,

The organic pollutants from pharmaceutical industries pose a threat to the ecosystem if not treated properly. The BOD and COD of the waste water, the pH and turbidity should be reduced to a permissible limit by various treatments available.

Nowadays some companies are using aerobic bacteria to treat wastewater. But most of the industries are still following chemical methods to treat the wastewater. Often the chemicals are toxic and non degradable and, therefore, there is need to try alternative methods.

India is rich in medicinal plants and macro fungi with which people are familiar and these have been used since time immemorial. Therefore, there is a need to explore and utilize the rich biodiversity through research for direct benefit to mankind. These medicinal plants could provide useful lead for the synthesis of natural coagulants.

* Bharath Institute of Higher Education and Research (Deemed University), Selaiyur, Chennai, India-600073.
e-mail id :–guna_sekar_g@yahoo.com

That are more environmental friendly, easy to handle and comparatively less toxic than chemical coagulants like Alum. The ultimate objective of this work was to carry out an *in-vitro* evaluation of some local medicinal plants for wastewater purification.

PLANT MATERIALS

***Moringa oleifera* (Drumstick)**

Fig. 1 : Moringa oleifera (Drumstick) tree

Moringa oleifera (Drumstick) tree, a native of India, grows widely throughout the tropics. It is also known as drumstick (because of the shape of the pods) and horseradish—describing the taste of its roots. Moringa grows rapidly from seed or cutting, and does well even in poor soils.

Seed extracts have been used as antihelminths and for treatment of liver disorders. Its oils are applied for rheumatic pains. Similarly, exudates from the bark of the tree (which is gum-like) have been used in the treatment of diarrhoea. The leaves and flowers of the plant contain pterygospermin, an unstable compound with low melting point and which readily decompose to benzyl lisothiocyanate. Pterygospermin has antibacterial activity against both gram-positive and gram-negative organisms[2]. It has also been reported that the bark of *Moringa oleifera* contains two alkaloids-Moringine and Moringinine.

***Moringa oleifera* (Drumstick) seed**

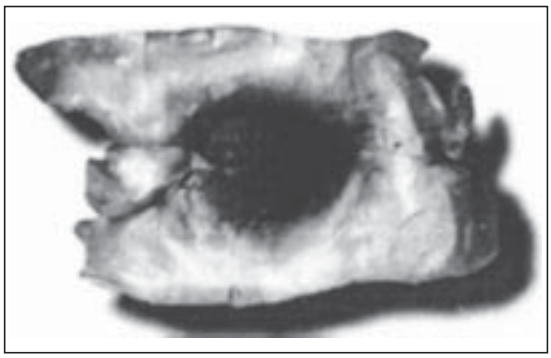


Fig. 2 : Moringa oleifera (drumstick) seed

For water treatment application, the seedpods are allowed to dry naturally on the tree prior to harvesting. The seeds are easily shelled, crused and sieved using traditional techniques employed for the production of maize flour. The crushed seed powder, when mixed with water, yields water-soluble proteins those posses a net positive charge. The solution acts as a natural cationic polyelectrolyte during treatment[3].

Moringa oleifera seed contains 40% by weight of oil, with the presscake remaining following oil extraction, contain the active constituents effecting coagulation. Confirmations of the high market value of the oil make the economic case for adoption of the presscake as a coagulant overwhelming.

***Moringa oleifera* (Drumstick) pulp**

Fig. 3 : Moringa oleifera (Drumstick) pod

The *Moringa oleifera* pulp is allowed to dry naturally on the tree prior to harvesting. The pulps are easily removed with knives then the collected pulp are crushed and sieved using traditional techniques employed for the production of maize flour. The crushed pulp powder is mixed with water.

Moringa pulp is light and when it is mixed with water, it floats, so the separation of water needs a separate filtrating unit to separate the pulp after treatment.

***Azadirachta indica* (Neem)**

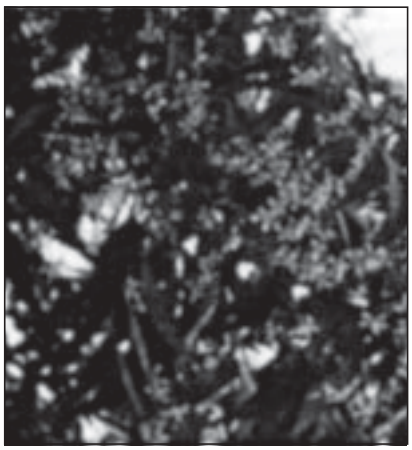


Fig. 4 : Azadirachta indica

Azadirachta indica (Neem) is a native tree of India, a tropical tree especially suited to semi-arid conditions. It is now grown in many Asian countries and in the tropical regions of the western hemisphere. *Azadirachta indica* considered to be part of India's genetic bio-diversity, is a medium large tree having short, straight bole, furrowed, dark brown to gray bark, and dense rounded crown of pinnate leaves. It belongs to the family Meliaceae and is becoming increasingly popular for its insect repellant traits and unique property of inhibiting the nitrification process in the soil. In India, *Azadirachta indica* grows in the plains and in areas up to an elevation of 1850 m. in most soil types including dry, stony, shallow soils, lateritic crusts, highly leached sands and clays. *Azadirachta indica* derivatives such as Azadirachtin, nimbicidin and a host of other compounds are now used in medicines and commercial pesticides. Many bioactive ingredients have been identified and isolated, the most important ones being azadirachtin and meliantriol. *Azadirachta indica* based pesticide formulations, which are safe, natural, bio-degradable, and manageable at the farmer's level and environment friendly, unlike chemical and synthetic pesticides, which leave behind residues polluting air, water and soil.

Azadirachta indica leaves are dried in the shadow. The dried leaves are easily shelled, crushed and sieved using traditional techniques employed for the production of maize flour. The crused seed powder, then mixed with water and used for the treatment. The treated wastewater gives pale brownish colour.

***Ficus religiosa* (Peepul tree)**

Fig. 5 : Ficus religiosa (Peepul tree) leaves

Ficus religiosa (Peepul tree) a native Indian tree, is a medium sized tree with a relatively short trunk and a large crown with wonderful wide spreading branches. The tree is semi or fully decidous in monsoon climates. Parts of the tree are useful in diseases of blood, vagina, uterus, leucorrhoea, burning sensation, biliousness, and ulcer.

Leaves first appear their colour is red-pinkish, but then they turn deep green and grow to about 12 to 18 cm long (5-7 inches). They are attached to long flexible stalks, which makes them rustle, flutter

and dance in the slightest whiff of wind. The foliage can often be dense. The alternate leaves are heart-shaped, shiny with an elegant tail-like tip, which is often called a "drip-tip", guiding water efficiently down to the soil.

Ficus religiosa leaves are dried in the shadow. The dried leaves are easily shelled, crushed using mixer. The crushed powder, then mixed with water and used for the treatment. The treated wastewater gives dark greenish colour.

MATERIALS AND METHODS

Water samples were collected from a pharmaceutical industry in Alathur, Tamilnadu. The appearance/cloudiness of these water samples were noted by visual observation. Similarly, the pH was noted using the pH meter, Turbidity was noted using the Turbidimeter, procedury. Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) using standard procedies. Seeds of Moringa Oleifera, pulp of *Moringa oleifera*, and the leaves of *Azadirachta indica* (Neem) and *Ficus religiosa* (Peepul tree) were previously obtained and dried, pulverized and stored in brown envelops unit ready for test. Seeds of *Moringa oleifera* (5 to 10 gm), pulp of *Moringa oleifera* (3 to 7 gm), and the leaves of *Azadirachta indica* (4 to 7 gm) & *Ficus religiosa* (3 to 7 gm) of the pulverized plant materials and Alum (100 mg) were each added to 200ml of the wastewater samples in 250ml brakers. The plant materials as per weight weighed and mixed in small quantity of wastewater to form paste and then mixed finally with the wastewater samples in the beakers. The same procedure was done for the Alum in the wastewater sample in the beaker. Beaker with 200ml of wastewater is kept as control. All the beakers were allowed to stand in a beaker for 24 hours.

The Turbidity and the pH were recorded, BOD/ COD test were carried out using standard procedures.

RESULTS

The Fresh wastewater was blackish in colour and more turbid with very bad odour in nature. After the 24 h treatment in a beaker, the wastewater treated with *Moringa oleifera* seeds showed light yellowish green colour and the sludge was well settled, when compared with the wastewater treated with Alum which showed pale white colour. This shows that *Moringa oleifera* seed treated wastewater has effect similar to that of Alum. *Ficus religiosa* leaves treated wastewater showed dark green colour and *Azadirachta indica* leaves treated wastewater showed dark brownish colour. *Moringa oleifera* pulp treated wastewater was dark yellowish in colour. The colour expressed by the leaves and pulp, showed turbidity in treated water. The leaves of *Azadirachta indica* and *Ficus religiosa* floated up as a layer due light weight. Due to lightweight of *Moringa oleifera* pulp, it also floated up to half the volume of the beaker. When the weight of the pulp increased, volume occupied by the pulp in the beaker was also increased.

The fresh wastewater pH is 9.08, which is alkaline in nature. The Alum 100mg treated wastewater reduced the pH value from 9.08 to 8.56. Where else *Moringa oleifera* seeds treated wastewater reduced the pH to neutral, that from 7.14 to 7.94 where the weight varied from 5g to 10g. When 10g *Moringa oleifera* seeds were used, it reduced the pH up to 7.14. The *Moringa oleifera* seed reduced the pH better than the Alum. *Azadirachta indica* leaves 6g reduced the pH up to 8.52 and it was better than the Alum. *Ficus religiosa* leaves 7g reduced the pH up to 8.66 but when comparing with Alum it has less effect. *Moringa oleifera* pulp 8gm that reduces the pH up to 8.84

but when comparing with the Alum it also has less effect. Fig 6 and Fig 7 show the effect on turbidity.

The fresh wastewater was very turbid and better action than Alum. *Moringa oleifera* seeds coagulated well about 90% of the particles in the samples leading to a clear supernatant. Floc

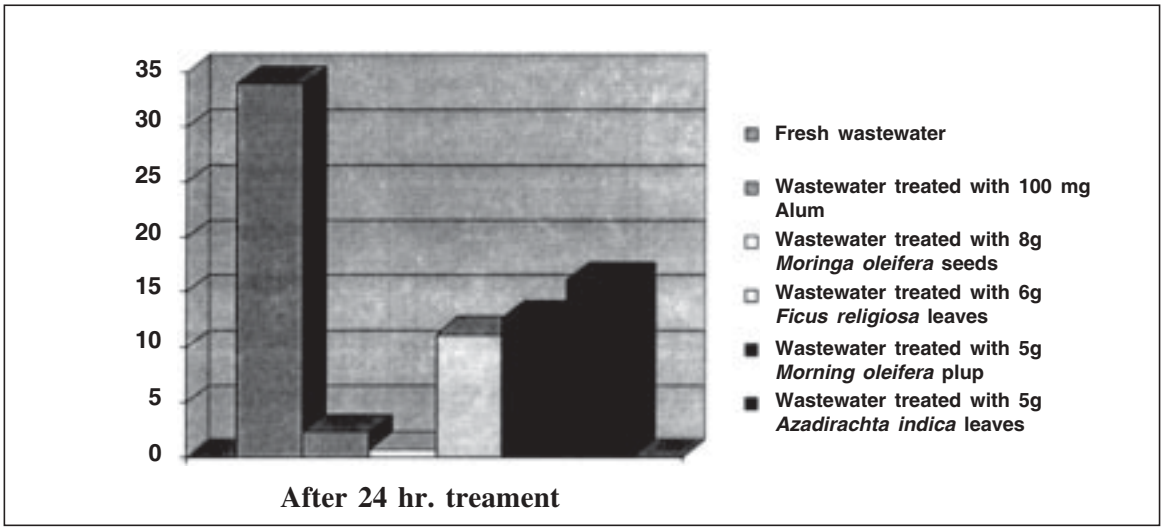


***Fig. 6** : Turbidity values after 24 hr. treatment*

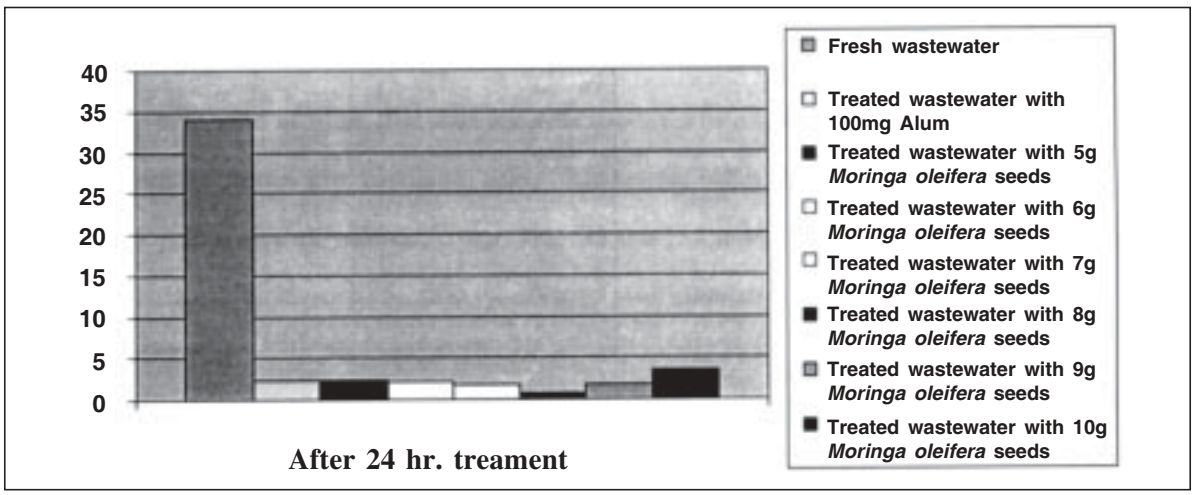


***Fig. 7** : Effect on turbidity after 24 hr. treatment with Moringa oleifera seeds*

blackish in colour, the turbidity was 34.0 NTU when measured using Turbidimeter. When it was treated with the plant materials it showed encouraging results when compared with the Alum, which is used as a coagulant for a long period in the industries. When the wastewater was treated with the Alum, it gave 2.3 NTU in the Turbidimeter. Where else *Moringa oleifera* seeds reduced turbidity to 0.7 NTU with 8g of seed powder, which shows settlement was slower with *Moringa oleifera* seeds where else Alum settles very fast but the coagulative effect of former was better than latter. The coagulative property of Moringa seeds could be attributed to a polymeric coagulatant earlier reported in the literature. The coagulative effect may be due to the cationic polyelectroyte protein present in the *Moringa oleigera* seeds. *Ficus religiosa* leaves, which reduce the turbidity upto 11.2 NTU with 6g

of leaves powder and Moringa oleifera pulp, reduced the turbidity upto 12.7 NTU with 5g of pulp powder. *Azadirachta indica* leaves reduced the turbidity upto 16.2 NTU with 5g of leaves powder. As per the result we can infer that *Ficus religiosa* leaves, *Moringa oleifera* pulp and *Azadirachta indica* leaves reduces the turbidity as like that of Alum. The plant materials also gives its colour on the treated water like *Ficus religiosa* leaves give dark green colour, *Azadirachta indica* leaves give pale brownish colour and pulp gives dark yellowish colour. This can also give turbidity to the treated water and this problem may be overcome by using the extracted plant materials.

The BOD/COD value of the fresh water was 1590/5778, which was reduced by the Alum upto 660/2386. *Moringa oleifera* pulp with 5g of powder reduced to 540/1632 and its was better than Alum. *Azadirachta indica* leaves reduced to the value 780/2386 with 6g of powder, which was as equal as the Alum. *Moringa oleifera* seed powder 8g reduced the value upto 855/2763 and *Ficus religiosa* leaves 5g reduced it upto 870/3265. Both these materials reduced the BOD/COD value equal to that of Alum.

The results show that the plant materials posses coagulative effect. Best coagulative effects were noted when 6 to 8 g plant powders were used. When compared to the untreated wastewater samples, all the plant materials were between 60-90% effective in purifying the water samples. Generally, the turbidity of the water samples reduced drastically after treatment with all the plant materials. The use of *Moringa oleifera* seeds as a water coagulant is gaining wide attention worldwide.

This study has indicated that wastewater can be treated with the use of plant materials. The need to exploit the potential of plants may offer cheaper and environment friendly methods of tacking water contamination and this may possibly overcome the hazards of using Alum.

REFERENCES

1. M. Cheesbrough, Medical laboratory Manual for Tropical Countries, Tropical Health Technology, Butterworth, pp 1-15, 1984.
2. E. A. Sofowora, Medicinal Plants and Traditional Medicines in Africa, Wiley, New York, pp 142-145, 1982.
3. G. K. Folkard, J. P. Sutherland, W. P. Grant Optimization of the use of natural coagulants for water purification. Tech. Rep. No. R4254. University of Leicester, 1989.

DO YOU KNOW ?

Q7. Which sea animal is the greatest diver?

Q8. Can a snake eat an alligator?

EMOTIONAL INTELLIGENCE : HOW DOES IT MATTER ?

Gurpreet Bajaj* Vinod K. Shanwal**

Over the last decade the concept of emotional intelligence has gained momentum for understanding the implications of behaviour and adaptation of an individual to his environment. The present article will give an overview of what is emotional intelligence and how it matters in our day-to-day life. The present article will also focus on different research findings and how it helps various sectors of society in a constructive manner.

Emotional intelligence (EI) has attracted considerable research attention in India and has also received amazing media exposure. EI was projected as a solution to numerous problems faced in work, education, and health domains. A number of studies were initiated in organizational and educational contexts and many more are being added to them. Emotional intelligence can be viewed as an ability that focuses on the interplay of emotions and intelligence. Mayer and Salovey (1997) stated that emotional intelligence is a type of social intelligence that involves the ability to monitor one's own as well as others' emotions, to discriminate among them and to use this information to guide one's thinking and action[7]. They gave four broad components of emotional intelligence.

(1) PERCEPTION, APPRAISAL AND EXPRESSION OF EMOTIONS

It includes indentification of one's and others emotions, ability to discriminate between accurate and inaccurate emotions and express them accurately.

* Defence Institute of Psychological Research, DRDO, Ministry of Defence, Timarpur, Delhi-54. Email–grupreet0911@yahoo.com

** Institute of Human Behavior and Allied Sciences, Dilshad Garden, Delhi-95. Email–vinodihbas@hotmail.com

(2) EMOTIONAL FACILITATION OF THINKING

It embraces generating emotions as aids to judgment and memory, encouraging problem-solving and facilitating reasoning and creativity. It changes mood swings from pessimistic to optimistic etc.

(3) UNDERSTANDING AND ANALYZING EMOTIONS AND EMPLOYING EMOTIONAL KNOWLEDGE

This includes the ability to label emotions and recognize relations such as relation between liking and loving, ability to interpret the emotions, understand complex and simultaneous feelings of love and hate.

(4) REFLECTIVE REGULATION OF EMOTIONS

It helps in promoting emotional and intellectual growth. It is concerned with the ability to stay open to feelings, both pleasant and unpleasant, ability to detach from an emotion, and ability to monitor and manage the emotions reflectively. It includes the selection of emotionally rewarding work, which enhances self-motivation.

Somewhat distinct from this mental ability model is a mixed model that includes personality traits. In this model emotional intelligence has been

conceptualized as involving much more than ability of perceiving, assimilating, understanding and managing emotions. This alternative conception includes emotion and intelligence along with motivation, non ability traits and global personal and social functioning.[2, 3, 4]

The mixed model defined, "emotional intelligence is an array of non-cognitive capabilities, competencies and skills that influence one's ability to succeed in coping with environmental demands and pressures"[2]. This model expanded the meaning of emotional intelligence by implicitly mixing non-ability traits. Bar-On reviewed the psychological literature for personality characteristics that relate to life success. Bar-On's work combines mental abilities (emotional self awareness) with other characteristics that are considered separable from mental ability such as personal independence, self-regard and mood. He believed that emotional intelligence along with intelligence could provide a more balanced picture of a person's general intelligence.

WHO ARE EMOTIONALLY INTELLIGENT ?

Emotional intelligence includes those traits that are most likely to ensure success in marriage or love affair and the lack of the same explains why people have utter failures and disasters in their personal and professional lives despite having high intelligence. An analysis of the traits of persons high on intelligence but low on emotional intelligence yields the stereotype of a person who is critical, inhibited and uncomfortable with others.

In contrast, persons high on emotional intelligence are poised, outgoing committed to others, sympathetic and caring, with rich and fulfilling emotional life[3]. It is often said that high intelligence may assure the person a top position, but it is not necessary that he became a top person. Today, the assessment criterion of the work place is rapidly changing; a new yardstick is being used to judge people. This is not merely in terms of how smart a person is or what his academic qualification is, but also by how well he is able to handle himself as well as others. Consequently, it has now been widely aceepted that to define success realistically and manage oneself as well as others effectively, emotional intelligence component needs to be essentially merged with intelligence.

WHY DOES IT MATTER ?

Since time immemorial, it has been widely accepted that mastering emotions always has an upper edge rather than becoming slaves of passion. According to Goleman, (1995) "when the emotions are too muted, they create dullness and distance, when out of control, too extreme and persistent, they become pathological, as in immobilizing depression, overwhelming anxiety, raging anxiety, and manic agitation" Management of emotions is both a skill and an art which includes the abilities to motivate oneself and persist in the face of frustrations, to control impulse and delay gratification, to regulate one's mood and keep distress from swamping the ability to think. Goleman clusters these characteristics under 'Emotional Intelligence'.[3]

It is beyond any shadow of doubt that there are individual differences in the usage of each of these abilities. Some are more comfortable in handling their own emotions and some are apt in their interpersonal relationships, but improvement in each domain or ability of emotional intelligence will definitely make the individual more emotionally intelligent.

CURRENT RESEARCH ON EI : AN OVERVIEW

Studies done in the organizational and educational contexts, as well as nurture of EI show the importance of emotional intelligence. In the organization domain, several studies examine the relevance and prevalence of EI in the context of the corporate sector. It has been shown that the need of EI is not uniform across occupations[8]. He compared Japanese and Indian managers and concluded that Japanese managers were high on thinking, while

Indian managers were high on feeling. It has been argued that since Indians, by and large, have high affiliation need, this needs to be tapped effectively through the appropriate use of the concept of EI that yields enhancement in productivity. The relationship of EI was studied with leadership effectiveness, success, and job satisfaction among Indian army officers.[9] It was found that emotionally more intelligent army officers adopted a transformational style of leadership to motivate their subordinates to perform beyond expectations. They also perceived them to be more successful in their careers. In educational sector, it has been reported[5, 6] that children with high EI are more confident, are better learners, have high self-esteem and few behavioral problems, are more optimistic and happier, and also handle their emotions better.

NURTURE OF EMOTIONAL INTELLIGENCE

It has been advocated that to nurture EI, teachers should enable children to handle their emotions, be supportive, accept students' emotions, teach students how to express their feelings and regulate emotional expression, encourage students to talk about their feelings, and provide children opportunities to observe models in real-life situations and through simulations. Emotional intelligence increases with age[4]. It can be learned, cultivated and increased in adulthood.

Therefore it can be said that besides being a hot buzzword, emotional intelligence carries a lot of weight in the current scenario where one has to master his or her emotions so as to become a productive member of the society. Individuals with high emotional competencies handle stress positively, embrace challenges instead of giving up, and organize thoughts automatically when pressurized. Qualities such as motivation, sympathy, self-control etc are the primary aspects of an emotionally intelligent person. These people have less mental health problems and they generally develop successful relationships with family, friends and fellow workers (Bajaj, 2004 : Shanwal, 2006). Emotional intelligence gives a competitive edge. Emotionally intelligent people feel more connected and socially integrated.

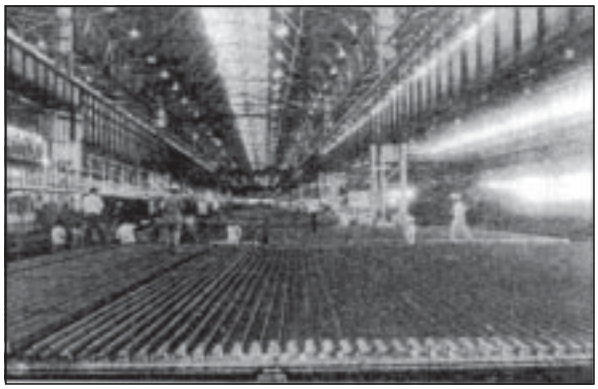
REFERENCES

1. G. Bajaj. *A Study of Socialization Practices and Broad Family Attributes as Antecendent Variables in Emotional Intelligence*. Unpublished Doctorate thesis. Guru Nanak Dev University, Amritsar, 2005.
2. R. Bar-On. *The Emotional Quotient Inventory (EQ–I)*. Technical Manual. Toronto Multi Health Systems, 1997.
3. D. Goleman. *Emotional Intelligence : Why matter more than IQ?* : New York Bantam Books, 1995.
4. D. Goleman. *Working with Emotional Intelligence,* New York Bantam Books, 1996.
5. Ghosh, P. *Everyman's Science*, **38**, 2-5, 2003.
6. Gill, V. Emotional quotient more important than IQ. *The Tribune*, 2003.
7. J. D. Mayer & P. Salovey. *What is emotional intelligence?* in Salovey P. & Slyuter D. J. (Eds) Emotional Development and Emotional Intelligence. New York; Basic Books, 1997.
8. Singh, D. *International Journal of Behavioral Sciences, **20**,* 2003.
9. Srivastava, S. *Samvegic labdhi ka mapan aur usake nirdharakon ka adhyyan* (Measurement of emotional quotient and study of its determinants). Unpublished doctoral dissertation. Dr. Ram Manohar Lohia Avadh University, Faizabad, 2003.
10. V. K. Shanwal. A Journal of Ministry of Rural Development, **54**(3), 28-30, 2006.

RAIL MANUFACTURE

N. Chakravarty, D.S. Gupta* & B. Roy**

Rails perform an important function as a carrying element and runaway. The important properties of railroads for improved performance are higher wear resistance, internal fatigue damage resistance, toughness, plastic deformation resistance, lower residual stresses and good weldability. The forces transferred by the wheel to the rail such as axle loads, track guidance, acceleration and deceleration result in very high dynamic stresses, large deformations and strain hardening of the rail steel within the contact zone. The force between rail vehicles and track are transmitted through the wheel/rail contact patch (for a small area of about 100 mm^2, contact stresses can exceed 200 MPa).



Thus, especially in the contact zone, rail steel should have good mechanical properties like yield strength, tensile strength, strain hardening behaviour and deformability. Rails are designed to resist wear and rolling contact fatigue and thermal stress caused due to temperature variations.

Over the years rail steel making has progressed from acid bessemer to basic open hearth to BOF and EAF. Continuous casting has largely replaced ingot route. Cleanliness and quality have been continuously improved. Sophisticated inspection procedures ensures that modern rails are almost wholly free of defects.

RAIL MANUFACTURE AT BHILAI STEEL PLANT

The rails manufactured by SAIL at Bhilai Steel Plant have a minimum UTS of 880 N/mm^2. These rails are supplied in standard lengths ranging from 13 m and 26 m. The chemical composition of Grade 880 is given in Table I. The process route is described in Fig. 1.

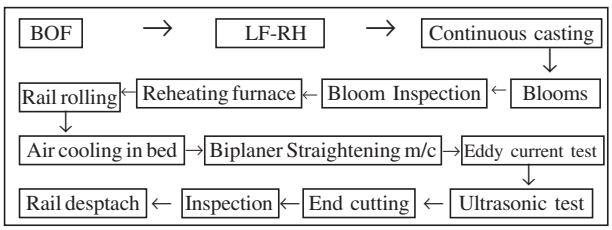


Fig. 1 : Flow-sheet of rail manufacture at BSP

TABLE I : CHEMICAL COMPOSITION OF GRADE 880 RAIL STEEL

C %	Mn %	Si %	S % (*max*)	P % (*max*)	H (*ppm*) (*max*)
0.6-0.8	0.8-1.3	0.10-0.50	0.035	0.035	2.5

Melting and Refining

Fine chemistry control through steel making process is pre-requisite for optimizing the mechanical properties of finished rails. Vacuum degassing is essential to lower the hydrogen content in the liquid steel which helps in preventing the formation of hydrogen flakes or shatter cracks in rails. The aluminium free deoxidation prevents the appearance of aluminates which otherwise would negatively affect resistance against fatigue failure.

Steel for rails is made in Basic Oxygen Furnace and treated in LF/RH to bring hydrogen level

* Technology Dissemination Centre, Bhilai Centre.

** Shape Rolling Group, RDCIS, Ranchi.

Reproduced from 'Steel Plant Technologies—an overview' published by Research & Development Centre for Iron & Steel. Steel Authority of India Ltd. Ranchi-834002 ; with permission.

below 2.5 ppm, and obtain desired chemistry and temperature of liquid steel.

CASTING

Rail steel is cast into blooms in continuous casting machine. During casting, care is taken to control the impurities by complete shrouding of the metal stream, use of special mould powder and submerged entry nozzles. Rails of superior quality, free from any metallurgical or surface defect can be produced from continuously cast blooms.

REHEATING AND ROLLING

Rails are hot rolled to final dimension in several stages starting from a bloom of rectangular cross-section proceeding to a final shape with cross-sectional area of about $1/12^{th}$ of original. The blooms are reheated in a pusher type reheating furnace and then rolled in the mill through roughing, intermediate and finishing stands. Rolling is completed above 950°C, a range in which the rail steel is well within the low-strength, high ductility, self-annealing austenitic phase.

Rolling pass scheme is adopted in such a way that the head table and foot of rail is more hot worked to get better surface quality and internal soundness.

The intermediate and finishing stands have special roll cooling system for minimum roll wear to achieve greater dimensional accuracy and better surface quality of rails.

Rail steels normally contain 0.68-0.75% C to produce a fully pearlitic microstructure for ensuring desired hardness, wear resistance and strength.

The length of as rolled rails is about 83 m for 52kg/m and 67 m for 60 kg/m rails. The 'as rolled rail' is cut to about 13.35 m or 26.5 m length at hot saws. Then on-line hot stamping of rails is done as per specifications.

COOLING

After hot stamping, rails are passively air cooled on cooling beds.

The rails are either lifted by magnet cranes at about 400-500°C and kept in stock for cooling or transported to another cooling bed for air cooling. After rails are cooled to less than 60°C they are processed at finishing operations like straightening, testing, end cutting, inspection and shipping.

Due to non-uniform shape of rails cross-section, the cooling rate in the rail is also non-uniform. As a result, internal stresses are induced which causes deformation thay may finally lead to a curved rail deformation in the longitudinal direction. The deformation occurring during cooling lead to a state of residual stresses in the rail that influences its mechanical behaviour in service. Straightening process, wherein the rails are passed through a series of rollers (roller straightening) which causes the rail to deform plastically through bending and contact, also result in development of high longitudinal residual stresses.

Residual stresses in rails can be of tensile as well as compressive type. Tensile stress along the axis of rolling accelerates the fatigue crack growth rate contributing to the fatigue failure of rails. Compressive residual stresses are favourable for better fatigue properties of rails in service.

TESTING

A number of tests are carried out to ensure that the rail conforms to the product specifications. On-line eddy current testing and ultrasonic testing are done to detect surface and internal defects respectively. Falling weight test, tensile and hardness tests, impact and macro examination, surface condition and section dimensions, straightness etc. are carried out at Bhilai Steel Plant whereas residual stress, fracture toughness and fatigue strength are carried out at RDCIS. For ensuring desired quality control inclusion rating and volume fraction, oxygen and nitrogen analysis are also regularly carried out.

The straightness at the ends is checked by means of 1.5 m scale straight edge. The deviation from straight edge in vertical direction should be between + 0.5 mm and – 0.0 mm and the deviation in the horizontal should not exceed 0.7 mm.

Several methods are available to determine the residual stresses viz. blind hole strain gauge

technique, sectioning technique, magnetic Barkhausen noise analysis, X-ray, ultrasonics, laser speckle interferometry etc. RDCIS has adopted 'transverse template cutting method' for residual stress measurement. In this method, one meter rail sample is collected from the rail. This method involves measurement of strains through electric strain gauges pasted on the surface of the rails across the profile (Fig. 2).

The reading of strain at the corresponding locations is converted to stress by multiplying with Young's modulus of elasticity for steel.

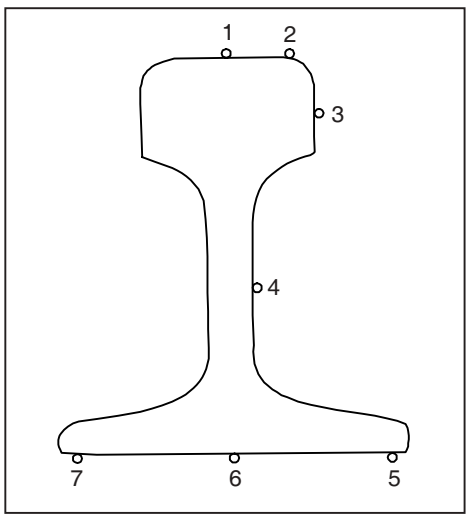


Fig. 2 : *Location of strain gauges for residual stress measurement*

DEVELOPMENTAL TRENDS

Process Improvements :

- Use of computerized production, planning and control system for shorter throughput times, reduced stock levels and higher yields. The system can handle the planning of orders as well as control in the rolling, finishing and loading of the products.
- Rolling of longer rails (upto 120 m).
- Contact-less measurement of the vertical geometry of the wheel running area by means of laser measuring probes.
- Automatic ultrasonic testing device for the detection of internal defects such as pin holes, segregations, flakes and macroscopic inclusions within the head, web and foot area of the rail over its total length.
- On-line dimension and straightness measuring system.

HEAD HARDENED RAILS :

Steady increase in average car loading, annual tonnage and concentration of traffic on main lines has placed ever greater performance demands on the rails. Technology has been developed to produce fine-grained pearlitic microstructure in the heads of on-line heat treated rails. As a result, hardness to a depth of 12-25 mm in the head of plain carbon steel rail has progressed from 250 HB (Brinell hardness) in the 1960s to 300-320 HB in the 1990s. Premium alloy rails are now heat treated to head hardness in the range of 340-370 HB. On heavy freight lines, these improvements have roughly doubled the rail lives.

Special processes have been developed for head hardening of rails. The rails are lifted at the run out table of the rolling mill and are dipped head down into a coolant at a certain specified immersion depth.

Another process is hardening of rails by a high-speed stream of water to produce thick hardened layer and to cover the zone of possible contact-fatigue failure. This hardening (by a high-speed stream of water) forms a particular curve for internal stresses with favourable effect on cyclic endurance and water resistance of the steel. The corrosion fatigue resistance for the flange also increased. High strength DHH (Deep Head Hardened) rails are developed with high resistance to internal fatigue defects. Wear has been remarkably reduced through the introduction of heat treatment to impart high strength by forming a fine pearlite structure.

Bainitic Steels for Rails :

The current rail steel microstructure is pearlite. Pearlitic steels, it seems, have been pushed through their limit with regard to mechanical properties. Bainitic steel is being considered as potential rail steel for future. Steel rails having a lower bainite microstructure are desirable for improved wear and fatigue resistance and greater impact toughness. Bainitic steels show a tensile strength of 1400 MPa. These rails are characterized by a high level of hardness, high toughness and the requisite weldability and can give as high as eight fold increase in service life compared with pearlite rails of 880 MPa minimum tensile strength. High-strength bainitic steel rails provide excellent rolling-contact fatigue resistance.

The composition of the bainitic steel is 0.15–0.45% C, 0.15–2% silicon, 0.3–2% manganese, 0.5–3% chromium and any one of the following elements : molybdenum, nickel, copper, niobium, vanadium, titanium and boron. The hot rolled rail is subjected to an accelerated cooling from the austenite region to a temperature of 500-800°C, at a rate of 1-10°C/s and then further cooling the rail to a lower temperature by natural or controlled cooling. The rail has a hardness of Hv 300-400 (Vickers hardness) in the centre of the rail head surface of the head and >Hv 350 in the gauge corner.

Micro-alloyed Rail Steels :

Micro-alloyed steel rails can give superior service performance. Micro-alloying of steel with niobium and titanium improves the strength characteristics of hot rolled and heat treated rails mainly due to reduction of inter-lammelae spacing of pearlite and to a less extent due to preciption hardening. The basic structural characteristics responsible for the changing of the impact toughness is the cementite lamellae thickness. The rails made of steel with niobium shows the most favourable properties and the best service durability.

Corrosion Resistant 90 UTS Rails :

A large section of rail layout is along coastal area and thus subjected to marine/saline atmosphere which corrodes the rails fast. Therefore, corrosion resistant rails have been developed to enhance life of rails under such operating conditions.

GLOSSARY

Fatigue Resistance : The resistance of the material to fracture when subjected to repeated (cyclic) stresses during use.

FACILITIES FOR RAIL MANUFACTURE AT BSP

- BOF, LF, RH, VAD, bloom casting
- 3 Pusher type reheating furnaces
- One 2 hi reversing roughing stand
- Two 3 hi intermediate stands
- One 2 hi finishing stand
- Six hot saws
- On-line computerised hot stamping
- Cooling beds
- One bi-planar rail roller straightening machine
- One on-line eddy current tester
- One on-line ultrasonic testing machine
- Six finishing groups with cold cutting carbide saws and gag press for straightening ends
- Additional finishing bay for increased production of rails.
- New finishing facility for long rails upto 260 m under installation.

SHORT COMMUNICATION

WHY SNAKES HAVE FORKED TONGUES

D. Balasubramanian*

From time immemorial, snakes have fascinated mankind. They evoke a mixture of fear, revulsion and fascination but not trust. Mythology around the world elaborates this point rather eloquently. The Bible says that it was serpent that led to the loss of innocence of Adam and Eve in the Garden of Eden after having sung the glory of the forbidden fruit. It was a serpent Kaliya that Lord Krishna had to subdue and again, it was a snake that had to be used by the Gods to churn out the poison that Lord Shiva had to ultimately hold till his neck turned blue. Even later day legends and stories do not hold the snake in esteem. The American Indians had an expression for the duplicity of the colonial white men, when they said : "White men speak with forked tongue". Why forked tongue? It literally meant speaking with two tongues or saying two disparate things at the same time; it thus characterizes two-timing and deceit.

Why a forked tongue? I now ask this question from a biological point of view rather than a mythological one. The answer to this question has eluded man for millenia but a tentative answer has just been given about 5 years ago. Dr. Kurt, of the Department of Ecology and Evolutionary Biology at the University of Connecticut, has hypothesized that the forked tongue acts as a dual sensory mechanism or a double sampling device. It helps to pick up molecules trailed off by other snakes or by prey. Molecules so sampled and picked up are then delivered to a pair of sensory organs, called Jacobson's organs, on the top of the oral cavity of the snake. In other words, tongue-flicking is a necessary exercise that lets the snake know who passed ahead of it on the ground and in which direction he passed.

When we think of that tongue, we see it essentially as a test sensor or a gustatory organ. Indeed, Aristotle appears to have said that the forked tongue of the snake should offer it a two-fold pleasure from savours, their gustatory sensation being as it were doubled.

Now, we know that the snake's tongue is also used as a tactile organ much like our fingers or skin. This would be of particular advantage and importance to a reptile like the snake, which has to protect itself from constant injury during its motion through the use of the scales on its skin. Perhaps the only time the skin comes in direct contact with the ground is when the snake sheds its old skin every season. But even there, the new scales are pretty much in place before the old skin is shed. The tongue should really be for other purposes because it is constantly being spread out, rapidly produced, oscillated and retracted into the mouth. It is about sixty years ago that Dr I Broman suggested that the snake samples odour molecules from the ground, picks them up at the tongue-tips and delivers them on to the sensors at the roof of the mouth, termed the vomeronasal organs (VNO) or the Jacobson's organs. This feature is not unique in snakes alone but is also common to other scaly

* L. V. Prasad Eye Institute, LV Prasad Marg, Banjara Hills, Hyderabad 500034, e-mail : dbala@lubly:itph.net. Article published earlier in The Hindu, Reproduced with permission.

reptiles of the genus *squamatae* which includes lizards, geckos and iguanas. All these have their tongues split to smaller or larger extents but, of course, the deepest fork occurs in the *varanid* family of snakes.

Why is it that some reptiles have an unbroken tongue and some have such deep forks in them? The answer to this puzzle seems to lie in the way these animals direct their movements towards the source or the stimulus. Biologists have called these directed movements as *taxis* : movement towards light is called phototaxis, exhibited by certain plants, some moths and similar insects; ants move towards specific odour chemicals through the movement appropriately called chemotaxis. Even in these directed movements there are two types. Certain animals do this as a function of time and pick up stimulus on two successive time periods on two different points. This comparison of successive stimulus intensities is referred to as klinotaxis. The ever-busy ants that keep on moving on a path do so by chemotaxis and, moving this way, they keep dropping chemicals they pick up along the trail that they hurry on.

The alternate mode is referred to as tropotaxis, where the animal measures the difference in the chemical concentration on, say, two sides of its body at the same time. This would require two sensors rather than one. And as the animal moves towards the stimulus, it has to constantly use its sensors on either side of its body, following two trails as it were. Imagine a snake slithering towards a rat-hole. How does it differentiate a rat-hole from any other similar structure? Or, how does it know it the rat-hole is deserted or there are rats inside? Visual information is not sufficient. It needs to have further information about occupancy or vacancy. This is provided by the odour molecules that the rat leaves behind when it hurried into its hole. These odour molecules tend to stay on the ground for several hours. If there were a chemosensory device that measures the concentration of these molecules, it would tell us exactly which path the rat took.

For a snake or a lizard to use chemosensory tropotaxis it must be able to sense the stimulus on two points. Dr Schwenk points out that this requirement is met admirably by the forked tongue. The greater the separation of the two tines of the tongue, the greater the sampling range. In many species, the distance between the two ends of the tongue is much larger than the width of the head or the snake itself. It would thus be possible for the snake or the lizard to stalk a prey that passed by sometime ago and judge pretty well the trail the prey took and what size the prey might have been, and other such important details.

One can now see the advantage of the forked tongue. It helps in tropotaxis–an animal with a normal tongue can retrace the movements of a prey, but it will have to move its head and body in a sequential manner to sample disparate points along the ground. On the other hand, if it has a forked tongue, a single flick of the tongue would be sufficient to assess the gradient of the chemical concentration. As Dr Schwenk says, a forked tongue functions as an edge detector to delimit the chemical zone of the prey and follow it with minimal deviations. The mechanism is instantaneous, while a lot more effort would be required by the snake if it did not have a forked tongue.

Using this hypothesis, Schwenk compared the extent of the forking of the tongue with their ability to follow scent trails. Those with double forked tongues such as snakes and *varianid* lizards seem to be highly proficient trail followers. Iguanas and geckos, who have only slightly notched tongues, do not follow scent trails as well.

What would happen if we pick up and cut off one of the forks of the tongue? It would then become equivalent to a gecko. It will not be able to follow scent trails, but can still pick up particles from the ground and deliver them to the VNO.

Indeed, this experiment was done 60 years ago by a scientist called Dr. Kahmann. Later on, Waters experimented by blocking one of the VNOs and leaving the other open. Snakes treated this way were unable to trail, but instead turned in a circle towards the unblocked side. In other words, the removal of the fork or blocking one of the VNOs deprives the animal of the ability to tropotaxic and makes it a chemotaxic animal.

One could also believe that the forked tongue would help in foraging for food rather than waiting for the food to come to it. It would help to follow the trail efficiently to its source. Analysis of the *squamatae* vindicates this point as well. The iguana waits for food to come to it, while snakes seek out the prey.

One would thus imagine that the snake literally speaks with its forked tongue, which it uses as a double antenna or as a double sensor and differentiates between the signals of the two. It is this difference that lets the snake know the size and shape of the prey and helps in tracking it. Strange but truly fascinating are the ways of evolution.

ANSWERS TO "DO YOU KNOW ?"

A1. The Bat!

A2. A sonic boom occurs when an aircraft crosses the sound barrier i.e. the speed exceeds the velocity of sound (about 6660 miles per hour at 10,000 feet above ground level). The aeroplane produces air pressure waves that pile up in front. The waves from highly compressed regions called shock waves create the boom.

A3. South Africa. Cape Town in the seat of the Government, Bloemfontein, the seat of Judiciary whereas Protoria is the seat of Beurocracy. This was done in 1910 during the formation of the Union of South Africa to appease regional sensibilities.

A4. 2003.

A5. A medicinal spring, water of which is curative of many ailments.

A6. Approximately 35 million.

A7. The sperm whale. This can stay underwater upto two hours and drive down to the depths of upto 3000 metres in ocean water.

A8. Yes. The South American snake, Anaconda which grows up to 10 m. does so routinely.

KNOW THY INSTITUTIONS

NATIONAL AIDS RESEARCH INSTITUTE, PUNE (N.A.R.I.)

In the early nineties it became evident that HIV infection was spreading widely in India and the national efforts for control of HIV infection needed to be backed by quality research. It was also realized that AIDS, being a multifaceted disease, needed multi-disciplinary research, epidemiology, field based trials and social and behavioral research. An Institute devoted exclusively to HIV/AIDS that could undertake research of such a diversity and magnitude was established to meet this requirement.

National AIDS Research Institute [NARI] was established in October 1992 in Bhosari, Pune on a seven acre plot. The Institute has progressively expended its activities in various aspects of research on HIV and AIDS through infra-structural development, capactity building & research programmes. The present infrastructure includes the Institute housed in a 28204 sq. mtr space, residential accomandation for the staff, a power plant to ensure uninterrupted power supply and an incinerator for safe disposal of bio-waste.

The Institute's research activies are guided by a Scientific Advisory Committee which includes eminent scientists from varied disciplines. All research projects are reviewed & approved by the Ethics Committee which also ensures that research is conducted with highest ethical standards. Establishment of a Community Advisory Board

which acts as an interface between the community and the researchers is a pioneering effort by NARI.

The Goal of the Institute is to achieve control of HIV spread and to provided care to HIV infected population (Care, Treatment & Vaccine). The vision is to build a research capability of distinction to face the challenge of growing HIV/AIDS in India. The Mission is to establish research initiatives that have an interface with intervention and policy developement to prevent and control the spread of the HIV/AIDS epidemic.

Objective of the Institute is Epidemiological and preventive research

● Research on the determinants and dynamics of HIV infection.

● Planning, development and prevention and control strategies including field based prevention & intervention research to reduce transmission of HIV.

Behavioral & Social Sciences

● Research on behavioral patterns associated with HIV, social relevance and impact of the infection on society.

● Provision of counseling services.

Developmental research

● Characterization of HIV, studies on genetic diversity of Indian strains and immune response to HIV.

● Research on candidate vaccines, diagnostics and drugs.

Patient care and management

● Clinical research and threapeutic trials including management of opportunistic infections and other HIV associated diseases and studies on anti-retroviral drugs for management of HIV disease in India.

National resource

● Generation of database to spear head research on HIV/AIDS in India.

● Virus bank.

Capacity Building

To undertake training programs, provide consultancy services and participate in national programmes.

Scientific Achievements of the Institute are

● Cohort of HIV Seronegative Persons : NARI established a cohort of patients attending STD Clinics and through their long term follow up collected very important information on the factors that are associated with the spread of HIV, the rate at which HIV infection is increasing in this group (Incidence) and role of associated disease such as Herpes simplex virus 2, syphillis etc.

● NARI conducted India's first HIV vaccine trial. Phase one trial of HIV-1 subtype C based Adeno Associated Virus vector based vaccine will be completed very soon. State of the art facilities have been established to carry out vaccine trials in the future also.

● Clinical Trial Unit : NARI has established a capacity to carry out clinical trials for anti-HIV drugs under international regulatory requirements. The center also provides treatment to HIV infected persons through National ARV roll out programme.

● Studies on Women Controlled Methods for Preventions of HIV : A facility to conduct studies in vaginal microbicides and female condom has been established. A number of Phase I and II studies, including one for an indigenous preparation, Praneem, have been carried out.

● Virus Bank : NARI has established a repository of HIV virus strains isolated from different parts of the country and have been characterized for phenotype. This is a National Resource available for Indian scientists.

● Starting in 1992, NARI has established a facility with trained manpower, state of the art laboratories, well equipped clinics and effective community outreach. This has resulted in an impressive array of research papers during last decade and generation of funds through extra-mural projects.

● Contribution to National Programme : NARI has close inks with National AIDS Control Organization it has played major roles in training the trainers programme for counselors, feasibility study for prevention of Mother to Child Transmission of HIV and AIDS, External Quality Assurance Programme for HIV testing and CD4 counts. It has recognized as a Chair for Technical Resource group for Research Development in HIV and AIDS. It is a regional centre for Sentinel surveillance in Western India.

In addition to research efforts NARI has also contributed in various ways to create awareness on HIV and AIDS. The outreach activities include :

● Radio talks

● Exhibitions

● Group meetings

● Networking with NGO's and resource building

● Talks / Awareness programmes for students, women, industrial workers and slum dwellers.

● Awareness programmes through media aids such as publication of books, information pamphlets, posters.

Scientific Communications

● By the end of year 2006, over 133 scientific papers have been published by NARI Scientists in National and International journals.

● Chair for Technical Resource Group (TRG) on Research and Development constituted by NACO : The TRG has brought out a joint consultative document on priorities for R & D on HIV and AIDS and document on recommendations for prophylaxis against Opportunistic Infections and post-exposure prophylaxis.

● National reference Centre for HIV testing : NARI is one of the 12 National Reference Centers identified by NACO for HIV testing in the country. NARI is supporting HIV testing and inplementing the National External Quality Assurance program for three states namely Maharashtra, Goa and Gujarat.

For more information please contact :

Director
National AIDS Research Institute
73, G-block, MIDC, Bhosari, Pune 411026, India, P.O. Box No. 1895
Telephone Nos. : 91-020-2712 1342
91-020-2712 1343
91-020-2712 1280
91-020-2712 1072
Fax No : 91-020-2712 1071
E-mail address : nari@pn3.vsnl.net.in

Conferences / Meetings / Symposia / Seminars

Date	Topic	Contact
16-17 June 2007	5th Infra **Educa–2007-an & Global Summit,** New Delhi.	**Friendz Exhibitions** I-11, Lajpat Nagar-II, New Delhi-110024 E-mail : info@friendzexhibition.com
3 August 2007	**Symposium on Natural Products : Past, Present and Future (NPPPF—2007),** Kolkata	**Dr. S. B. Mahato** B6/6, Iswar Chandra Niwas 68/1, Bagmari Road, Kolkata-700 054 E-mail : sbmahato2002@yahoo.com
6-8 September 2007	Conference on **Theory and Practice of Operational Research in Information Technology & Supply Chain Management,** Madurai	**Dr. M. Mathirajan** Department of Management Studies, Indian Institute of Science Bangalore 560 012 E-mail : msdmathi@mgmt.iisc.ernet.in
13-15 September 2007	National Seminar on **Applied Geology in Engineering-Environmental Sciences,** Dwarka, New Delhi	**Prof. P. S. Saklani** Netaji Subhas Institute of Technology New Delhi 110045
19-20 September 2007	National Symposium on **Geochemistry of Energy Resources and Precious Metals,** Hyderabad	**Prof. K. S. Prakash Rao** P. B. No. 706, Osmania University, 1-2-7/1 ROJA Kakatiyanagar, Habsiguda, Hyderabad - 500 007 E-mail : ksprao1939@yahoo.co.in
6-7 October 2007	**XXVII Annual Conference of Society of Toxicology, India (STOX) & International Workshop on Toxicology towards Diplomate of American Board of Toxicology** (DABT), Bangalore	**Dr. K. Jayakumar** Department of Pharmacology & Toxicology Veterinary College Bangalore - 560 024 E-mail : stox2007@rediffmail.com

Date	Topic	Contact
15-18 October 2007	ASME India **Oil and Gas Pipeline Conference,** Initiatives New Delhi	**Gauri Nath** Program Manager, Strategic ASME International, 3 Park Avenue New York, NY 10016 E-mail : nathg@asme.org
18-20 October 2007	6th International LOWRAD Conference **The Effects of Low and Very Low Doses of ionizing Radiation on the Human Health and Biotope,** Budapest,	**G. Safrany** National Research Institute for Radiobiology and Radiohygiene 1221 Budapest, Anna 5., Hungary E-mail : lowrad2007@hp.osski.hu
22-25 November 2007	International Symposium on **Advances in Neurosciences** and Silver Jubilee Conference of Indian Academy of Neurosciences, Varanasi	**Prof. M. K. Thakur** Department of Zoology Banaras Hindu University Varanasi-221 005 E-mail : mktian2007@gmail.com
30 Nov–2 Dec 2007	National Symposium on **Problems of Anaemia in India : Genetics & Environment,** Kolkata	**Dr. Geeta Talukder** Ramakrishna Mission Seva Prathistahn, Vivekananda Institute of Medical Sciences, 99 Sarat Bose Road, Kolkata-700 026 E-mail : geetatalukdar@hotmail.com
7-9 February 2008	**Molecular and Clinical Aspects of Gonadal and Nongonadal Actions of Gonadotrophins,** Delhi	**Dr. P. K. Chaturvedi** Dept of Reproductive Biology All India Institute of Medical Sciences New Delhi-110 029 E-mail : gonadotropin2008@gmail.com

S & T ACROSS THE WORLD

HEAVY ION COLLIDER

Brookhaven National Laboratory in USA is in the forefront of research to understand the basic structure of matter. Its Relativistic Heavy Ion Collider is helping determine what the universe may have looked like in the first few moments of its creation. Findings to date have led to compelling questions in the field of quantum chromodynamics, the theory that describes the interactions of the smallest known components of the atomic nucleus.

Similarly, the proposed National Synchrotron Light Source (NSLS)II, one of the US Department of Enenrgy's 20-year plan is an advanced third generation medium-energy electron storage ring that will produce X-rays 10,000 times brighter than the current Synchrotron Light Source. The unprecedented brightness of NSLSII will lead to many advanced capabilities in a wide range of scientific disciplines, including materials, nanoscience, life sciences and chemistry, geoscience etc.

Then there is Brookhaven's Centre for Functional Nanomaterials, one of the five nanotechnology centres that have been approved by the US Department of Energy. This will provide researchers with state-of-the-art capabilities to fabricate and study nanoscale materials.

Brookhaven's cutting edge brain imaging work on obesity, addiction and ageing is based on the use of physical tools like magnetic resonance imaging (MRI) and positron emission tomography (PET), which have benefitted people world wide.

(Brookhaven National Lab, Nov 30, 2006)

ENERGY EFFICIENCY IN BUILDINGS

With its team of internationally recognised scientists, Australia's CSIRO is actively studying ventilation, heating and cooling systems to help improve thermal comfort and energy efficiency in buildings, tunnels and car parks.

CSIRO applies advanced computer modelling technology to improve building design in two broad areas, viz :

- Its thermal technologies and energy efficient building design tools assist architects to demostrate the efficiency of a building design to clients for significant reduction in future heating and cooling costs, which include a combination of modelling expertise and CSIRO software created to suit Australia's unique needs.
- Its ventilation modelling and technologies include several analysis tools that help architects and engineers assess the performance of natural and mixed-mode ventilation of residential, commercial and industrial buildings.

CSIRO has developed a number of new products for implementing their objectives which include Energy Express for Architects software for calculating operating energy consumption ; Nat HERS and Accurate for rating heating and cooling energy efficiency in new buildings, and CHEMIX an integrated multizone thermal and natural ventilation program.

(CSIRO, Nov 30, 2006)

MERCURY IN FOOD CHAIN

Mercury is highly volatile, insoluble in water, and hard to capture from flue gas. It is spewed into the atompshere by coal fired power plants and persists there before it oxidizes, thus entering the food chain with harmful effects.

Scientists in the University of Berkeley, California, USA, have developed a potentially cheap and efficient way of removing mercury from coal-fired power plant emissions. The technique involves injecting a specially formulated gas into the mercury laden flue gas of the coal fired power plant, where it converts the elemental mercury into oxidized mercury which is then more easily captured by the existing pollution control process, thereby curbing contamination of the food chain.

(Science@Berkley Lab, Nov 30, 2006)

PRESERVING FERTILITY

Cancer is a dreaded disease, and young women may risk losing their ovarian function and fertility after treatment for cancer.

The Center for Reproductive Research at the North-West University, Chicago, USA has launched a new expeimental programme whereby a cancer partient's ovary is removed and frozen for possible future use. The long term goal is to be able to extract and mature eggs from cryopreserved (frozen) ovarian tissues to initiate pregnancies, once the cancer treatment has been completed.

Eligible participants will have one ovary surgically removed at the University Hospital in an outpatient procedure known as laparoscopy before starting cancer treatment. 80% of the ovary will be preserved for the patient's future use, while 20% will be used by researchers to explore ways to extract and develop immature eggs.

According to the researcheras, this breakthrough may permit not only the potential preservation of fertility options for female cancer patients, but may also be applied to normal in vitro fertilization patients. This procedure when fully developed could change radically the way infertility is viewed, reduce and eliminate embryo storage, and provide better options for women who do not respond to hormonal therapy.

(EurekAlert, Nov 30, 2006)

भारतीय विज्ञान कांग्रेस संस्था

14, डा० विरेश गुह स्ट्रीट, कोलकाता 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

Telegram	:	SCICONG : CALCUTTA	Fax	:	91-33-2287-2551
Telephone	:	(033) 2287-4530, 2281-5323	E-mail	:	iscacal@vsnl.net
Website	:	http://sciencecongress.org			iscacal_2004@yahoo.com
		http://sciencecongress.nic.in			

Terms of Membership and Privileges of Members :

Membership of the Association is open to persons with *Graduate or equivalent academic qualification* and interested in the advancement of science in India.

1. **Member :** A person willing to be enrolled as new Member has to pay an annual subscription of Rs. 200/- **along with an admission fee of Rs. 50/-** (for foreign* U.S. $70) only. The annual subscription of a Member shall become due on the 1st April of each year. Anyone who fails to pay the subscription on or before the *15th July* in any year shall lose the right of voting and / or holding any office of the Association for that year. A Member failing to pay the annual subscription by the end of March of the following year shall cease to be a Member.

   Members may contribute papers for presentation at the Science Congress. They will receive, free of cost, reprint of the Proceedings to Session of any one section of their interest and also the bi-monthly journal of the Association "Everyman's Science".

2. **Sessional Member :** Sessional members are those who join the Association for the Session only. A Sessional Member has to pay a subscription of Rs. 250/- (for foreign U.S. $60) only.

3. **Student Member :** A person studying at the under-graduate level may be enrolled as a Student Member provided his/her application be duly certified by the Principal/Head of the Department. A Student Member shall have the right to submit papers for presentation at the Session of the Congress of which he/she is a member, provided such papers be communicated through a Member, or an Honorary Member of the Association. He/she shall not have the right to vote or to hold any office. A Student Member shall not be eligible to participate in the Business meetings of the Sections and the General Body.

4. **Life Member :** A Member may compound all future annual subscriptions by paying a single sum of Rs. 2000/- (for foreign U.S. $ 500) only. Any person who has been continuously a member for 10 years or more, shall be allowed a reduction in the compounding fee of Rs. 50/- for every year of such membership, provided that the compounding fee shall not be less than Rs. 1,200/- (for foreign U.S. $ 12.50 and U.S $ 300 respectively). A Life Member shall have all the privileges of a member during his/her lifetime.

**Admission fee of Rs. 50/- is needed only for becoming a new annual member and not for sessional member / life member / Institutional member / student member / donor.*

5. **Institutional Member :** An Institution paying a subscription of Rs. 5,000/- (for foreign U.S. $ 2,500) only, can become an Institutional Member of the Association. It shall be eligible to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional Member shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress Session as also a copy of the Association's journal "Everyman's Science".

6. **Donor :** Any person paying a lump sum of Rs. 10,000/- (for foreign U.S. $5000) only, can become a Donor of the Assocaiation. An ***INDIVIDUAL DONOR*** shall have all the rights and privileges of a member during his/her lifetime. An Institution paying a lump of Rs. 50,000/- (for foreign U.S. $25,000) only, can become ***INSTITUTIONAL DONOR*** of the Association, which shall have the right to nominate one person as its representative to attend Annual Session of the Science Congress. An Institutional / Individual Donor shall be eligible to receive, free of cost, a copy of the complete set of Proceedings of the Annual Science Congress as also the Association's journal "Everyman's Science".

A) **Presentation of Papers :** A copy of complete paper accompanied by an abstract in triplicate not exceeding one hundred words and not containing any diagram or formula, must reach the Sectional President General Secretary (Hqrs) Latest by *September 15*, each year.

B) Members of all categories are entitled to railway Concession of return ticket by the same route with such conditions as may be laid down by the Railway Board for travel to attend the Science Congress Session provided that their travelling expenses are not borne, even partly, by the Government (Central or State), Statutory Authority or an University or a City Corporation.

C) Members of all categories are entitled to reading facilities between 10.00 a.m. to 5.30 p.m. on all weekdays (except Saturdays & Sundays) in the library of the Association.

D) Members of all categories may use Guest House facilities, Lecture Hall hiring at the rates fixed by the Association from time to time.

Note : All Money Orders, Bank Drafts etc. should be drawn in favour of "*Treasurer, The Indian Science Congress Association*". Members are requested to mention their Card No. while making any correspondence to ISCA office.

---

* (A Foreign Member means one who is normally resident outside India.)

भारतीय विज्ञान कांग्रेस संस्था

14, डा० विरेश गुह स्ट्रीट, कोलकाता 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

Telegram : SCICONG : CALCUTTA
Telephone : 2287-4530, 2281-5323
Website : http://sciencecongress.nic.in
Fax : 91-33-2287-2551
E-mail : iscacal@vsnl.net
iscacal_2004@yahoo.com

APPLICATION FORM FOR MEMBERSHIP

To
The General Secretary
The Indian Science Congress Association
14, Dr. Biresh Guha Street,
Kolkata-700 017

Stamp Size Photograph

Dear Sir,

I like to be enrolled as a Member / Life Member / Donor / Sessional Member / Student Member / of The Indian Science Congress Association.

I am sending herewith an amount of Rs. ..... in payment of my subscription by Bank Draft / Money Order / Cash for Membership / Life Membership Subscription / from the year 1st April 200 ..... to 31st March 200 .....

I am interested in the following section (Please tick any one).

SECTIONS

1. Agriculture and Forestry Sciences
2. Animal, Veterinary and Fishery Sciences
3. Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences)
4. Chemical Sciences
5. Earth System Sciences
6. Engineering Sciences
7. Environmental Sciences
8. Information and Communication Science & Technology (including Computer Sciences)
9. Materials Science.
10. Mathematical Sciences (including Statistics)
11. Medical Sciences (including Physiology)
12. New Biology (including Bio-Chemistry, Biophysics & Molecular Biology and Biotechnology)
13. Physical Sciences
14. Plant Sciences

(Please type or fillup in Block Letters)

Name (in block letters) : _____ SURNAME _____ FIRST NAME _____ MIDDLE NAME

Academic Qualifications :
(Evidence to be submitted)

Designation :

Address for Communication :
(including State, City/Town and Pin code)

Phone No. & e-mail

Permanent Address :

Yours faithfully

Date : Signature

- *As per resolution of Executive Committee in its meeting held on October 10, 2004 application for membership of ISCA in 'Care of' of some other person is generally discouraged. However, if in the application form "care of" address is given then there should be also signature of the person in whose name "care of" is given.*
- *Admission fee of Rs. 50/- is needed only for becoming a new annual member and not for sessional member / life member / Institutional member / student member / donor.*

PUBLICATIONS OF INDIAN SCIENCE CONGRESS ASSOCIATION

1.	A Short History of the Indian Science Congress Association	Rs. 10/-
2.	A decade (1963-1972) of Indian Science Congress Association in India	Rs. 10/-
3.	Science and Integrated Rural Development	Rs. 10/-
4.	Survey, Conservation and Utilisation of Resources	Rs. 10/-
5.	Science and Technology in India During the Coming Decades	Rs. 15/-
6.	Impact of the Development of Science and Technology on Environment	Rs. 150/-
7.	Basic Research as an Integral Component of Self Reliant Base of Science and Technology	Rs. 90/-
8.	Man and the Ocean	Rs. 140/-
9.	High Altitute Studies	Rs. 75/-
10.	Indira Gandhi on Science, Technology and Self Reliance	Rs. 100/-
11.	Environmental Priorities in India and Sustainable Development	Rs. 25/-
12.	Resources and Human Well Being : Inputs from Science and Technology	Rs. 25/-
13.	Scientific Research in India Progress in Earth Sciences	Rs. 120/-
14.	Frontiers of Science and Technology, the Indian Context vol I	Rs. 50/-
15.	Frontiers of Science and Technology, the Indian Context vol II	Rs. 175/-
16.	Natural Disaster Management : the West Bengal Scenario	Rs. 45/-
17.	A Tribute to Prof P C Mahalanobis	Rs. 35/-

18.	Platinum Jubilee lecutures	1994-1995,	1995-97	1997-98 &	1998-99
	Part I — Physical Sciences	100/-	150/-		165/-
	Part II — Biological Sciences	90/-	175/-		225/-
	Part III — Engineering & Earth Sciences	70/-	128/-		240/-
	Part IV — Social Sciences	50/-	85/-		130/-

19.	Platinum Jubilee lectures, Biological Science (1999-2000) & (2000-2001)	Rs. 250/-
20.	PROCEEDINGS of Annual Science Congress — (Part, I, II, III, IV)	Rs. 300/-
21.	Selected Lectures (2002-2003) & (2003-2004)	Rs. 320/-
22.	**EVERYMAN'S SCIENCE Published Bimonthly**	

Individual—50/- Institutional—200/-

For Orders, Write To : The Indian Science Congress Association,
14, Dr. Biresh Guha Street, Kolkata-700 017
Fax : 033-2287-2551. E-mail : iscacal@vsnl.net

*Members are entitled to 33.33% discount on the above prices