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EDITORIAL

During last one year, a well-participated international workshop-cum-conference and an intensive workshop-training programme on Social Network Analysis (SNA) were organized respectively by Indian Statistical Institute at Kolkata and National Institute of Science, Technology and Development Studies (NISTADS) of Council of Scientific & Industrial Research at New Delhi. Theoretical and methodological moorings of SNA, its applications in various fields of research, its tools, techniques and software available for use and its potential for future development were in the agenda. It seems, as if, we have become suddenly aware of it ! While it is partly true at the national level of our social science academic activities, but that does not hold at the international level. SNA has become a subject of graduate and post-graduate studies in a number of universities of European continent, U. K. and the U. S. A.

A large body of scholars and researchers is involved in an interdisciplinary organization, the International Network of Social Network Analysis (INSNA) which also publishes a newsletter, Connections. In addition, a journal, Social Network is also being published regularly. Though the notion of social networks was used analytically only in 1954 by J. A. Barnes in 'Class and Committees in a Norwegian island parish (*Human Relations*, 7, 39-58), the concept has been used in investigating diverse topics of research, such as, from sociology of science, social influence and consensus to the world political and economic system, community, markets, belief systems, social perception or cognition, diffusion and adoption, decision making, exchange and power, bibliometric data, crime, farmers's practices, political movements and conflicts/alliances (including data on Paris Communes), data from archives and so on. Correspondingly, quite a number of significant publications have come out which we may certainly

refer to. For those who are interested in statistical—mathematical treatment of SNA, there is *Social Network Analysis : Methods and Applications* ; BT Wasserman S. and Faust K Cambridge University Press, U. K., 1994. A comprehensive compilation of papers on applications of SNA in various fields of research has been made by J. Scott in his ed. *Social Networks Critical Concepts in Sociology. Vol. I-IV* (Routledge Taylor of Francis Group, London, 2002. Besides, a significant collection of papers on application of SNA in economic topics has been edited by Bhaskar Dutta and M. Jackson titled *Networks and Group. Models of Strategic Formation insight*, Springer Verlag, Berlin, 2003. For a thorough insight in the perspectives of SNA, *Networks in the Global Village* edited by Barry Wellman, Boulder Co., Westview, U. S. A. 1997 provides an elaborate base to begin with.

Why has SNA been able to gain so much of momentum in methodology of social research in such a short period ? Because, the concept of SNA and for that matter, that of social network is grounded in the pattern of articulation of a social relationship among a set of objects or actors. The methodology of SNA provides a technique of analysis to study, the pattern of flow of a social relationship from one actor (object) to another. Hence, it is a structural study based on interaction among the constituent units of a network. The articulation of a social relationship means establishing links among those constituent units which may be individual human actors or groups of them, communities or villages, towns, regions, countries, authors, events, book-references, etc. Thus, one comes to find out whether the social relationship has established a tie or link between a pair of units. If yes, it is one, otherwise zero which produces the zero-one model of quantification of distribution of a qualitative relationship. Incidentally, the frequency or quantum of interaction

can also be considered to draw multiple ties giving a weighted network, where the frequency or quantum is the weight of the flow from one to another. Hence, SNA has enabled researchers to move beyond routine analysis of data, treating individual characteristics as variables to incorporate pair-wise ties of relationship as data.

Diagrammatically a social network produces a di-graph, while it can be arranged as a matrix as well. So, even though the basic parameters are only a few — the number of 'vertices' in graph-theoretic terms (i.e., the number of actors or objects) denoted as N and the number of ties, m , which link the vertices. Various important concepts in social research have become amenable to quantification and to quantitative analysis using appropriate mathematical and statistical methods. Reciprocity, cohesiveness, fragmentation, connectivity, reachability, hierarchicalness, etc., which are commonly used as metaphorical terms in sociological parlance, can now be applied analytically to measure and compare different groups and communities. As for an interesting illustration in this context, we refer to an analysis of social networks of twenty one rain-fed villages of West Bengal : the social networks derived from the articulation of social relation of help and support provided by a household to another at the time of an emergency or a crisis. The image of rural

households in the villages apparently, like little communities helping each other was not at all tenable. On the contrary, the values of graph-theoretic measures of reciprocity obtained from the twenty-one social networks varied widely from the minimum of 0.0% to 99.1% with the median value being 33.3%. For a detailed discussion of data and analysis, see Rao, A. Ramachandra and Bandyopadhyay, Suraj, "Measures of reciprocity in a social network ; *Sankhya*, 49A, pt2 141-148, 1987.

Social network based deterministic graph-theoretic mathematical derivation of measures relevant for social research which have so far appeared to be 'out of bounds' of quantitative analysis, combined with application of probabilistic approach to modelling of social network data, their analysis and drawing inference for use of social scientists are giving a new look to social science research. In fact, computing methodology, particularly technique of simulation, has now become an integral part of methodology of social science research due to complexities of SNA. We end the present write-up with the following quotation from Goethe ; "Mathematicians are like French men, whatever you say to them they translate into their own language and forthwith it is something entirely different". Mathematicians, then, no doubt included statisticians of today as well.

Suraj Bandyopadhyay

"The further backward you look, the further forward you can see.

— Winston Churchill

PRESIDENTIAL ADDRESS

SCIENCE IN THE SERVICE OF THE NATION

PANDIT JAWAHARLAL NEHRU*

(Edited version of the material available at the Association)

“I should like to assure this Science Congress and our friends who have come from abroad that we want to cooperate with Science abroad in every way to advance the cause of peace in the world, peace and progress of humanity. But while giving that undertaking and pledge, I want to make it perfectly clear that we will not cooperate in the ways of war”, said the Hon’ble Pandit Jawaharlal Nehru, Vice-President of the Interim Government, in his presidential address to the 34th session of the Indian Science Congress, which met on January 3, 1947, at the University grounds, Delhi.

Pandit Nehru expressed the hope that now, when India was on the verge of independence and Science in India too was coming of age, it would try to solve the problems of the New India by rapid, planned development on all sectors and try to make her more and more scientifically-minded.

Surely, said Pandit Nehru, Science was not merely an individual’s search for Truth. It was something infinitely more than that if it worked for the community. “For a hungry man or a hungry woman, Truth has little meaning. He wants food. For a hungry man, God has no meaning. He wants food. And India is a hungry, starving country and to talk of Truth and God and even of many of the fine things of life to the millions who are starving is a mockery. We have to find food for them, clothing, housing, education, health and so on—all the absolute necessities of life that every man

should possess. When we have done that we can philosophise and think of God. So, Science must think in terms of the 400 million persons in India. Obviously, you can only think in those terms and work along those lines on the wider scale of coordinated planning.”

Pandit Nehru hoped that the Science Congress would devote itself to this task and not wait merely for Government to take action. “Governments may be good and may be bad”, said Pandit Nehru, “but Governments normally are very slow and the only thing that moves them is some immediate public outcry which affects their future indirectly. Therefore, I should discourage among the scientists a reliance always on what Government may or may not do.”

SCIENTIFIC DEVELOPMENT

“Naturally, they have a right to expect things from Government, and, speaking just as one member of the present Government of India—speaking, may be, partly for my colleagues but largely for myself—I may say that we are intensely interested in scientific development in India and we shall do everything in our power to encourage scientific research. We should like to tap all the latent scientific talent in the country and to give it opportunities for growth and service to the community.

“What the future will bring I do not know, I can neither foretell the future, nor have I any authority to bind my country down to what it may or may

* General President, 34th Indian Science Congress held during 3rd January to 7th January, 1947 at Delhi.

not do in future, but in these days, so soon after the last war, when people again think of wars and when scientists are yoked into work in preparation for future wars, I think it is desirable and necessary that men and women of Science should also think about the way they are often misused and exploited for base ends and should make it clear that they do not want to be so exploited.

“Anyway, I do hope that India in future will not allow herself to be dragged into wars which are likely to be far more terrible than any that we have experienced thus far. “I say that, and yet I know how difficult it is for a line to be drawn between scientific work for peace and for war. This great force-atomic energy-that has suddenly come through scientific research may be used for war or may be used for peace. We cannot neglect it because it might be used for war, obviously in India we want to develop it and we will develop it to the fullest. Fortunately, we have eminent scientists here who can do so. We shall develop it, I hope, in cooperation with the rest of the world and for peaceful purposes.

“It is a tragedy that, when these enormous forces are available in the world for beneficent purposes and for raising human standards to undreamt of heights, people should still think of war and conflict and should still maintain economic and social structure which promote monopoly and create differences in standards of wealth between various groups and peoples. It is a tragedy, whatever other people might say about, it, and no man of Science should accept it as a right ordering of events. So in India today, while we are busy with our own political and economic problems, we have inevitably begun to think more and more of the vaster problems that face us and in the decision of which Science must inevitably play a big part.

“I invite all of you who are present here, young men and old in the field of Science in India, to think in these terms of India's future and become crusaders for a rapid bettering of the 400 millions

in India, and crusaders of peace in India and the world and international cooperation for peace and progress”.

BOMBING OF HIROSHIMA

Describing the atom-bombing of Hiroshima as “horrible beyond words”, Pandit Nehru said : “Science has its destructive side and constructive, creative side. Both have gone on side by side and both still go on. No one knows which will ultimately triumph. Hiroshima became a symbol of this conflict and, in spite of all the decisions of the Atomic Energy Commission of the UNO—and we welcome those decisions, of course, in so far as they go—the doubt remains in one's mind as to where we are speeding.

“On the other hand, apart from the atomic bomb aspect of it, we are obviously on the threshold of a new age in the sense of enormous power resources being put at the disposal of humanity and the community. Will this new age change—and I think it will change—enormously the whole structure of society ? My mind goes back to the time when gunpowder burst upon the world. Gunpowder at any rate pushed the Middle Ages away completely, and fairly rapidly, in course of time, brought or helped to bring about a new political and economic structure.

“Of course, there were many forces at work. Nevertheless, gunpowder did produce that powerful effect on society and ultimately out of the feudal order a new capitalist order gradually developed. Now I wonder whether this so-called atomic bomb is not also the herald of a new age, of a new structure of society, which has to be established in order to fit in with present conditions. I myself am convinced that there is going to be no very great progress either in Science or in other ways unless certain fundamental changes take place in the social structure.”

COMMUNAL DISTURBANCES

Referring to the communal disturbances, Pandit Nehru said : “Many of us are naturally tremendously worried with some events that are happening in India. Many of our friends from abroad must also have their minds filled with the picture of conflict in India because that conflict, bad as it is in India, is magnified a hundred-fold when it crosses the seas and people seem to think that the sole or main occupation of the people in India today is to cut each other's throat.

“While conditions are in some respects not at all good, still when we think of the brighter picture of India, whose people, after having been largely static for many years, are in motion today, then those conflicts become rather petty in their perspective. When a whole people are on the move, they go astray here and there, but the main thing is the vitality they possess and, even if they go astray, they will come back to the right path.

“That is the real thing, the encouraging thing, that makes one certain that India has a tremendous future in store for her and that, as soon as we get over our present troubles, there will be a flowering

of Science and other activities in India which will probably astonish the world.

“The first objective, it seems to me, from any point of view and more especially from the point of view of Science, is to help in the building of a free and self-reliant India. India today has made its mark in the world of Science, more especially in Theoretical Physics and some other departments also. We have done well when we have hardly tapped the talent in India. We have only scratched the barest surface of the Indian people, and yet we have done tolerably well, and now, when I think of what we can do, and will do no doubt when we open the doors of opportunity to a large number of people in India, then the kind of picture I see rather overwhelms me. If we could tap, say even five per cent of the latent talent in India for scientific purposes, we would have a host of scientists in India”.

Pandit Nehru welcomed the foreign delegates present and concluded : “I hope this Science Congress, meeting at a time which in India's history is a very significant time, will prove also very significant in the development of Science in India.”

O-TILLAGE IN RICE-WHEAT CROPPING SYSTEM

Avijit Sen*

The author describes various conventional tillage practices of rice-wheat and the problems involved. The two main problems of late sowing and high tillage cost of the cropping system can be solved by conservation tillage.

INTRODUCTION

Contribution of rice and wheat, which was about 55% just prior to Green Revolution era, has now gone up to 77% of the total food grain kitty of India. Out of the 30 major cropping systems identified by ICAR, rice-wheat occupies the first place both in terms of area (11 m.ha) and production (more than 150 m tones) and spreads over gangetic alluvial soils of Punjab, Haryana, Uttarakhand, Uttar Pradesh and Bihar. In 25% of the total rice area of the country, it is grown in rotation with wheat which is likely to increase further in near future with the introduction of photoperiod non-sensitive wheat varieties of varying duration¹.

Less favourable climatic condition of the eastern part of the Indo-gangetic plains results in the lower yield of wheat in U. P. and Bihar. Among various reasons, rice-wheat cropping system of U. P. suffers mainly from late sowing of wheat which reduces the yield to a considerable extent. Delay in wheat sowing beyond late November in warmer areas results in grain yield loss of 1% ha⁻¹ day⁻¹. Moreover, pre-sowing tillage operations are also very expensive. These twin problems of late sowing and high tillage costs of wheat can be overcome by conservation tillage (zero tillage) which is reported to have several advantages over conventional tillage practices. According to Soil Conservation Service

of USA (1984), conservation tillage is referred to as any tillage and planting system in which at least 30% of the surface is covered by residues after planting with a view to reducing soil erosion by water, whereas any system that maintains at least 1120 kg/ha of small grain residues equivalent on the surface during critical wind erosion period is qualified as conservation tillage. In rice-wheat cropping system one way of increasing wheat yield is by advancing the sowing after harvesting of rice component so that wheat will be able to exploit the winter to its fullest extent.

Phillips² *et al.* defined no-tillage system as planting of the crops either entirely without tillage or with just sufficient tillage to allow placement and coverage of the soil to enable the seed to germinate and emerge. Usually, no further tillage/cultivation is done before harvesting. In the no-tillage method, application of herbicides, planting and harvesting are the operations which are to be taken care of. Its success depends on soil condition at sowing time and subsequent residue management of field. Apart from being economical, time saving and energy efficient it manages weeds, conserves moistures and advances sowing time also. In addition to this no-tillage has been found to have the following beneficial effects.

(a) Turn-around-time between the harvesting of paddy and sowing of wheat delays the sowing of wheat crop and thereby reducing the wheat yield

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particularly after the late harvesting of long duration rice. Zero tillage reduces this time.

(b) Due to relatively higher clay content of rice soils, the quality of tilth does not become optimum even after 8-10 passes of heavy tractor for sowing of wheat by normal seed drill. Zero-till drill does not have to face these problems.

(c) Because of the sub optimal condition of soil the farmers are forced to sow the wheat by broadcasting method which results in uneven distribution and germination. Zero-till drill on the other hand ensures line sowing, proper establishment of crop and resultant higher productivity.

(d) Blind puddling of rice fields makes the soil uneven and un-uniform in moisture content which also delays the tillage operation. Under zero tillage this situation can be avoided.

(e) In the uneven field due to stagnation of water after first irrigation in wheat, the yellowing of leaves takes place. Under zero tillage this situation does not develop.

(f) Rice-wheat cropping system requires about 1200 mm of water as a whole for its sustenance. Hence places having 1100 mm of rainfall cannot afford to grow these two crops continuously without depleting ground water reserve. Consequently, in long term this is likely to have a deleterious effect on the soil moisture health. Against this scenario zero tillage can play an important role and address the problem by conserving the moisture and reducing its requirement.

PROBLEMS OF RICE-WHEAT CROPPING SYSTEM

In rice-wheat cropping system, rice residue management seems to be a big problem for the sowing of wheat and its establishment under zero tillage system. There are various practices for rice harvesting and varying amount of rice stubbles are left in the field after harvest. In combine harvesting,

the height of rice stubbles left in the field also varies. In an experiment conducted at Pantnagar where wheat was sown with ZTD at varying heights of standing rice stubbles (10, 20, 30 cm) left in the field and hand harvested close to ground, it was observed that germination, growth and yield of wheat was uniform irrespective of the height of rice stubbles. However, problem arises with loose rice straw which impedes the proper movement and functioning of the drill. Care is to be taken to see that the loose rice straw is either removed manually or by machine which incidentally has been developed by GBPUAT.

It has been estimated that a crop producing 5 t of rice, removes from the soil about 155 kg nitrogen, 20-25 kg phosphorus, 140 kg potassium and 25-30 kg of sulphur. About 75% of potash, 30% of nitrogen and sulphur and 25% of phosphorus are retained by the straw³. At present most of the rice areas of Punjab, Haryana and western Uttar Pradesh are harvested by combine and 75% of the combine harvested leftover rice stubbles/straw is burnt, which not only pollutes the atmosphere but leads to a significant loss of renewable nutrient and organic matter of the soil also. Hence, burning of crop residue in the zero tilled field is strictly prohibited and machine which can operate smoothly in the combine-harvested fields is required to be developed.

ZTD MACHINE

Zero till drill machine was originally introduced in our country from New Zealand through CIMMYT and was further modified at GBPUAT, Pantnagar. It is a modified form of simple tractor drawn seed drill and very easy and convenient to handle. The machine is used to sow the crop directly into the uncultivated field just after the harvest of previous crop (rice) by eliminating the tillage operations. The furrow openers are of inverted 'T' type spaced at 20 cm row spacing.

The machine is having the following specifications.

Type	Tractor mounted
Power requirement	45 hp (33.6 kw) tractor
Size (L × W × H)	1800 × 600 × 1100 mm
Frame	Rectangular–Mild steel box section 70 × 70 mm.
Number of furrow openers	9/11– spaced 200 mm with provision for changing the row spacing
Type of furrow openers	Inverted ‘T’ type
Seed metering device	External fluted feed rollers of die aluminium, number of flutes = 10
Fertilizer metering device	Gravity type with adjustable hole and vertical rotor agitator/variable holimesh type
Transmission system	Sprocket chain drive
Ground drive wheel	Front mounted floating type with lugs on wheel periphery, diameter = 380 mm, width 105 mm, number of lugs = 10, height of lugs = 30, lug angle = 90°.
Overall weight	250–260 kg.
Unit cost	Rs. 11,000 – 15,000/-

Among other things, the main advantage of using this machine lies in its low energy consumption which makes it more eco-friendly and sustainable. Rautaray⁴ reported that as compared to convention tillage, it is more time saving, fuel efficient, etc.

Parameters	Zero till drilling of wheat	Conventional sowing	% saving due to ZTD
Time of sowing (hr./ha)	3.5	11.5	69.6
Diesel requirement (l/ha)	14.0	38.3	63.5
Operational energy (MJ/ha)	810.9	2177.0	62.8
Cost of seeding (Rs./ha)	665	1865	64.3

ZERO TILLED CROP ESTABLISHMENT METHODS

With 80% germination, zero tilled crop faces 4–5% failure where the germinated seeds failed to grow and emerge as seedling. Compared to conventionally sown wheat, the germination and emergence percentage in zero-till drilling have been found to be little less for which higher seed rate (120 kg ha⁻¹) is applied to take care of it⁵.

Infiltration rate in the zero tilled field during rabi season following different crop establishment methods of rice in the preceding kharif season remains higher where zero tillage is adopted for wheat in the puddled and cultivated rice field than the zero tilled rice field (Fig. 1). It has been observed that Zero-tillage with plot weeded in 30 cm strips along the maize rows leaving 60 cm unweeded and 5 tonnes/ha dry weed cut and spread over inter-row space as live mulch prior to the

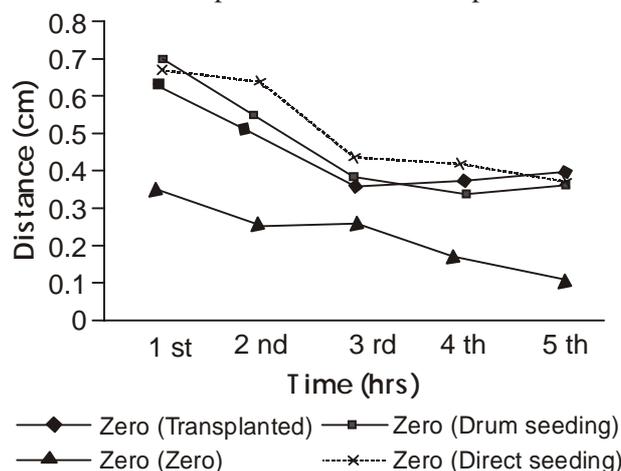


Fig. 1. Infiltration rate (cm/hr) in zero tilled wheat field following different crop establishment methods of rice in kharif

seedling reduced run-off from 48 to 22% and soil loss from 12 to 3 tonnes/ha/year and increased the yield of successive wheat from 7 to 12 tonnes/ha at Dehra Dun, Uttarakhand⁶.

Conservation tillage generally increases soil strength by developing particle to particle contact, and helps in conserving soil moisture by reducing evaporation loss : Compaction from conservation tillage increases thermal conductivity of soil due to decreased porosity and increased contact between particles. Residues on the surface reduce the soil temperature also. In the nutrient cycle, conservation tillage immobilizes the applied nitrogen, increases the heterotrophic bacteria, and activity of denitrifiers. Favourable effect of soil fungi on the formation and stability of soil aggregates is long well established, although specific mechanism involved in it is yet to be fully understood. One of the theories relates to the aggregating and stabilizing effect of glomalin a glycoprotein that comes off the hyphae of mycorrhizal fungi which live in a symbiotic association with roots of many plants. Experiments have clearly established higher aggregate stability and glomalin content in the no-tilled plots than conventional tilled field⁷.

HERBICIDES AND TILLAGE OPERATIONS

Dramatic progress in the development of herbicides has decreased the necessity of soil manipulation for weed management, and even if tillage is reduced to minimum, some soil still retains desirable physical properties. Hence, in such soils primary tillage operations are not required at all.

In zero-tillage consistent and satisfactory performance of herbicide becomes a prerequisite as cultivation cannot be taken up to destroy vegetation that escapes herbicides. Before sowing initial vegetation present in the field can be managed by herbicides having relatively short residual effect e.g. Paraquat, Glyphosate, etc. During the subsequent growth highly selective and persistent

herbicides are required to reduce the potential crop weed competition. Selection of suitable crop is also an important technique for weed management in long term zero tillage system. Crops with slow seedling growth or a long ripening phase can be grown only under persistent and highly selective herbicide treatments, otherwise fast growing and weed suppressing crops which remain competitive even during late growth stages are to be preferred. Tillage system influences weed seed distribution in different soil micro environments soil aggregates. In the upper layer of soils, conventional tillage incorporates seeds more uniformly among various soil aggregating classes, whereas in reduced tillage, weed seeds tend to accumulate in the deeper un-aggregated soil fraction. In wheat the most obnoxious weed is *Phalaris minor*. Lower *Phalaris* population and dry weight has been observed under zero tillage as compared to conventional tillage. The less *P. minor* problem under zero tillage system is due to less soil disturbance. The compact soil inhibits germination of seed which are pushed to the lower layer of soil during puddling for the preceding rice and remain there till the time of wheat seeding.

During early nineties *P. minor* took a menacing proportion in the wheat field in Punjab and Haryana where under severe infestation the yield losses were found to go up⁸ to 80%. Along with that it developed resistance to Isoproturon and cross-resistance to some of the herbicides like Diclofop. The situation came to such a pass that the farmers were forced to harvest their green wheat crop as fodder in many parts of Haryana and Punjab. Under these circumstances, Zero tillage came as a blessing and the weeds could be brought under manageable control by this practice.

ADVANTAGES OF ZERO TILLAGE

Overall trials conducted in the experimental stations and farmers fields on zero tillage in the rice-wheat growing areas of Indo-gangetic plains established certain advantages as given below.

(1) Zt advances wheat sowing by 10-15 days resulting in higher wheat yield over conventional tillage (CT). Increase in yield is round 10% which in certain situations can go up to 50%.

(2) The cost of preparatory tillage of wheat is reduced by Rs. 1500 to 2000 per hectare.

(3) The energy/fuel requirement of ZT is about 1/10th of the conventional tillage. Thus on a large scale it can lead to considerable saving of energy/fuel with beneficial effect on the environment.

(4) Considerable tractor time is saved by ZT thereby increasing its efficiency by many times.

(5) In ZT field emergence of crop is earlier than CT.

(6) Weed growth particularly *P. minor* is much restricted in ZT, but broad leaf weeds like *Rumex spp.* is more.

(7) After rice harvest sowing of wheat can be done with residual moisture and in certain cases pre sowing irrigation can be safely avoided.

(8) The amount of water required for first irrigation in wheat under ZT is much less than CT. Adverse effect of first irrigation in wheat under ZT is not found.

(9) ZT can be followed in fields having low soil moisture content and in such cases first irrigation is to be advanced.

(10) Under, ZT system due to placement of fertilizers at proper depth of soil, the use efficiency of fertilizers is likely to increase.

(11) Use of O-tillage in the same piece of land for prolonged period reduces soil erosion, induces more water infiltration and retains more moisture in the field leading to higher productivity. Reports (2001) from the Institute of Agricultural Engineering (Bhopal), PAU, HAU, Pantnagar and Banaras Hindu University (2002) indicate that zero-

till drilled crop performs better than conventionally sown wheat in the rice-wheat cropping system.

It has been reported in the 74th Annual General meeting of the ICAR Society held on July 16, 2003 that adoption of zero tillage in more than 3.75 lakh ha of wheat (following rice) has saved Rs. 100 crore during the last calendar year (TOI, New Delhi, July 16, 2003).

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RESOURCE CONSERVATION AND MANAGEMENT IN DOMESTIC LIFE : A BURNING NEED OF THE TIME

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Each individual should understand the importance of precious water, mineral energy and bio-resources. Conservation is the most cost effective and environmentally sound way to reduce our demand for water, energy, plant and animal products. Thus some simple steps to conserve water, energy and biodiversity at individual level are enumerated in this article. If we all practise these steps, we really can change the world and sustainable development at all levels can be achieved.

INTRODUCTION

Conservation always leads to a prosperous life. However, conservation of resources is somewhat different from the concept of preservation. Conservation of resources means their best possible utilization. It is the method of keeping life evergreen. Thus, we must consume resources judiciously to provide maximum possible access to the resources for both the present and future generations.

Our goal is that each and every person should know the value and importance of resources. By applying simple techniques and creating awareness at domestic level, all of us can take part in conservation process.

WATER CONSERVATION

Out of the total water (both surface and ground water) on earth, only less than one percent is useful for human use. Ground water level is rapidly depleting throughout the world. Heavy withdrawal of groundwater by accentuated pumping of a large

number deep tube wells for agricultural, domestic and industrial uses causes critical hydrogeological conditions in urban areas. As a result, ground water troughs with lowest elevation of few metres from the mean sea level have formed in many urban areas. This trough, along with reversal of natural hydraulic gradient, defunctness of deep tube wells, diminishing yields of deeper aquifers and unproductive nature of shallow aquifer, causes cumulative environmental impact on the ground water regime.

Therefore, each individual should understand the importance of the valued ground water and surface water resource. Conservation of water is the most efficient and eco-friendly way to reduce our demand for water. Using less water puts less pressure on the ground water. Another important solution to this acute problem is rain water harvesting, an old technology that is gaining popularity in a new way which is the principle of collecting and using rain water from a catchment surface. Rooftop collection and roadtop collection of rainwater should be carried out at individual levels to partially solve the acute problems arising due to over exploitation of ground water. Harvesting rainwater should be a common responsibility of the general public for sustaining the secure life as

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it will provide drinking water, domestic water, water for livestock, and small irrigation. It provides a way to replenish ground water levels and it provides to arrest sea water intrusion in the coastal area.

Each individual must know the importance of this precious water resource. By applying the following simple techniques or awareness at domestic level all of us can take part in water conservation process.¹⁻⁵

- Do not let water flow unnecessarily while brushing teeth or shaving. Fill the mug with a few inches of water to rinse your razor. Save 5 liters each day.
- Turn on the tap slowly ; use water with a slow flow. Use water-conserving appliances such as, low flow showers, low flush toilets and aerated faucet (a device with a hand-operated valve for regulating the flow of a liquid from a pipe)
- Install an ultra low-flow toilet that requires only 6 liters per flush. Avoid flushing the toilet unnecessarily.
- Put a plastic bottle or a plastic bag weighted with pebbles and filled with water in your toilet tank. Displacing water in this manner allows you to use less water with each flush. Save 5 to 10 liters a day.
- Put dye tables in your toilet tank and wait to see if the color appears in the bowl (without flushing). If it does, you have a leak! It should be repaired immediately. Save 300 liters a month.
- Use a bucket of water instead of shower for bathing. A 10-minute shower wastes many liters of water as compared to using water from a bucket. Otherwise shorten your showers. Even a one or two minute reduction can save up to 700 liters per month.
- If you have a geyser and you are taking a shower, do not waste cold water while waiting for hot water to reach the showerhead. Catch that water in a container to use on your outside plants or to flush your toilets. Save 300 to 400 liters a month.
- Close the taps properly after use so that not a single drop of water goes waste.
- When you drink water, take as much as you need to avoid wastage.
- Wash clothes with as much of water as needed. Run only full loads in the washing machine and dishwasher. Save 400 to 800 liters per month.
- Drive your car/bike/scooter/bicycle on to lawn to wash it. Rinse water can help water the grass. Tell your children not to play with the garden hose. Save 10 liters a minute.
- Do not run the hose while washing your bike and car. Use a bucket of water. A quick hose rinse at the end saves 150 liters each time. For a one bike/car family that's up to 1,200 liters a month.
- Wash vegetables, fruits etc in a pan of water instead of washing them under running water. Save 250 to 350 liters a month.
- Do not throw away water that has been used for washing vegetables, rice, etc. Use it to water the plants and to clean the floor.
- Sock the dishes before washing them to reduce water and detergent usage.
- Groundwater contamination is by household chemicals is a growing concern. While washing dishes by hand, use the least amount of detergent. This minimizes water needed for rinsing. Save 50 to 150 liters a month.
- Do not defrost frozen foods with running water. Plan ahead by removing frozen from the refrigerator overnight. Save 200 to 400 liters a month.
- The water coming out of kitchen can be reused to water plants, which also helps in recharging

of water table. Likewise, water coming out of bathroom can be reused for the same purpose.

- Collect rainwater in your garden by digging a pit. Collection of water can be done directly and also by drawing collected water from top roof through pipes to that pit in a suitable manner. This water can be used to water the plants or clean the floor. This also helps in recharging water table underground.
- Water plants before 8 A. M. or after 5.30 P. M. to minimize evaporation.
- Cut down watering on cool and overcast days and do not water in the rain. Adjust or deactivate automatic sprinklers. You can save up to 400 liters each time.
- Water in several short sessions rather than one long one. For example, three ten minute sessions spaced 30 minutes to an hour apart will allow your lawn to better absorb moisture than one straight 30 minute session.
- Only water when your lawn is thirsty. Over watering promotes shallow root growth making your lawn less hardy. To determine if your lawn needs to be watered, simply walk across the grass. If you leave footprints, it's time to water. If it springs back, when you lift your foot, it doesn't need water.
- Sprinkler methods of irrigation should be utilized. Check sprinkler system valves periodically for leaks and keep the heads in good repair. Adjust the timer on automatic sprinklers according to seasonal water demands and weather conditions. Install a rain shutoff device on automatic sprinklers to eliminate unneeded applications.
- Avoid sprinklers that spray a fine mist, which increases evaporation.
- Install a drip irrigation system for watering gardens, trees and shrubs. Drip irrigation provides a slow, steady trickle of water to

plants at their roots through a network of hidden pipes and hoses. The systems are regulated by a controller that can be adjusted for different levels of watering according to the needs of the plants. Drip irrigation systems reduce over watering, inefficient watering and weed growth.

- Have an evaporative air conditioner ? Direct the water drain line to a flowerbed, tree base or a lawn.
- If you have a pool or small pond, use a pool/pond cover to cut down on evaporation. It will also keep your pool/pond cleaner. Save 1000 liters a month.
- Locate your master water shut-off valve so that water can be saved if a pipe bursts.
- Show children how to turn off the faucets completely after each use.
- Complain to the authority for any waste of water in public places.

You can do family water audit to see whether water is used wisely or not (Table-1).

Table 1 : Family Water-Audit

Personal habits ↓	Often	Sometimes	Never
Marks allotted→	4	2	0
Use a bucket of water in stead of shower for bathing. Avoid taking bath in a bathtub frequently.			
Flush the toilet only when necessary.			
Turnoff the water while brushing your teeth			
Fill the mug with a few inches of water to rinse your razor, while saving.			
Use a bucket and mug when washing the bike, bicycle and car.			
Turn water faucet off tight			
Put water in the kitchen sink to wash and rinse dishes			

Personal habits ↓	Often	Sometimes	Never
Marks allotted→	4	2	0
Run the washing machine only when it is full.			
Wash vegetables, fruits etc. in a pan of water instead of washing them under running water. Don't throw away water that has been used for washing vegetables, rice etc.			
Install rainwater tank in your home.			

If your score is 20 to 30 : Great job ! You are on your way to saving hundreds of liters of water a month.

If your score is 10 to 20 : You are off to a great start ! Learn more easy ways ; you can save hundreds of liters of water a month on indoor water usage.

If your score is 0 to 11 : You have a lot of room for improvement. You learn how to save hundreds of liters of water a month.

ENERGY CONSERVATION

Coal, petroleum and other mineral resources which have accumulated in nature over millions of years and cannot be replaced. The interaction between the natural resources and the population has to be maintained at a balance in order to ensure the continuity of the human race.

When we look around us at all the machines/appliances (lights, fans, bikes, cars etc.) that are running, we simply cannot imagine life without all these. However, can we ever imagine the amount of energy that is being used to run all these ? India's overall consumption of energy is very low, but compared to its gross domestic production its relative consumption is very high. Fortunately people are becoming aware of the problem of consuming too much energy. Thus they are making a conscious effort to conserve it. Hence at an individual level, every one of us should follow

some of the small steps to conserve energy as enumerated hereunder.^{1,2,6,7,8,9}

- Use fuel in an economic way.
- Walk or use bicycle rather than drive whenever possible. Because, it occupies less space, releases no pollutant and provide healthy exercise.
- Avoid using car or scooter or bike for short distances. Use public transport as much as possible. Use pool cars.
- Switch off your car/bike/scooter engines, if stopping is more than two minutes.
- Make a habit of using non-conventional energy resources (solar, wind, geothermal, biomass energy) as much as possible instead of using conventional energy sources (coal, petroleum and natural gas).
- Get your car or scooter serviced regularly to keep the petrol consumption low. Heavy vehicles specially need regular servicing to reduce fuel consumption and reduce pollution levels.
- Plan your trips and routes before setting out. It will save the unnecessary fuel consumption.
- Organized cooking activity can save about 20% energy. Plan and keep things ready before you start cooking. Soak rice, pulses etc. before cooking to reduce cooking time and save fuel.
- Keep vessels closed while cooking and always use small, narrow mouthed vessels to conserve energy and cook on low flame to save 6 to 10% energy.
- Use right quantity of water required for cooking, use the lowest possible heat to maintain boiling or steaming and reduce consumption of gas or kerosene. Pressure cookers use much less energy than ordinary pots and pans. Use pressure cookers with separators for cooking.
- Use solar cooker or biogas for cooking instead of natural gas and save cost of two LPG cylinders annually.

- When the food is almost cooked, switch off the gas/stove and keep the vessel closed. It will get completely cooked with the steam already present inside.
- Use flat and wide bottom pans for best contact with the heat, with tight-fitting lids to keep the steam in the pan.
- Get your family to eat together to avoid repeated warming of food ; it will save fuel used for re-heating. It also preserves the nutritional value of food.

Electricity Conservation

- Switch off fans and lights when not in use.
- Use tube lights instead of bulbs. Tube lights consume less power. Moreover prefer slim tube lights which give better light and consume less electricity.
- When possible, use one large bulb rather than several smaller ones. Keep bulbs/tubes clean.
- Use low voltage lights particularly prefer energy-efficient compact fluorescent light to yellow bulbs (incandescent light bulbs). Since no heating is involved, a compact fluorescent lamp requires 20 per cent of the electrical energy used by an incandescent bulb to produce the same amount of light. Oxides of nitrogen, particulate matter (dust) and mercury³.
- Avoid using halogen lamps as they consume a lot of electricity.
- In daytime, keep windows and doors open and do not put on lights at daytime. Use natural daylight as much as possible.
- Position your reading tables near the windows and cut down on your electricity bill by reading in natural light.
- Select a light shade of paints for walls and ceilings, as it will reflect more light and reduce electrical consumption.
- Defrost the refrigerator regularly. Do not open the refrigerator too often. Also, do not open it for too long. Avoid putting food in the refrigerator when it is still hot.
- Keep your refrigerator temperature at 3°C. Freezer temperature should be maintained at -12°C. Check your refrigerator/freezer door gasket periodically for signs of deterioration.
- Vacuum or brush the cooling coils (in back) of your A/C at least every six months. If your room air conditioner is more than 10 years old, it could be doubling your cooling costs. Clean or replace your air conditioner filter monthly so your A/C runs efficiently. Use ceiling fans to circulate air. Do not forget to turn fans off when you leave the room. Avoid heat-producing activities like ironing and cooking, when A/C is on.
- Plug on your iron only after you get all your clothes together.
- Use your microwave oven in place of ordinary oven whenever possible. When you have to use your oven, cook more than one item at a time. Preheat oven only 5 to 8 minutes when baking ; do not preheat oven for roasting.
- Self-cleaning ovens have thicker insulation and will retain heat, making these models more energy-efficient than regular ovens. Use the self-cleaning feature on your oven only when absolutely needed.
- Dry your clothes in the sun instead of using the dryer in the washing machine. Maximize use of natural heat.
- The electricity consumption by your geyser can be considerably reduced if the members of your family bathe in quick succession and switch it off as soon as it is no longer required.
- Avoid switching in of heavy duty appliances during peak hours, i.e., 6 a.m. to 9 a.m., and 5 p.m. to 8 p.m.

- Use small cooking appliances (electric fry pans, toaster ovens, etc.) whenever possible.
- When you search for a new washing machine in the market, buy a high efficiency model that will use an average of 30% less water and 40-50% less energy.
- Use of solar lanterns and solar street lighting system must be encouraged. It saves electricity to a great extent.
- Install a solar water heater instead of electric heater. It is very economical.
- We must complain to the authority for any waste of electricity in public places.

If we shall practise few of these simple steps, we can save up to 30% – 50% on our electricity bill. Consumption levels of some commonly used appliances are given in **Table–2**. Thus we can do family electricity audit so that we can use electricity efficiently without any waste.

Table 2 : Consumption levels of some commonly used appliances		
Appliance	Capacity	Consumption
Instant geyser	3000W	3 units/hour
Immersion rod	1000W	1 unit/hour
Air conditioner	1500-2500W	8.5-14.5 units/day
Air cooler	170W	1.7 units/day
Fan	60W	0.6 unit/day
Refrigerator	200W	2 unit/day
Electric kettle	1000-2000W	1-2 units/hour
Hot plate	1000-1500W	1-1.5 units/hour
Oven	1000W	1 unit/hour
Toaster	800W	0.8 unit/hour
Iron	750W	0.65-0.75 unit/hour
Incandescent bulb	100/60/40 W	0.5/0.3/0.2 unit/day
Fluorescent lamp	40/20 W	0.28/0.15 unit day
Slim tube	36 W	0.26 unit/day
Compact fluores-cent lamp	7/9/11/13/15W	0.66-0.09 unit/day
Source : Energy Management Centre, Ministry of Power, Government of India		

SOIL CONSERVATION

Recent researches reveals that some 75 billion tones of ‘top soil’ (the fertile layer) are eroded away every year by different geological agents and converted to wasteland. More usually, when new soil is formed from parent rocks, 1 cm of soil may take from 100 to 1000 years to build up. Soil is no longer a renewable resource. Only the top thin layer of the soil with humus is vital to grow food and is sustaining the entire civilization. Every year 27 mha of valuable fertile and productive land out of total 3200 mha world’s potentially food producing land is being lost by desertification. Every minute a chunk of fertile agricultural land of the size of a tennis court is being converted into wasteland¹.

Thus, loss of soil i.e. soil erosion is an age old problem. To face this problem soil conservation techniques are being applied. Soil conservation is the protection of soil against excessive loss of fertility by natural, chemical or artificial means. All of us can take part in this conservation process. There are many ways that each of us can help in solving this environmental problem at domestic level. Some of the steps to be followed are given herewith^{1,2}.

- Do not leave any patch free of plants or grasses in your premises.
- Do not let your garden or field soil naked and avoid the coming of it in contact with direct wind. For this, high rate of vegetation is the best solution.
- Do as much vegetation as you can in your garden. Because more plantation means more binding of soil. Hence soil loss will be minimized to a great extent.
- Do not water soil with a great force and in a haphazard way. It erodes the top soil layer.
- If you plan to plant on a steep slope in your farm or garden, the soil can be conserved by

terracing the area. It helps in slowing the rain water flowing down as water soaking will take place rather than carrying soil away.

- Avoid removing the cut grass, live it on the lawn. Cuttings serve as moisture-retention mulch and a natural fertilizer.
- Cover the soil in your farm or garden with a layer of mulch to prevent soil erosion in the rainy season and to conserve soil moisture. Mulch can be made from grass clippings or leaf litter.
- Compost from kitchen scraps, from poultry and cow sheds acts as organic matter, which enrich the soil naturally. Use them.
- Support environmental campaigns in your state and community against cutting down of trees.

BIODIVERSITY CONSERVATION

Each year, around 17-18 million hectares of tropical forests and woodlands are eliminated from the face of the earth. Similarly 4.5 million hectares of rain forest are depleted for timber, paper, fuel wood and for clearing land for fodder to export to meat producing industries. Every day a minimum of three species of life is permanently disappearing from the earth and at the current rate of habitat destruction, it will become 3 species per hour in just 10 years. Some biologists believe that extinction of one plant species may eventually lead to the extinction of up to 30 insect and animal species in the food chain because all animals depend on plants for their food and survival¹.

The most important cause of biodiversity crisis is the disturbance of natural habitats. Biodiversity at local, regional, continental and global scales is critically threatened by human activities. All these losses of biodiversity have already been caused by human influences, including extinctions of numerous species and the losses of natural communities. The rapid destruction of forests and the growth of human habitations and activities

have reduced the natural habitats of animals and birds. Loss of habitat is one of the major pressures on several endangered species and had led to the extinction of many rare and endemic species. We thus have the responsibility of preserving the remaining habitats and their inhabitants and it can also be done at domestic level. Some of the tips are as follows^{1,2,10,11}.

- Plant more trees of local or indigenous species around your home and your workplace and encourage your friends to do this.
- If your urban garden is too small for trees, plant local shrubs and creepers instead. These support bird and insect life that form a vital component of the food chains in nature. Thus domestic biodiversity conservation will be feasible and can support a limited but valuable diversity of life.
- If you live in an apartment, grow a terrace garden using potted plants on your balcony. Window boxes can be used to grow small flowering plants, which also add to the beauty of your house.
- Whenever and wherever possible prevent trees from being cut or if it is not possible for you to prevent this, report it immediately to the concerned authorities. Old trees are especially important.
- Never present flower bouquets. Instead give a potted plant and encourage your friends to do so.
- Participate in the events that highlight the need for creating Sanctuaries and National parks, Nature trails, open spaces and saving forests.
- Support project tiger, project elephant etc. and join NGOs that deal with environmental protection and nature conservation.
- Be kind to animals. Stop friends from disturbing or being cruel to wild creatures such as birds, frogs, snakes, lizards and insects.

- Attract wildlife such as small mammals like squirrels, to your garden by providing running or dripping water.
- Do not buy products made from ivory. Elephants are killed for their tusks, which are used to make a variety of ivory products.
- Do not buy products like purses, wallets, boots that are made from reptile skins. If you are not certain that a product is made from a wild species, its better to avoid using it.
- Involve yourself and your fiends in activities carried out during wildlife week and other public functions such as massive plantation programme.
- Learn about birds and identify the birds that are common in your area. Understand their food requirements and feeding habits. Construct artificial nesting boxes for birds. This will encourage birds to stay in your neighbourhood, even if their nesting habitat is scarce. You can learn more about birds by making a birdbath. Birds need water to drink and to keep their feathers clean. You can make a birdbath out of a big ceramic or a plastic saucer. Having birds around your home, school or college can even help increase species diversity in the area.
- When you visit a zoo, learn about the animals that are found there. However, do not tease or hurt them. They have a right to a peaceful existence. The zoo is, in any case, not an ideal home for them.
- If you have a pet, feed them well and give them a proper home and in an emergency proper medical care.
- Do not catch or kill butterfiles or other insects. Butterflies, moths, bees, beetles and ants are important pollinators.
- Dragonflies and spiders, act as biological pest-control agent (natural enemy of pests).
- Do not disturb or destroy the natural habitats of birds or animals.

- If you are not a vegetarian you should depend more upon plant food than on animal foods. The same amount of plant food that would feed 100 pure vegetarians would only feed 13 non-vegetarians. Therefore, be a vegetarian, conserve the biodiversity and save the planet¹.

PAPER CONSERVATION

The paper on which we write and books etc. are obtained or made from the most valuable natural resource i.e. from wood, straws and other plant products. The paper mills take wood and transform the raw product into paper. Recent research reveals, to produce a ton of paper 16-18 average sized trees are axed and each year every one of us consumes paper and board equivalent to at least two green trees which in turn lead to massive erosion of biodiversity¹.

Hardwood logs (beech, birch and maple) and soft woods (pine, Spruce and bamboo) are harvested from managed forestlands or purchased from local farms and timberlands across the world and are transported to mills for processing. The rate of paper consumption puts stress upon the natural resource ultimately. So, it is our duty to use paper economically for the sake of trees. As we can save plants, then only we can conserve biodiversity and can save our planet. Some tips of economic use of paper are enumerated hereunder^{1,2}.

- Do not burn or tear or throw away old newspaper and waste paper as garbage, instead sellings them to raddiwala. He will sell it to recycling factories and it can be used for making paper packets.
- Do not waste paper bags. You can reuse it for storing purpose.
- While shopping, choose products in limited packaging. It will not only help cut down on the amount of waste in landfills, but also helps in reducing our need for paper and packaging.

- Buy recycled paper products for your home ; e.g., sheets of paper and envelopes etc.
- Reuse cartons and gift-wrapping paper.
- Donate used books, journals and magazines to libraries of schools, colleges or universities.
- Old calendar pages can be used to make colourful copy covers, envelopes and gift-wraps.
- Keep your school textbooks neat and clean. Don't tear any pages. You can pass it on to your juniors or, poor children in school.
- Blank pages from previous class copies can be stapled together to make a rough copy.
- Use both sides of paper to write on. Leaving one side blank is definitely wastage of resources.
- Don't waste blank sides of photocopies or computer printouts. You can write on them.
- Avoid use of greeting cards frequently and insist on oral greetings.
- Avoid presenting and accepting gifts in heavily wrapped paper or plastics.
- Avoid using paper napkins, instead keep and use re-usable cotton handkerchiefs.
- Donate used articles to charity organizations instead of disposing them as waste.
- Insist on repair of instruments and appliances rather than replacement.
- Carry tiffin/lunch to schools/colleges/work places in reusable boxes rather than in disposable plastic/paper wrappings.
- Adopt the golden rules of 3R's (waste reduction, re-use and recycling) in daily life.

However, use of paper plates or paper decorations must be encouraged when you hold a party as they are biodegradable.

TIPS FOR WASTE MINIMIZATION

Domestic conservation can be possible, when measures will be taken for waste minimization at individual level. A number of steps to reduce the waste at domestic level are enumerated herewith¹.

- Buy durable goods and avoid disposables as far as practicable.
- While shopping insist on bulk buying. Prefer to buy products packed in reusable and refillable containers.
- Carry reusable cotton bags for grocery shopping.
- Refuse plastic bags for small items and reuse them several times before discarding.
- Compost your kitchen wastes at home.
- Insist on both side printing and photocopying unless absolutely necessary otherwise.
- Reuse one sided printed paper before discarding.

CONCLUSION

The resource saving ideas we use at home can also be used in our school, college, university, offices and public places. As individuals, groups and community, let us wake up before it is too late. We should not only understand what conservation is all about but also implement measures to conserve water, energy and biodiversity at all levels. We really can change the world with just practising one of the simple steps. The key is that the more we commit to take the step, the more we can change the world. Through this article, an effort is made to warn about the way we live here in India and the sustainable way we should live in. This effort will certainly create the ways and means of the environmental awareness to the society. Hopefully, making aware of small steps is a sure win war against greed, ignorance, incompetence, lack of concern and apathy.

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DO YOU KNOW ?

Q1. What is/was Enola Gay ?

Q2. Which are more common-boy twins or girl twins and why ?

HYDROTHERMAL VENTS : LIMITS TO LIFE

K. P. Biswas*

Heat loving (thermophilic) animals love to live in places where temperatures exceeds 80°C, such as hydrothermal vents. Hydrothermal vents arise, where cold sea water interacts with freshly formed hot ocean crust along the chains of submarine volcanoes, called mid-ocean ridges. The basic requirements for hydrothermal circulation are a source of heat and a pathway for sea water to circulate within the rock. It represents significant cooling process for the planet as a whole. Hydrothermal fluxes of chemicals, notably, iron, manganese, methane, hydrogen and hydrogen sulphide help to buffer the chemical balance of the ocean and atmosphere. Variation in geology, chemistry, physics and biology make every vent field unique and unusual. High temperature venting on the sea floor gives rise to plumes which ascend through the oceanic water column, until they reach a level of neutral buoyancy, some hundreds of metres above the sea bed before subsequent lateral spreading.

More than 400 new species have so far been found at vent sites. These organisms range from anaerobic microbes to tube worms, shrimps, mussels and crabs. Hydrothermal fauna thrive in extreme conditions of temperature (350°C or more) acidic pH (pH 3-4) and with highly toxic dissolved hydrogen sulphide and heavy metals, like, cadmium, arsenic and lead. Life on vent has adapted this unfavourable environment in many ways. Vent shrimp *Rimicaris exoculata* replaced their optics of compound eye by an extended naked retina. Successive metamorphosis of eye anatomy and photo pigment in vent dwelling crab have also been observed in adaptation to the demands of transition from deep sea pelagic larval habitat to the bathy pelagic vent environment only to gain the sensitivity of glowing vent amidst of eternal darkness of ocean floors.

INTRODUCTION

While searching for universal common ancestor, the ancestor of all life, some scientists believe that the common ancestor of all life was "thermophilic" or heat loving microbes that might have lived in hot water environment at hydrothermal vent at the bottom of the ocean, 3.5 billion years ago¹ when the Earth was probably warmer. The discovery of the archaea in 1970 also suggested its hot-water origin. These single-celled organisms share characteristics with the bacteria and the eukaryotes, more complex creatures, such as, fungi, plants and animals. In many phylogenies,

the modern groups, most closely related to the common ancestor of archaea and bacteria, are hyperthermophiles that live in places where temperatures exceed 80°C, such as hydrothermal vents on the ocean floor.¹

The study of the ribosomal RNA, an essential part of the cell's protein-making machinery, reveals about the temperature of its habitant. Organisms in hot environments have ribosomal RNA, rich in pairs of the bases guanine (G) and cytosine (C). These G-C pairs are more tightly bound than the alternative adenine (A)-Uracil (U), and are, therefore, more stable at high temperatures.¹

Hydrothermal activity in deep sea was discovered in 1977 on the sea floor near the

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Galapagos Islands. John Edmond² was the first to recognize the full importance of hydrothermal activity. He used the first observations from the Galapagos Islands to make precise estimates about the extremely high temperatures (around 350°C) that hydrothermal fluids can reach and discussed their significance in terms of chemical fluxes to the oceans.

Hydrothermal vents arise where the cold sea water interacts with freshly formed hot ocean crust along chains of submarine volcanoes, called mid-ocean-ridges, which run for more than 50,000 kilometers across the world's ocean basins. Soon after sea floor venting was first discovered, it was thought that hydrothermal activity may be geographically rare and occur only along the volcanically active region³. But evidence has been found of extensive hydrothermal activity along the world's slowest-spreading and least volcanically active plate tectonic boundary, the Gakkel Ridge, beneath the permanent ice cover of the Arctic Ocean. Vent fluids collected from two known sites of Indian Ocean have shown that these samples are more chemically enriched than similar fluids studied previously. Fifteen years ago, it was commonly thought that hydrothermal fluids should all have a similar composition that would remain unchanged for decades. But from the evidence of Von Damm's report, it seems that we are still some way from understanding about the full flux from hydrothermal activity of the oceans.

DISTRIBUTION OF VENT SITES

Early efforts at synthesizing the global distribution of hydrothermal vents indicated a linear relationship between "plume incidence" (defined as the percentage by length of ridge axis overlain by hydrothermal plumes) and ridge spreading rate and thus magmatic heat input. To estimate the number of individuals at vent sites expected from this relationship, it is assumed that the plume overlying a single vent source will extend over ten kilometres of ridge axis.

Several recent studies have found departures from the linear relationship between hydrothermal activity and spreading rate on intermediate and slow-spreading ridges. Many have suggested that tectonic activity (faulting) is the mechanism that allows for prolonged focused venting where magmatic heat supply is low. Of late, on the ultra slow spreading portion of the south west Indian ridge between 10° and 16°E, where there is very little volcanic activity, several hydrothermal sites have been discovered associated with large faults. Even the fast spreading northern East Pacific Rise, where hydrothermal activity would be expected to be most closely tied to the magma budget, has been found to have a wide range of vent frequencies at similar spreading rates, indicating that on the scale of individual ridge segments the distribution of vents is controlled by the degree of faulting in the volcanic rocks.

The basic requirements for hydrothermal circulation are a source of heat and a path way for sea water to circulate within the rock. Slower spreading rates imply a weaker thermal gradient (less heat input at the ridge axis) and thus deep-thrusting faults are required for circulating sea water to reach high temperatures on slow-spreading ridges. On the Mid Atlantic Ridge and south west Indian ridge such faults enable the establishment of high temperature vent systems, often in areas quite distant from ridge volcanoes.

Submarine hydrothermal venting along mid-ocean ridges is an important contributor to ridge thermal structure and the global distribution of such vents has implications for heat and mass fluxes from the Earth's crust and mantle and for biogeography of vent-endemic organisms.

In the Galapagos region, scientists discovered hydrothermal vents, under water fissures, where superheated water bubbles pour out of the sea floor. But till 2005, black smokers chimneys that spew a flood of dark mineral particles, characteristic of vent phenomena, was not discovered.

In the past couple of years, marine scientists have discovered numerous vents, once a handful of isolated vents has expanded into a dizzying diversity of oceanic wonders.⁴

Recently in cold Arctic waters and in South Atlantic, the biggest plume ever recorded of hydrothermal chemicals was released from an under water eruption. Variations in geology, chemistry, physics and biology make every vent field unique and unusual.² Nearby along Mohns Ridge, at the base of 100 metres high cliff wall formed after an earthquake, a series of hydrothermal mounds were discovered, each topped with several smoker vents. The fluid pouring out of the smoker chimneys were bubbling at 263°C.

Chemical plumes have been laboriously traced to locate vent sites. The ecosounder also help to locate the vents and image the plumes from the signals, which appear to be an associated school of fishes.

On the southern part of the Mid-Atlantic Ridge, the under water mountain range runs like a backbone down the middle of the Atlantic Ocean. As many as two dozen hydrothermal vent fields have been located in the northern part of this mountain chain.

Near 5° south, two potential vent sites, a kilometre apart were mapped with high resolution sonar. While photographing the field of potential black smoker with a digital camera, the camera burnt through as it contained fresh basaltic lava flows, at temperatures close to 400°C. This temperature is the highest measured so far along the entire Mid-Atlantic Ridge. The high temperature indicates that fluids are being heated close to a magma source, most likely from a recent upwelling or volcanic eruption. The effect of recent volcanic activity on submarine hydrothermal systems has so far been documented only along fast and intermediate spreading centres, such as, the East Pacific Rise, but not from slow spreading ridges, where volcanic eruptions are rare.

CHARACTERISTICS OF HYDROTHERMAL ACTIVITY

Hydrothermal activity is a part of the way in which the Earth works and is intimately linked to plate tectonics and occurs almost exclusively at ocean ridges. To Earth scientists it represents a significant cooling process for the planet as a whole. For oceanographers, hydrothermal fluxes of chemicals, notably, iron, manganese, methane, hydrogen and hydrogen sulphide help to buffer the chemical balance of the ocean and atmosphere. The best estimates suggest that the entire volume of ocean is processed through high temperature vents every ten million years and through deep sea hydrothermal plumes every few thousand years.

High temperature venting on the sea floor gives rise to plumes which ascend through the oceanic water column, entraining sea water until they reach a level of neutral buoyance some hundreds of metres above the sea bed. Subsequent lateral spreading of these plumes with their associated signatures in temperature, chemical tracers and suspended particulate material, provides a means by which new hydrothermal vent sites can be located.

Submarine thermal springs, also called deep-sea hydrothermal vents, have been discovered on the Galapagos Rift and on the East Pacific Rise. They are remarkable in two ways. Firstly, their physico-chemical conditions are extreme, since the water emerging from the fissures is hot, anoxic, acidic and contains an enormous amount of H₂S. This water mixes with normal surrounding oceanic water which is cold 2°C, contains oxygen at pressure of more than 50 Torr, no H₂S and has a pH value around 7.5 ; consequently, over a short distance, the physico-chemical conditions change steeply. Secondly, in these special waters, a dense biomass is supported by the primary production of sulfide oxidizing bacteria. Large pogonophoran tube worms, clams, mussels and brachyuran crabs are found ; some species of these groups have never

been observed elsewhere. Their physiology is beginning to be known.

Water samples are collected to check that the MAPR signals do indeed indicate hydrothermal plumes. Several chemical tracers, such as manganese are diagnostic of a hydrothermal origin. Total dissolved manganese concentrations in the 85° E plume exceed 10mN with background values less than 1 mM. The plumes at 85°E, in their thickness, height of rise and magnitude of signals indicate the most vigorous hydrothermal venting observed anywhere. Chemical confirmation is important both for large unambiguous plumes, and also for the smaller MAPR signals.

Hydrothermal activity gives rise to characteristic chemical signatures (sulphide and methane gradients), which vent crustaceans may use to locate active hydrothermal fields, as well as thermal gradients (2°C to greater than 360°C). Light generated at the vents is sufficient to support vision in an otherwise aphotic world and could serve as a superfluous near-field settlement hint if juveniles approaching the vents can detect it.

The sea floor is on an average, about 4 kilometres from the surface. Shallow hydrothermal vents occur in less than one kilometre depth below the surface. Recent studies have shown that truly shallow hydrothermal vents are within the reach of scuba dive and are very different from their deep water counterparts.

In 2004, a rich shallow-water vent ecosystem was discovered in Eyjafjördur (Icelandic northern fjord).⁴ The area contains a series of chimneys and fissures stretching for about 500 metres. The tops of some chimneys are only a 14 metre dive from the surface. All the chimney's spout fresh water, contaminated with less than 1% sea water and at temperatures reaching 77°C. The chimneys form their own landscape providing a unique habitat for the animals and plants in the area.

But shallow vents are not always desirable.

Near Ambitle Island, Papua New Guinea, some vents spew out a toxic cocktail of arsenic with a splash of sea water. As much as 1.5 kilograms of arsenic flows daily from these vents into the surrounding coral reefs.

HYDROLOGICAL CYCLES AND PLUMES

Through hydrological cycle water is circulated through the depths of the Earth. It has long been suspected that surface material can be carried to the Earth's deep interior by subduction of ocean crust and associated mantle, and then returned to the surface by plumes rising through the mantle. The mantle plumes can carry deeply subducted ocean crust and sediment as well as the residue of ocean crust creation from depth back to the surface.

At depth of 1000 metres or more in the ocean, however, the pressure is sufficient for magma to retain water as it destroys glass by contact with sea water.

The recycled material would contain comparatively large amounts of water. Marine sediments rich in clay minerals can retain 10% or more water bound in their lattices. Circulating sea water hydrates, the basaltic oceanic crust eventually raising its structurally bound water content to 2-5% by weight. Additional water is present in the pore space in both sediments and basalt. The amount of water carried into the mantle in subducted oceanic crust and sediment exceeds 1×10^{12} kg per year (10 million tons) enough to drain the ocean in little more than a billion years if the water were not returned from the mantle.

Release of water from subducting oceanic crust has long been believed to cause the magma production fuelling volcanoes that ubiquitously sit atop subducting zones. The notoriously explosive nature of the volcanoes is largely due to the high water-content of their magmas. The dehydration process is so efficient. It was calculated that 92% of the water is extracted from subducting sediment

and 97% from the subducting oceanic crust. The deep hydrological cycle thus appears to be short-circuited, with most subducted water quickly returning to the surface through volcanism rather than being carried into the deep mantle. Water released by dehydration could carry away much of the soluble-element content of subducting crust and sediment.

In the seismic area (85°N, 85°E) where volcanic activity was observed in 1999, extremely thick plumes were observed upto 1400 metre and were centred more than 1000 metres off the sea floor. Typical maximum rise height for hydrothermal plumes in the Pacific and Atlantic oceans are 200-400 metres. The plumes at 85°E in their thickness, height of rise and magnitude of signals indicate the most vigorous hydrothermal venting in the area.

Sharp plume in both light scattering and temperature at 2009m, between 8°E and 18°E, wide spread plume at 3100 to 3200m between 8°E 18°E and small plumes at 3400-3500m between 21°E and 31°E were identified along 1100 kilometre section of the Gakkel Ridge in the Arctic Ocean.

Much of the Pacific Ocean's sea bed is a single plate that, over the past 70 million years, has drifted slowly northwest relative to the layers beneath it. The hotspot is the result of a rising plume of hot buoyant rock, which deforms the overlying tectonic plate and spreads out beneath it.

The solid rock rising up through the plume is released from the enormous pressure of the Earth's interior and starts to melt. Long-lived hot spots (the result of a rising plume of hot buoyant rock) such as that beneath Hawaii, the Galapagos Islands and Cape Verde Islands, west of Africa, are believed to depend on stable plumes that arise from convection currents originating deep within the mantle. They may have their roots in the upper mantle less than 660 kilometres below the surface or deeper at about 2900 kilometres at the boundary between the lower mantle and the seething cauldron of iron-rich material that forms the Earth's core.

The gas dissolved in water from hydrothermal vents at the mid ocean ridge is thought to come from the uppermost region of the mantle.

For the detection of hydrothermal plumes, Miniature Autonomous Plume Recorder (MAPR) have been used during geo-physical surveys along more than 1100 kilometres of the Gakkel Ridge from 8°W to 85°E, which recorded temperature and light scattering (indicative of suspended particulate material) with depth. Optical back scatter is the primary tool by which hydrothermal plumes are detected with the help of MAPR light scattering sensors, because temperature signals are generally extremely small and more rapidly dissipated. Increased optical back scatter results from the presence of suspended particles formed by the oxidation of hydrothermal iron and manganese on mixing with sea water.⁵

The character of MAPR profiles can be used to locate the proximity to the source of hydrothermal activity. Temperature difference associated with hydrothermal plumes are generally small (less than 0.01°C) and only perceptible close to the site of venting. Both the amplitude and shape of light scattering peaks provide information on location. Larger signals and profiles with multiple peaks indicate close proximity to the source. More than a few kilometres away from the vent site, light-scattering peaks will be smaller and smoother in shape and temperature signal will be small if detectable.

While geochemical survey and mapping of the slow spreading Carlsberg Ridge with multibeam swath bathymetry, a kind of sonar that produces beautiful high-resolution images of the sea floor topography, plume sensor (MAPRs) were attached to the dredge, just in case, to pick up any hints of a plume from a submarine eruption. The sensors had detected, in the chemistry of the water, evidence for a recent under water explosion. Further laboratory tests showed that they had not come across just any hydrothermal plume. It was an

“event plume”, meaning it came from a single under water eruption.⁵

From an “event plume”, the smoke is like a wild fire, whereas from a vent field, the smoke is like from a candle. The newly discovered one is turned out to be the most energetic and biggest event plume ever seen, 7 to 20 times larger than previously recorded. It had risen 1400 metres above the sea floor, measured one kilometre wide and was drifting for 70 kilometres along the ridge. Twenty million cubic metres of lava would be needed to create the heat to drive such plume. Clearly it came from a major volcanic eruption.

ECOLOGY OF HYDROTHERMAL VENTS

While investigating into the ecology of animals living in deep-water hydrothermal vents, the crab *Xenograpsus testudinatus* have been found to live at enormously high densities around the sulphur-rich hydrothermal vents in shallow water, at depth less than 200 metres, off Taiwan, even though this acidic environment (pH 1.75-4.60) is low in nutrients. Thousands of *Xenograpsus* crabs swarm out of their crevices at slack water, when currents are weak or absent and feed frantically on the sea floor over an area of few square metres, on the vast quantity of zooplankton that are killed by the vent's sulphurous plumes, and rain down like marine “snow”. These opportunistic feeding behaviour explains how the crabs are able to survive in the adverse toxic environment of these shallow hydrothermal vents.

When the water currents are weak or absent, the vent plumes are directed vertically, instantly killing any organism in their path and causing it to drop straight down the water column. This mass descending zooplankton has the appearance of falling snow. Dead fish and fine particulate matter also gradually precipitate around the vent.

When the currents increase, and the deadly plumes alter the course, the dropping of dead zooplankton ceases and the crabs return to their

crevices. As tides in Taiwan are semi-diurnal, crab feeding runs takes place twice daily. The crabs time their foraging to coincide with these marine snow falls to maximize their efficiency in harvesting the plankton kill. This opportunistic feeding behaviour by *Xenograpsus* crabs, has not been seen in any other hydrothermal organism, represents a remarkable adaptation to their nutrient poor environment.

The shallow-water vents off Kueishan Island (121°57'E, 24°50'N) in northeastern Taiwan, erupt sulphurous plumes and bubbles of gas, mainly carbon-di-oxide, nitrogen, oxygen, sulphur dioxide and hydrogen sulphide through large smokers (2-6 m in height) at 65°-116°C where only two species of brachyuran crab, *Xnovaeinsularis* and *X testudinatus* have been found to live.⁶

High sulphide concentrations are normally important for forming a chemolithotrophic food-web, and the growth of sulphur dependent bacterial mats. But in Kueishan Island, these food sources are not found. Instead these shallow water vents discharges high concentrations of elemental sulphur (99.5% purity) and toxic volcanic gases. As a result the habitat is species-poor, compared with the species rich communities associated with deep water vents. Shallow water vents are low in animal diversity.⁶

As regards the ecology of *Xenograpsus* crabs, the species *X novaeinsularis* has been observed feeding on the ocean floor using its setae-tipped pincers, but its diet is not known. At Kueishan, *X testudinatus* have been found to congregate in large numbers in vent crevices (average density of 364 crabs per square metre). The question arises as to how this sulphur rich acidic ecosystem support such a substantial crab population and what are the crabs feeding on? Dissection of *Xenograpsus* specimens revealed that their guts were full of zooplankton mainly, pelagic copepods. Studies of their mouth parts and gastic mill confirm that the species is a scavenger.

FAUNAL DIVERSITY

More than four hundred new species have so far been found at vent sites, informing the discovery of one new species every two weeks, on average, throughout the past thirty years. These organisms range from anaerobic microbes to the spectacular red-plumed tube worms *Riftia pachyptila*, which can reach several metres in length.² In between, organisms like blind shrimps of the Mid-Atlantic Ridge, now also known to be present in the Indian Ocean. They are only a few centimetres long, but swarm in millions around individual vent sites. Hydrothermal vent microbes seem to sit at the very base of the tree of the life and provide insights into the origins of life on Earth.

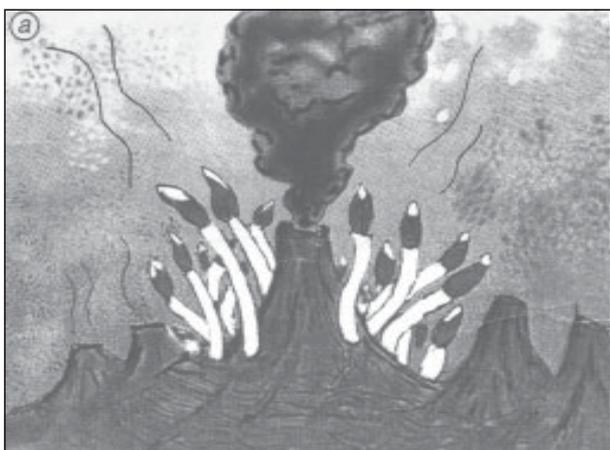


Figure. Deep-sea vent tube worms, *Riftia pachyptila*, growing in the vicinity of deep-sea hydrothermal vent. (Source-R. Maheshwary, Current Science ; 92(7), 2007)

Hydrothermal fauna, thriving in extreme conditions of temperature, pressure, pH and salinity, show us the limits to life on Earth. A typical hydrothermal vent may emit fluids that are not only too hot. (350°C or more), but also acidic (pH 3-4) and highly toxic with high concentrations of dissolved hydrogen sulphide and heavy metals, such as, cadmium, arsenic, lead. Life on our planet has adapted to almost the entire range of physico chemical variables observed at least on Earth's outermost shell. Even quite conservative estimates

suggest that the inclusion of all the microbes that are thought to be present beneath seafloor hydrothermal systems could double the estimates of the total biomass on Earth.

During volcanic eruption on the sea floor, huge quantities of these micro organisms, together with life-sustaining chemical nutrients, are released into the overlying water column. Deep-ocean currents propel these materials along the ridge crest. Taken together these findings suggest that there is a corridor of high productivity water, a few tens of kilometres wide and less than 500 metres from top to bottom that makes its way through the deep ocean, allowing rapid colonization of new vent sites.

Eyeless rift shrimp called *Rimicaris exoculata*, residing at the vents of Atlantic, have been found to possess two reflective patches running down their backs. The patches, which had never been noticed before looked like some kind of sensor. It is thought that they might be highly modified eyes for sensing light. But the question arose why would a shrimp in the lightless depths need eyes?⁷

Using a sensitive camera, designed for astronomical imaging, for vent mapping expedition, to take picture of the seemingly pitch black chimneys, the explorer found the vents to glow. Marshalling of the evidence convinced the biologists that the shrimps use their eyes (reflective patches) to keep them close enough to the vents to feed on bacteria, but far enough to prevent them being cooked by the ferocious heat.

Scientists found photosynthetic bacteria living in the black depths. If further research shows that the creatures live by the vents all the time and do not visit from brighter areas, then these bacteria would be the first organisms ever found to photosynthesize without sun light.

Five hundred metres below the surface, the warm water flowing from hydrothermal vents in the ice cold waters of the Arctic Ocean, iron

oxidizing bacteria (*Gallionella ferruginea*) cover the sea floor over kilometres. Within this region, short mineralized chimneys sprout up, each around 15 centimetres high and often topped with delicate sea lilies (*Heliopecten glacialis*) that make them look like oasis in the desert.

Using temperature sensor in this site, along Mohns Ridge, where tectonic plates are spreading at a rate of about 16 mm per year, it was discovered that the chimneys bathed the sea lilies with a flow of fluids at 0.5°C, warm for Arctic Ocean, the background temperature of the site being -0.3°C.

On the most southerly vent field at 9°33'S, very young and small mussels have been found to dominate the ecosystem.

For upto 200 metres around the vents, in northern Icelandic fjord, microbes coat the sediment and corals with a red and green biofilm. These organisms seem to be able to survive the contamination by catalysing the reverse chemical reaction, oxidizing arsenic (iii) back into less soluble arsenic (v).

Galapagos chimneys (six black smoker chimneys 12 to 14 metres high) like islands themselves are home to unique animal species. Or it may be that the chimneys provide a high way for animals exploiting the special conditions the vents create. Larvae could drift in the vent plume from chimney to chimney up and down the mid ocean ridge.⁴ Animals could be seen in the area. Further exploration, collection of the organisms and genetic testing will tell if they are new species.

Hydrothermal vents along mid-ocean ridges host short lived ecosystems of diverse endemic fauna including several crustacean species, some of which undergo planktonic development as larvae upto 1000 metre above and 100 kilometres away from the vents.

METAMORPHOSIS AND ADAPTATION FOR VENT LIFE

Along the mid-ocean ridges of the Atlantic and Pacific are hydrothermal vents (volcanic) from which water emerges at temperature upto 350°C, more than three times the boiling point at the surface. This exorbitant heat and the minerals that emerge with the water supports a diverse fauna, including a number of crustaceans with very unusual eyes.

The shrimp *Rimicaris exoculata* was the first vent crustacean found with unusual eyes. In the creature, the optics of the compound eye, which allow images to be resolved have disappeared and been replaced by an extended naked retina much larger than the eyes of related species.^{7,8}

Adult species of vent dwelling crabs, *Bathogrea thermodyron* also have naked retinal structures similar to those of *Rimicaris*. The early "zoea" larvae of the crab, which live not in vents, but as deep sea plankton, have normal apposition compound eyes. These eyes progressively lose their optics during development and turn into the naked, rather, amorphous, retina of the adult.

The pigments in the eye that respond to light also change. They are maximally sensitive to blue light (477 nm) in the planktonic zoea larvae to blue-green light (479 nm) in the later megalopa larvae, which already inhabit vents and finally to longer wave length blue-green light (489 nm) in the adult eye.⁸

It was originally thought that there was just enough short-wave length energy in the black-body radiation from the vent water itself to provide a few photons that would allow a green sensitive pigment to detect something. But more recent measurements suggests that there is still more light in the visible range. Sulphide oxidation can cause chemiluminescence in the visible range and there are several other more exotic physical phenomena that might also contribute. Whatever may be the

origin of vent light, however, it seems that there is enough for rudimentary vision with a non-resolving retinal structure.

A bare retina cannot determine the direction of light in front of animal or behind it. The gain in abandoning the machinery of resolution is sensitivity.

The amount of light available to a detector from a given source of light is proportional to the area of aperture of the detector and the size of the cone (solid angle) over which light is received. In a shore crab, the area of aperture of each eye facet is about 0.001 mm² and the solid angle over which the receptors accept light is about 3 square degrees. For adult *Bythograea* if the whole eye is viewed as a single detector, the aperture area is about 1 mm² and the acceptance cone is a hemisphere (20.626 square degrees). The overall sensitivity ratio between the naked retina and the proper eye is about 7 million to 1.

Naked retinas are not confined to vent animals. The benthic fish, *Ipnops murrayi* has the surface of its flattened snout covered in naked retinas, and many crustaceans from deep water seem to have converged on the same drastic strategy for finding the vague direction of very dim light. In *Bythograea* such eyes (naked retina) are not degenerate, but are well adapted to the prevailing light condition.

Successive metamorphosis of eye anatomy and photo pigment context of the Pacific vent crab, *Bythograea thermydron* have been observed in adaptation to the demands of transition from a larval habitat in the deep sea plankton to the bathy pelagic vent environment.⁹ Eyes of crab larvae (zoea) contain a short-wave length photo pigment that is well matched to the dim blue light of mesopelagic waters. Descent towards the depth at which vents occur and where crab settles (2500 metres) includes entry into the aphotic zone, where solar photon fluxes at visible wave lengths are insufficient to support vision. So vision in the

megalopa larvae, most sensitive in the blue-green wave lengths is an adaptation to detect bioluminescence in deeper bathy pelagic waters. Near the bottom, hydrothermal vents generate light in the near-infrared and visible portions of the spectrum. Sulphide oxidation at the vents generate chemiluminescence at visible wave lengths between 380 and 620 nm. Crystalloluminescence, triboluminescence and sonoluminescence in the vent effluents contribute to the visible light. The naked-retina eyes of the first juvenile crab are well suited to serve as photon gradient detectors, supplementing chemical and thermal senses for proper orientation towards the vents during settlement and assisting in the selection of an appropriate habitat for juvenile life. Eyes of third stage juvenile crabs are similarly adapted to detect dim light. Negative phototaxis to the vent light in settled crabs would prevent them from scalded while foraging dangerously close to localized venting.

Adult *B. thermydron* live for more than 10 years with an adult intermoult duration 3-4 years. As related shallow-water brachyuran crabs do not under go visual metamorphosis, the metamorphosis of the eyes of *B. thermydron* appears to be a specific adaptation for life at the vents.

CONCLUSION

Considering the size of the ocean and their hidden treasures there are many surprises left for us.

Explorations from the relatively well characterized vents on the Mid-Atlantic Ridge, to the rarely visited depths of the Indian Oceans and seas around Fiji and Easter Island result in startling new insights into the vent creatures.

These creatures thrive in a peculiar environment that at first glance, seems hostile to life. They live along cracks in sea floor where water, super heated by volcanic activity, gushes out of towering

chimneys. These hydrothermal vents are home to communities of fantastic organisms ranging from mats of bacteria living off sulphides to long pale, red-tipped tubeworms that sway in the current.

Understanding the diversity and distribution of fauna at these different vent sites, together with evolution of hydrothermal systems (physically and chemically) over years and decades are one of the main fields of modern hydrothermal research. The way forward is in developing deep sea observatories for long term interactive investigation using internet connections with fibre optic cables and global satellite communications for providing a glimpse of deep-sea environment remotely but in real time.

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DO YOU KNOW ?

- Q3. Which is the only Sino-Tibetan Script that is found in the Indian Currency note ?
- Q4. What is Pandiculation ?

SCIENTIFIC RESEARCH AND VALUES

P. K. Nagar* and Shipra Nagar**

In this article different motives that exist behind scientific research are dealt with. Authors tell about the integrity, objectivity and ethical values of scientific pursuit.

Science proceeds through individual scientists who express values of their culture and tradition when they engage in scientific research. Values that promote the ultimate goal of acquiring reliable knowledge imply a certain set of characteristically scientific actions, but the relevance of other values in the practice of science are thereby not eclipsed. Science is shared knowledge based on common understanding of some aspects of physical or social work. For this, the social conventions of science play an important role in establishing the reliability of scientific knowledge. If these conventions are broken, then the quality of science suffers. Einstein¹ described three sorts of motives behind scientific research namely, enjoyment of intellectual power, satisfaction of practical purposes and a sort of religious following. Many of our institutions have different characters with different goals, which imply that science, cannot be truly objective. The people who perform research have different values and they will inevitably select research areas which agree with their values. This may impart biases on the scope and possible results of their research.

Values intersect with science in three ways. The first relates to epistemic values which guide scientific research itself. Secondly, the scientific enterprise is always embedded in some particular culture and values enter science through its individual practitioners. Thirdly, values emerge from science, both as product and process and get distributed in the culture of a society. The pursuit of science as an activity is itself an implicit

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endorsement of the values of the developing knowledge of the world. Most nations have adopted many values with benefits. Creators of new knowledge should be provided the atmosphere of the universities, unfortunately, in many of our scientific organizations, superior personnel, undermine the morale of those in the universities from where most of us have come. Here begins the erosion of our ethical, moral and traditional values.

A scientist has to promote integrity, objectivity and ethical values² in the pursuit of science. The disproportionate assets of scientific knowledge³, scientific fraud, abuse of power, grabbing of other's work by bosses in institutions⁴ are spreading like cancer and we must devise strong measures to curb these or else, our youths will revolt. It has been correctly pointed out⁵ that our scientific community is vulnerable more so when heads indulge in unethical questionable practices hence, such scientists and "big bosses" should be exposed at all platforms. "Big Science" atmosphere has gripped many Indian scientists who think doing research with small funds is below their dignity. Now, it is fashionable to have a big empire of a research team that does the work while the leader goes all over the world. This big team concept is a real departure from values. At present, the hallmark of a successful scientist, in the minds of society, is the number of times he visits abroad either in attending conferences as a delegate or panel member. The thing in fashion is the so-called keynote address and being invited to chair a session. The best work is still done by one or two people working together with some help from post-doctoral fellows.

In recent years, the allocation of credit has become a burning issue in the listing of authors.

Science has become a much more collaborative enterprise than in the past⁶. Several considerations must be weighed in determining the proper criteria for authorship between a student, research assistant and a senior scientist. Although guidelines are available for medical sciences since the last two decades⁷, but for agricultural and basic sciences these are not available. In most of the Indian universities and institutions, research supervisors/guides largely govern and dictate self-made rules for determining the authorship and the sequence of names. The research student is generally at the mercy of the guide and he has to obey the rules imposed by the guide, especially at the time of thesis submission. Often a name is included in the list of authors though the person has little or nothing to do with the concept of work. Such ‘honorary’/‘courtesy’ authors, are often the bosses or pseudoguides, dilute the credit of the work for the people who actually did the real bench work. As correctly pointed out⁸ the issue of authorship should be handled by the senior scientists/guides/supervisors professionally, since they have already made their career, rather than emotionally or egoistically which is important in making or breaking the career of the research scholars. Further, they should see themselves that nothing undue is given to anybody and who have really conceptualized the problem are not neglected. The fact that irrelevance and mediocrity that so commonly characterize Indian scientific community arise out of lack of accountability. Beyond a point, mediocrity completely overshadows the few bright ‘spots’ here and there. It is also common knowledge that mediocrity manages to dominate and this is often achieved by eliminating better quality of scientific endeavours universities and national institutes. One essential condition in accountability is that everybody in the system should know as precisely as possible what is expected of him and what he expects of himself.

Indian scientific society unfortunately has become either highly individualistic or sycophancy-

oriented. Therefore, a real group activity wherein a leader is recognized through his work, an ability to plan, interpret and communicate, does not develop easily. It has often been said that in India, an appropriate peer review system does not exist in the sphere of science and technology. If the system fails, it is because of the failure of ‘peers’ who either do not rise to the level of competence or impartiality. There is always an important aspect of Indian attitude which often, if not always, prevents operation of impartial peer review system. The ‘peers’ in their judgment first realize and conclude that the achievements in the thesis/project are poor, and hence it should be rejected or closed. No sooner this decision is taken, their is concern expressed science managers that it would be a harsh decision. The problem is that there is clearly the capability to take right decisions, but at the final stage an individual emerges as a more important entity than the system or science resulting in mediocrity to dominate and science suffers. One must carefully analyze the way research institutions are run nowadays. Hierarchy is unavoidable in any organization. However, it is perhaps much stronger and much fossilized than necessary in many of the research laboratories. A degree of democratization in functioning would enhance the sense of participation and purpose among younger and junior scientists. Perhaps representatives of scientific community from every rank should formally constitute a body whom the head of the institution should meet at prescribed intervals to discuss all scientific problems in a cordial and friendly manner, rather than in a dictating manner. We must endeavour to create conditions under which a senior scientist is respected for his/her scientific worth and not for the administrative positions that he/she holds. In science and technology, excellence cannot be a parameter of quality and/or quantity viewed independently of the entire global standards. This attribute is neither static nor absolute. On the other hand, it is regularly evolving and exerting in the process an impact on mankind that brings about

newer heights and standards of living. As correctly pointed out⁹, science pursuit ought to be an honest occupation and the quality of students produced by the university systems affects scientific output. Further, as long as we do not make education and scientific research free from political and bureaucratic control, we will fail to realize the true potential of science in nation building.¹⁰

If we only generate a cultural value of reflecting on the methods we use in the pursuit and evaluation of science¹¹, one can overcome many of the shortcomings of the scientists' community. Values grow in good social soil and are not merely subjective in character but are means to introduce normative enquiry and to investigate consequences of actions with competence to address questions of conduct and character. They also provide a nexus between moral and intellectual development and also between knowledge and character. Thus it is clear that values cannot and should not be separated from science. The desire to do good science is

itself a human value and so is the conviction that standards of scientific honesty and objectivity need to be maintained at all costs.

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DO YOU KNOW ?

- Q5. We know that CTC stands for Calcutta Tram Company. However when it comes to CTC brand tea, what does the abbreviation mean ?
- Q6. All languages are written using a two dimensional script. Which language uses a three dimensional script ?
- Q7. For a good fit what is the best time to buy shoes, morning or evening ?
- Q8. Which mammals are colour blind ?

FORMABILITY OF STEEL SHEETS

B. Sarkar, B. K. Jha, S. K. Chaudhury

BASIC TECHNOLOGY

Sheet metal forming refers to the processes wherein metal sheets are formed in the cold condition into various kinds of shapes and products. Formability can be described as the ability of the sheet to be formed into useful shapes without excessive localised thinning. The formability of a given steel sheet is determined by a combination of several factors (both intrinsic and extrinsic in nature). The 'intrinsic' factors relate to the material characteristics like strain hardening index (n), plastic anisotropy ratio (r) and the strain rate sensitivity (m), while factors concerning forming technology like die design, lubrication and friction conditions, speed of forming, forming technique employed etc. are considered as 'extrinsic' issues.

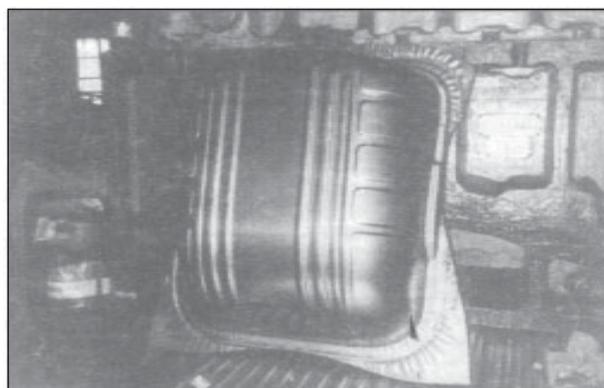
Factors Influencing Formability of Steel

The intrinsic factors that influence the formability of steel sheets are described below.

Chemical Composition

Steels intended for cold forming applications require lower levels of interstitial elements like carbon and nitrogen. Over the years, carbon content in formable steels has been brought down from a level of 0.05% in extra deep drawing (EDD) quality steel upto lower than 0.003% in case of interstitial free steel. Bake hardening steels have carbon content below 0.02%. Elemental nitrogen (free) is found

harmful for forming applications. Total nitrogen should be maintained as low as possible (–30 ppm). Substitutional elements like Mn, P and Si are also not desirable to be present beyond permissible limits of 0.15%, 0.015% and less than 0.02% respectively.



Inclusion Level

A low level of inclusion is desirable for attaining good formability property. Inclusion levels should be maintained at less than 0.1%. Apart from this, types of inclusions are also important. The presence of angular shaped alumina inclusions and stringer type MnS inclusions are particularly harmful, as these favour easy nucleation of crack during forming. Therefore, it is necessary to modify the shape of inclusions into globular form by addition of Ca and rare earth elements.

Microstructure

The formation of coarse ferrite grains (20-40 microns in size) is considered suitable for achieving better formability properties. However, very coarse grains give rise to surface defects during forming known as 'orange peeling'. Further, orientation of ferrite grains (texture) also plays an important role in determining formability properties.

* Steel Product 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.

Crystallographic Texture

In order to maximise drawing property of the sheet, the orientation of most of the ferrite grains should be such that their {111} planes lie along the rolling plane. Such type of favourable orientation is achievable only by careful chemistry and annealing practice.

Surface Texture

The other form of texture that influences the forming property is the nature of surface roughness. For forming operation, some extent of surface roughness (40-50 microns) is desirable. This can be achieved through temper rolling by optimising reduction in the range of 0.5-1.2%.

Sheet Thickness

The thickness of the sheet has profound influence on the formability of the sheet for a particular grade and microstructure. In general, the formability property improves with increasing sheet thickness.

Tensile Properties

The influence of intrinsic properties of sheet metal on formability can be described through detailed analysis of tensile properties like yield strength, yield point elongation, ratio of yield strength to tensile strength, uniform elongation, n , m and r . Improved formability can be ensured by achieving higher values of n , m and r .

Evaluation of Formability

Tensile Test

This is the most widely used test for the assessment of sheet metal formability. Tensile properties like n , m and r can be determined through this test. However, this test has its own limitations. Since formability must involve interaction between materials and tools, tensile test fails to yield information on the behaviour of sheet metals under forming conditions. Because of these reasons, other tests have become necessary.

Erichsen Cup Test

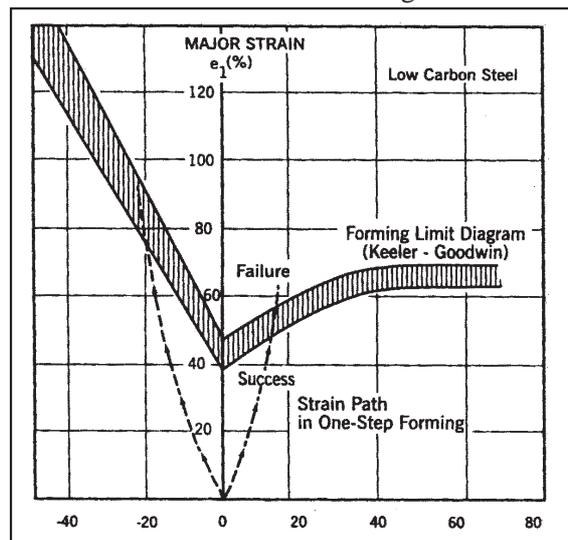
Erichsen test is the earliest form of punch stretching test wherein a 20 mm hemispherical punch is pushed into a rigidly clamped sheet metal specimen until fracture. In USA, it is also known as the Olsen test.

Fukui Test

This is a combined r and n test. Here, a circular blank is drawn with a hemispherical punch into a conical die. The conical cup value upto which a sheet can be successfully drawn is the criterion.

Forming Limit Diagram

Forming limit diagram is the most powerful tool to evaluate the formability of sheet steels. Generation of forming limit diagrams (FLD) involves stretching different width specimens over a rigid punch. By varying the specimen width, the lateral constraint can be varied to achieve failure in modes ranging from uniaxial tension through plane strain to balanced biaxial tension. A schematic forming limit diagram and strain path for low carbon steel has been shown in Fig. 1.



Forming Operations

Forming is a process of converting a flat metal sheet into a desired shape without fracture or excessive localised thinning. It is carried out in presses, where a piece of metal sheet (called blank)

is held on its edges by a blank holder ring and is deformed by means of a punch and die. The common types of forming operations are :

Bending : It is the most common type of deformation and is used in almost all forming operations. Two types of bends commonly employed are the V-bend/U-bend and the wiping bend.

Stretching : Stretching is the process of forming by the use of tensile forces over a tool. It is used to produce parts having large curvature.

Deep drawing : It is a forming process which involves shaping flat metal sheets into cup shaped articles by pressing a flat blank into a die with a punch. An optimum hold down pressure is required to prevent wrinkling.

Coining : In this process, the sheet metal is compressed between two die surfaces. It is extensively used for making coins and parts with similar surface features.

Implication of Forming Processes on Formability

Press performance of sheet metal is influenced by the choice of forming process and the technology of forming. Technology of forming encompasses speed of forming, type of lubricant used, the tolerance between die and punch, sheet holding pressure etc.

The stability of lubricant depends on the following characteristics :

- Viscosity
- Sulphur and chlorine
- Corrosion potential
- Emulsion stability
- Fatty compounds
- Hydrogen ion concentration (pH)

Table I shows the types of lubricants used for different forming applications.

TABLE I : LUBRICANTS USED FOR DIFFERENT FORMING APPLICATIONS

Forming Process	Lubricants Used
Blanking and piercing	Straight oil, compound oil, emulsions with sulphur, chlorine, fatty esters
Coining	Light oils with fatty or chlorine containing additives
Deep drawing	Compounds oils, emulsions or pastes with chlorinated compounds and fatty esters with additives. Soap based lubricants are also used.
Spinning	Water base emulsions and solutions containing chlorinated and sulphochlorinated additives
Roll forming	Water base emulsions and solutions to form both coated and bare steel. Solvent based fluids are preferred in case of galvanised steel.

Drawing load is a function of mean wall diameter, instantaneous outside radius of the flange, blank thickness, die radius, mean value of the flow stress of the blank material, coefficient of friction between the blank and the die and the blank holding pressure.

Stretching load depends only on the yield strength, the tensile strength and the cross-sectional area while the bending load depends on the length of the bend parallel to the bend axis, metal thickness, die opening factor, width of the die opening and the tensile strength of the metal.

DEVELOPMENTAL TRENDS

New Materials

The rapid expansion of the automobile industry has led to an intensive development of newer steels with better formability property. Examples are ultra low carbon (0.001% C) interstitial free (IF) steel and high strength IF steel.

New Methods of Testing

Laser ultrasonics is used as a non-contact technique to determine the crystallographic structure, the average plastic strain ratio and the thickness of steel.

Advanced Forming Technologies

Adoption of electro-magnetic forming, hydroforming and laser quench methods have resulted in significant improvement in formability of steel sheets.

Alternate Methods of Predicting FLDs

A model for predicting FLDs has been developed which can precisely predict the combined effect of

strain rate sensitivity, strain hardening and thickness on formability of sheets.

GLOSSARY

Strain Hardening Exponent (n) : This is the most important sheet metal property that influences its formability. It indicates the material's ability to distribute strain and is readily obtained from a tensile test.

Plastic Anisotropy Ratio (r) : This is an important parameter which indicates the ability of a sheet metal to resist thinning. It is defined as the ratio of width strain to thickness strain and can be determined by pulling a tensile specimen upto 15-20% strain. It can also be determined from the resonant frequency of the material.

Strain Rate Sensitivity (m) : This is a material property which influences the ability of the material to resist necking. This can be obtained from tensile tests conducted at two different strain rates.

{ Contributed by Sri B. Sarkar, PRM and Dr. B. K. Jha, AGM, Application Engineering Centre and Dr. S. K. Chaudhuri, GM, RDCIS Bokaro Centre }.

TYPICAL PROPERTIES OF FORMABLE QUALITY STEELS PRODUCED BY SAIL

Product	Specification	Grade	YS (Mpa)	UTS (MPa)	US/UTS	%Elongation
Hot Rolled	IS 10748 / 1995	I, II, III, IV, V	170-310	290-490	0.59-0.64	15-30
	IS 6240 / 1999	A, B	215-245	330-450	0.52-0.70	25
	E 34		333	372	0.90	27
	E 38		390	440	0.89	25
	BSK 46		460	550	0.84	20
	SAE 1020		310-320	440	0.70-0.73	15
Cold Rolled	IS 513 / 1994	D	250	270-410	0.61-0.93	23
		DD	250	270-310	0.81-0.93	26
		EDD	170-220	280-320	0.53-0.79	32
	SAILCOR		320	430	0.74	22
	HSCR	26	260	350	0.74	22-26
		35	350	430	0.81	

SHORT COMMUNICATION

WHY SAVE THE TIGER ?

D. Balasubramanian*

The tiger has always fascinated man. At once majestic and awe-inspiring, it has inspired both the noblest and the basest reactions in us. At the noblest end are the words of the poet William Blake who saw divinity in the burning eyes of the animal. At the worst must surely be the genocide of the tiger population, perpetrated over centuries by man in the form of game-hunting and poaching for non-existent aphrodisiacs in the body of the cat. In retrospect, one of the more chilling and revulsive chapters in the history of the Raj would be the elaborate tiger hunts that the white Sahebs went on and the hunting parties arranged for the representatives of the Raj by the rural rajas, mostly in efforts to curry favours.

Rudyard Kipling could not bring himself to appreciate or enjoy such killings. One sees more Blake than Bacchus in his description of Sher Khan, Hathi, Baloo and Mowgli. And Colonel Jim Corbett, who wrote *Man-Eaters of Kumaon*, had this to say :

There is however one point on which I am convinced that all sportsmen will agree with me, and that is, that a tiger is a large-hearted gentleman with boundless courage and that when he is exterminated—as exterminated he will be unless public opinion rallies to his support—India will be the poorer by having lost the finest of her fauna.

And,

The author who first used the words ‘as cruel as

a tiger’ and ‘as bloodthirsty as a tiger’...not only showed a lamentable ignorance of the animal he defamed but coined phrases which ... are mainly responsible for the wrong opinion of tigers held by all except (those) who have had the opportunity of forming their own opinions.

As for their man-eating notoriety, Corbett points out that

...such a tiger has been compelled, through stress of circumstances beyond its control, to adopt a diet alien to it. The stress of circumstances, in nine cases out of ten, wounds and in the tenth case old age. The wound ... might be the result of a carelessly fired shot or the result of the tiger having lost his temper when killing a porcupine.

So much for the cruel and bloodthirsty tiger!

There is a real danger that in the next fifty years—when our great grandchildren celebrate the centenary of the publication of *Man-Eaters of Kumaon*—the tiger will have been extinct ; dead as a dodo, as the phrase goes. (The Dodo, it may be recalled, was a clumsy bird that could not fly, which inhabited the islands of Mauritius and Reunion once upon a time. It no longer does so, there or anywhere else, since it is now extinct). The total number of tigers present all over the globe today has been estimated to be between 7,000 to 8,000. There were probably ten times as many in India alone, just a century ago. In 1970, the total number of tigers in all of India was a pitifully small 1827. Thanks to Project Tiger, this has now risen to 4334 today, accounting for half the world's population of tigers.

* 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.

MAN-MADE CATASTROPHE

As mankind grows in numbers and uses more and more of the earth for our activities, we face such dilemmas about conserving other species and life forms that cohabit the earth with us. Man keeps expanding his own territory of activities and habitat, in competition with those of other species on earth. This causes the depletion or destruction of the natural habitat of the other species. Indeed, it is worth remembering, as Harold Morowitz reminds us in one of the August 1991 issue of *Science*, that the coming to fruition of *homo sapiens* with its capacity for reflective thought, is a biological event of catastrophic impact on local and global ecosystems. The invention and spread of agriculture 10,000 years ago was an event of great dimensions. With farming, man converted large areas of forests, savannahs and plains into fields and pastures. This “humanization of the earth” caused the loss and perhaps even the extinction of hundreds of plant species and certainly as many, if not more, insect species. Morowitz says.

As the Irish potato famine and the desertification of Sahal show, agricultural practices may also have devastation social and economic consequences. Humans, because of their engineering abilities, create another geosphere, namely the technosphere.

With increasing human population, the amount of unexploited lands and weaters will dwindle. Agriculture is necessarily a monoculture. Thus, the diverse varieties of plant and animal species will dwindle too. So biodiversity decreases as human population increases.

WHY PRESERVE BIODIVERSITY ?

The loss of biodiversity should be of concern for three basic reasons. Drs. Paul Ehrlich of Stanford University and Edward O Wilson of Harvard University have listed these in a comprehensive

review in the same issue of *Science*. The first reason is ethical and aesthetic. As humans who rule this earth, it is our moral responsibility to protect what are our only known living companions in the universe. Throughout history, many a society has realized this and even written this up in their books and parables. The underlying thought is as noble as it is practical. The aesthetic justification is even easier, since we like to preserve what we find beautiful, and pass it on to our children. Such aesthetics takes on many forms. It could be sheer enjoyment of beauty as with the polar bear, the peacock's feathers, the adorable panda, the majestic tiger or the culturally important American bald eagle. You cannot put a price tag on these ; they are beyond practical considerations.

The second reason is utilitarian. Tall, wild grass might not be aesthetically pleasing but it is out of such grasses that wheat, rice and corn were domesticated and cultivated by man for his food. Agriculture, medicine, textiles and housing are direct results of such borrowing from the vast storehouse of nature. A quarter of all medicines used by man come from plants and microbes. But for the lowly *rhizobium*, the global nitrogen balance would be upset. Only 7,000 plant species have so far been estimated to be used by man, out of the lakhs that abound on earth. Biodiversity is thus a precious genetic library, of which we know only a few items on the shelves.

The third reason is the networking role that diverse species play in constitution and maintaining an ecosystem. The generation and maintenance of soils, the atmosphere, the rain forests, the sunderbans, the coral reefs—each one of which is a natural ecosystem—depends on the interplay of a whole diversity of organisms and species whose actual number defies enumeration. As has often been said, the prime rule of ecology is : “Everything depends on everything else”.

In a complex situation of this nature, it is difficult to pinpoint the role and the value of each species. It is ideal to hold that each one of them is valuable and useful and hence to also hold that no species should be wiped out. This ideal position is usually attenuated or “pragmatized” by the realization that human activity, by its very nature, reduces biodiversity. Michael Soule lists seven sources of biotic degradation—all from human activities. (1) Population pressures, poverty and hungry (leading to deforestation, trade in rhino horns or ivory), (2) short term gains and denial of long-term failures (teakwood and sandalwood trading, strip-mining), (3) anthropocentrism (not supporting non-utilitarian causes—who cares if the tigers are gone?), (4) economic pressures on a community (cash-cropping of coffee or cocoa leading to loss of tropical forests), and (5) policy factors (civil wars, corruption, breakdown of law and order).

THE EIGHT-FOLD PATH

Soule also describes what he terms as the eight paths that should be used to “protect living nature from humanity”. Rather than focus on one or two ways, it is best to utilize all the eight routes, choosing the right mode to suit the right situation. These are : (a) *in situ* preservation, in the form of wildlife areas, biosphere reserve and the like—as with the Silent Valley of the Kerala region, or the Bandipur sanctuary and Corbett National Park ; (b) *inter situ*, in the form of conservation systems where native species still exist—as in the case of Ladakh, Lahaul and Spiti, which are rocky and non-arable but where local habitats are unique ; (c) sustainable reserves such as rubber plantation, tea estates and groves ; (d) ecological restoration projects, where a degraded habitat is allowed time to restore itself and enrich the native species ; (e) sanctuaries for sensitive species of diverse nature—as in the case of Bharatpur, Ranthambore

or several parks in the Himalayan Terai ; (f) agroforestry schemes which are efficiently managed and oriented towards production ; (g) *ex situ* living, where animals are placed, nurtured and propagated as with pandas or white tigers in zoos, and botanical gardens that serve a similar purpose for plants ; and (h) *suspended ex situ*, meaning artificial programmes such as germ-plasm banks, tissue culture collections, seed storage facilities and freezing embryos, eggs and tissues in liquid nitrogen so as to revive them later.

Indeed, the last mode has been most persuasively argued by a physicist named Gregory Benford, who advocates it in the November 1992 issue of the *PNAS, USA*.

Our situation resembles a browser in the ancient library at Alexandria who suddenly notes that the trove he had begun inspecting has caught fire. What to do ? There is no time to patrol the aisles, discerningly plucking forth a treatise of Aristotle or deciding whether to leave behind Alexander the Great's laundry list. Instead, a better strategy is to run through the remaining library, tossing texts into a basket at random, sampling each section to give a broad coverage.

In this sense, it would be best to take a systematic sampling with long-term storage by freezing. Teams trained to simply collect, without analyzing, require minimal labour by research biologists. Freezing at the site can be done with ordinary ice or dry ice ; liquid nitrogen can be used only as a long-term repository. The idea is to pass on to later generations the immense biodiversity that exists now.

The best strategy would be to preserve some fraction of each ecosystem, and to freeze as many as possible. Dr Benford has also worked out the economics of it and finds that it might cost several million dollars per year. But then, as he says, the task is monumental and so are the potential benefits.

As for what the future generations will do with this repository, it is best to take the viewpoint.

As saviours of the Library of Life we are at best marginally literate, hoping that our children will be better readers and wiser ones.

Many techniques and methods will emerge with the next a few decades in a most unexpected fashion. We already know that such techniques have emerged in the last five years, for example

the method of amplifying large amounts of DNA from miniscule amount called the PCR method. I conclude with his final sentences :

Such measures should be debated, not merely by biologists, but by the entire scientific community and beyond, because all our children will be affected. These are the crucial years for us to act, as the Library of Life burns furiously around us, throughout the world.

• Science of Asian Monsoon •

By Dr M. J. Varkey

ISBN 81-7525-762-8

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Conferences / Meetings / Symposia / Seminars

Thirteenth International Workshop on Quantum Systems in Chemistry and Physics (QSCP-XIII), July 6-12, 2008, Lansing, Michigan, USA.

This workshop, like the previous ones will bring together chemists and physicists interested in Quantum systems in molecular, nano and material sciences. The emphasis will be on many-body methods, innovative theory, computational realization and applications. The workshop will include sessions on :

- A. Concepts and new methods in Quantum Chemistry
- B. Molecular Structure and Spectroscopy
- C. Atoms and Molecules in strong Electric and Magnetic Fields
- D. Condensed Matter, Complexes and Clusters, Surfaces and Interfaces
- E. Molecular and Nano-Materials and Electronics
- F. Reactive Collisions and chemical reactions
- G. Computational Chemistry, Physics and Biology

Contact : E-mail—qscp 13-. -chemistry.msu.edu and website-www.chemistry.msu.edu/qscp13

Fifth Biennial Conference of The Indian Society for Ecological Economics (INSEE), January 21-23, 2009 in Ahmedabad, Gujarat.

The main theme of the Conference is Environmental Governance. The Conference is aimed at professional strengthening of the emerging interdisciplinary areas of ecological economics and expansion of its use in research, teaching and policy making. Participation of professionals from diverse disciplines in natural sciences, engineering, law and social sciences is encouraged.

- A. Emerging Concepts and applications of interdisciplinary knowledge involving ecology and economics.
- B. Regulatory institutions, regulatory failures, pollution control boards, EIA debate etc.
- C. Institution for natural resources management and needs for innovation
- D. Markets and Environmental governance, carbon credit, etc.
- E. Information, knowledge and IPR regimes for environmental governance
- F. Gender issues in environmental governance
- G. Law, judiciary and environmental governance
- H. Global environmental governance—climate change, WTO, etc.
- I. Alternate frameworks for environmental governance-Green Parties, Green consumerism etc.

Contact : Sri Sushil Kumar Sen, C/O Institute of Economic Growth, University of Delhi Enclave, (North Campus), Delhi-110007, Fax : 011-27667410

S & T ACROSS THE WORLD

ASTEROID RACES TOWARDS MARS

Astronomers have discovered a 164 ft wide chunk of space rock hurtling towards Mars having a 1 in 75 chance of striking the Red Planet sometime this month, and releasing 3 megatons of energy at the point of impact. The asteroid which has changed its course now will not hit Mars in all probability.

If the strike is made, it will present a spectacular sight for space watchers, though the event itself has plenty of precedents. Indeed, the craters that pock the surface of Mars, Mercury, the Moon and other solar system bodies come from just such collisions since the last four billion years or so and our planet Earth too has evidence of several such collisions although erosion, continental drift, and vegetation have erased most of them.

One such collision which is still very visible is the Meteor Crater in Arizona, USA which blasted out some 50,000 years ago by a hurtling meteorite. In 1994, the comet Shoemaker-Levy 9 crashed into the planet Jupiter and broke up while still in orbit, enabling astronomers to watch nearly two dozen individual parts. However, as Jupiter is made mostly of thick clouds, there was no lasting scar, and because it is located so far away from Earth the event was not quite as spectacular as this one had promised to be.

(www.time.com, Dec 27, 2007)

GIANT CLOUD OF ANTIMATTER

A giant cloud of antimatter, roughly 10,000 light years across which generates the energy of 10,000 Suns located on the western side of the galactic centre of our Milky Way galaxy, was discovered by astronomers in the 1970s.

The origin of this antimatter which was a vexing

mystery has now been raced through satellites to binary stars that contain black holes or neutron stars, which are churning out at least half the antimatter or perhaps all of it.

(NASA, Jan 9, 2008)

NANOIMAGING PINPOINTS CATARACT

Atomic force microscopy has been used for the first time to study the membranes of cells in a patient's eye cataract to determine the cause of the disease.

The eye's lens focuses light and forms a sharp image on the retina, thanks to the organisation and specific properties of its constituent cells. As in all tissues, cellular exchanges are essential for nutrition and removal of waste products but in the eye they must none-the-less be adapted to the particular properties of the lens. The membranes of lens cells contain protein assemblies, the aquaporins and connexons : the former act as water channels and the latter as channels for metabolites and ions. Together these membrane proteins ensure cell adhesion.

Using atomic force microscopy, which images the surface of a sample with the precision of one nanometer, the researchers are studying how these protein assemblies actually function. An atomically sharp tip is scanned over the sample surface and its movements are tracked by a laser. The resulting data can be used to draw a topographical map of the sample. By comparing assemblies of aquaporins and connexons in membranes of healthy and diseased lens cells, the researchers have identified the biological changes that cause cataracts.

(www.nano werk.com, Oct 22, 2007)

CARBON REDUCTION IN NEW BUILDINGS

A BRE report released recently confirms that it is possible to reduce carbon emissions from energy use down to zero in the majority of new non-

domestic buildings as long as onsite, nearsite and offsite renewable solutions are employed.

The report goes on to say that there is a cost associated with building to zero carbon. The cost would vary widely both in form and in the use of the building. However, preliminary modelling suggests that the premium could range from over 30% down to as low as 5 to 10% of baseline costs.

The report points out that a challenging yet

achievable timeframe for achieving zero carbon in new non-domestic buildings along the lines set for housing is needed. With a trajectory similar to that adopted for the Code for Sustainable Homes, a deadline of 2020 could be adopted.

The report has been widely welcomed and the BRE has pledged itself to fully participate in the efforts to implement its recommendations.

(BRE, Dec 21, 2007)

ANSWERS TO "DO YOU KNOW ?"

- A1. The Aircraft that dropped the first atom bomb-the one on Hiroshima on August 06, 1945 that killed 1,40,000 people.
- A2. Girl twins are more common because they survive the tough condition in a shared womb better.
- A3. Manipuri.
- A4. The stretching of body while yawning.
- A5. CTC-Crushed, Tear and Curi Tea.
- A6. The Braille for the blind.
- A7. Evening, because the footsize grows to maximum till then.
- A8. All mammals, except monkeys and apes.



भारतीय विज्ञान कांग्रेस संस्था

14, ड० विरेश गुहा स्ट्रीट, कोलकाता 700 017, भारत

THE INDIAN SCIENCE CONGRESS ASSOCIATION

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

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Website : <http://sciencecongress.nic.in>

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iscacal_2004@yahoo.com

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.

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-
- 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.)



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E-mail : iscal@vsnl.net

Website : <http://sciencecongress.nic.in>

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

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YOUNG SCIENTISTS AWARD PROGRAMME : 2008-2009

To encourage Young Scientists, The Indian Science Congress Association has introduced a number of awards in different disciplines in January 1981. These awards carry a sum of Rs. 25,000/- besides a Certificate of merit. There are 14 awards, one to be given in each Section.

1. Applications or nominations are invited from members (Life & Ordinary) of the Association who had paid their subscription **on or before May 31, 2008**. The upper age limit of the candidates for the award is 32 years as reckoned on December 31, 2007 (only those born on or after January 1, 1976 are eligible).
2. Four copies of full paper along with four copies of the abstract (not exceeding 100 words) shall have to reach the office of the General Secretary (Hqrs.) not later than May 31, 2008. At the top of each copy of the paper and its abstract, the name of the Section where the paper is to be presented should be indicated. The Sections are : (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 Sciences & Technology (including Computer Sciences) (9) Materials Science (10) Mathematical Sciences (including Statistics) (11) Medical Sciences (including Physiology) (12) New Biology (including Biochemistry, Biophysics and Molecular Biology and Biotechnology) (13) Physical Sciences and (14) Plant Sciences.
3. Four copies of the bio-data of the candidate including full name and address (with Phone, Fax and E-mail) along with the date of birth (duly supported by an attested copy of the certificate), research experience and membership number etc., should be appended to the full paper.
4. Work should have been carried out in India and this has to be certified by the Head of the Institution from where the candidate is applying.
5. The candidate should give an undertaking that the work which is being submitted has not been presented in any other Conference/Seminar/Symposium for consideration of any award.
6. In case of a paper by more than one authors, the candidate (young scientist) has to be acknowledged by the other author(s) (in terms of a certificate) as having made the major contribution. A Young Scientist could present only one paper in any one Section (and not a second paper with the same or related work in any other Section).
7. Full paper will be assessed for their content and at the most **six** Young Scientists in each section will be invited to make oral presentation of their papers in October. The selected scientists will be provided admissible travelling and daily allowances by the ISCA.
8. The final selection for the awards will be done by a duly constituted committee and the awards will be given at *96th Indian Science Congress* to be held from January 3-7, 2009.
9. The last date for receiving papers is **31st May, 2008**.
10. *All correspondences should be made to : The General Secretary (Hqrs.), The Indian Science Congress Association, 14, Dr. Biresw Guha St., Kolkata-700017. Tel. Nos. (033) 2287-4530/2287-5323 Fax No. 91-33-2287-2551, E-mail : iscacal_2004@yahoo.com/iscacal@vsnl.net Website : <http://sciencecongress.org>.*

GUIDELINES FOR SUBMISSION OF MANUSCRIPTS

1. Everyman's Science intends to Propagate the *latest message of science* in all its varied branches to its readers and through them, to every one interested in Science or Engineering or Technology. *Research articles* usually meant for publication in periodicals devoted to particular branches of Science & Technology and addressed to specialised sections of the readers, are not appropriate for Everyman's Science. Instead, popular or easily intelligible expositions of new or recent developments in different branches of Science & Technology are welcome.

2. Manuscripts should be typewritten on one side of the paper with double spacing. Articles should be written generally in non-technical language and should not ordinarily *exceed 2000 words*. Articles must be understandable by the average enthusiastic readers with some modest scientific background but outside the field. It should not be a review article in a specialised area. Without being too technical, it must also reflect state of the art situation in the field. A *summary* in 50 words should be submitted along with the paper highlighting the importance of the work. *Two copies* of the manuscript complete in all respects should be submitted. The title should be written in capital letters and name(s) of the author(s) should be given along with the Department, Institution, City and Country of each author.

3. Illustration & Tables : The size of illustrations should be such as to permit reduction to about one-third. Legends and captions should be typed on a separate sheet of paper. Photographs should be on glossy paper with strong contrast in black and white. Typed tables should be in separate pages and provided with titles and their serial numbers. The exact position for the placement of the tables should be marked in the script. Authors are specially requested to reduce the number of tables, illustrations and diagrams to a minimum (maximum of 3)

4. References : References to be given on a selective basis, (maximum of 10) and the order of placement should be numerically with (a) name(s) of the author(s) (surname last), (b) name of the journal in abbreviated form according to the 'World list of Scientific Periodicals' and in italics, (c) volume number (in bold) (d) page number and (e) year of publication.

For citations of books the author's name should be followed by the (a) title of the book, (b) year of publication or edition or both, (c) page number, (d) name of publishers, and (e) place of publication.

5. The Indian Science Congress Association and the Editors of Everyman's Science assume no responsibility for statements and opinions advanced by the contributors to the journal.

Reprints : The communicating author will receive 1 copy of the journal and 10 reprints free of cost.

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