EVERYMAN'S SCIENCE

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COVER PHOTOGRAPHS ***(Left to Right)***

Past General Presidents of ISCA

1. **Dr. D. N. Wadia (1942, 1943)**
2. **Prof. S. N. Bose (1944)**
3. **Sir S. S. Bhatnagar (1945)**
4. **Prof. M. Afzal Husain (1946)**
5. **Pandit Jawaharlal Nehru (1947)**

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EDITORIAL

GUIDANCE FOR THE GUIDE

In most universities in India, members of the faculty can, if they so desire, guide researchers for the Ph.D. degree if they have Ph.D. degrees themselves and if there is a doctoral programme. Professors can also act as guides by virtue of the positions they hold even if they do not have Ph.D. degrees. While it is accepted widely that only those who have been good researchers themselves can be good guides, it is also true that not all good researchers make good guides. Moreover, not all Ph.D. degree holders can claim to have done good research. Today even school teachers need to undertake formal training to be good teachers. Should we then think of training programmes for potential guides before we allow some researchers to work under them ?

A proven method of training abroad is through post doctoral fellowships where fresh Ph.D.s help senior faculty members who guide doctoral candidates. This, however, is not the norm in India.

It is well known that good players do not necessarily make good captains or coaches. Ian Botham, a brilliant English cricketer, was a miserable failure as a captain. Yet he flourished under a mediocre cricketer Mike Brearly who proved to be an outstanding captain. The hockey wizard Dhyan Chand was unsuccessful when he tried coaching after his retirement. He was a genius and his talents were innate. Nobody taught him to be great and accordingly, he did not know how to turn a mediocre player into a great player. Similarly, even a great researcher can be a mediocre guide. A mediocre researcher, however, can seldom be a great guide.

If research guides were required to undergo training, then some of the things they will need to understand and appreciate will include the following :

- The research student is not a slave, not even an Assistant. He is actually a collaborator who may well have special skills the guide himself lacks.
- The scholar is not there to help the guide. He is there to shape his future and, therefore, his interests must receive the first priority.
- It follows that it is unethical to prolong their search for more publications for the guide even if the student is a co-author.
- The scholar must not be confined to a narrow area and must be given a wide horizon to enhance his growth. This is discussed in more detail later in this write-up.
- A scholar is always impressed by the intelligence, experience and reputation of his guide. Yet his true respect and love would be for one who is sympathetic, supportive and who is available when he is needed.
- The guide should not be a task master, he should command respect rather than fear.
- Guides who give appointments to scholars once in a while and/or operate through assistants are at best consultants who get away with something that is unethical.
- The good guide's role can never be restricted to research only and he has to be sensitive to the scholars emotions and personal problems.
- The scholar needs to be told that once he accepts a research problem suggested by the guide, the problem becomes his problem and he must assume responsibility about how to go about in studying it with or without the guide's help. The student must learn to think on his own.

● If a study comes to a point where it needs a relook—a bit of twist or even total abandonment—then the guide's role becomes critical.

Recently, the subject of a guide's role has been discussed in *Nature* in a feature article entitled "Nature's guide for mentors" (vol. 447, June 14, 2007, p. 791) and some of the views expressed in this article are included in the discussion that follows.

Essentially a research guide needs to be something or more than one who gets some research done and papers published for mutual benefit. He needs to be a Mentor. The word Mentor first appears in *Iliad*. When Ulyses went away to take part in the Trojan war, he arranged for a wise man named Mentor to take charge of his young son and bring him up to be a fine man. He knew that it could be years before he returned home. A good guide, if he is a mentor, will assume a similar role and help the researcher not only to get a degree within a reasonable period but also help him or her to get established in life too.

The journal has collected opinion of some 250 scientists, mostly mentees and some mentors, about what makes a mentor enviable. The collective opinion was something like this.

A mentor sees all his interactions with students as life long and, therefore, keeps in touch with his former students. He is passionate about science and passes on his passion into his students through infectious enthusiasm. His expectations from his students are set high to induce the students to exceed their own goals. Yet he must not create too much stress that breaks the students' spirits. He should avoid cynicisms and unnecessary adverse comments and should rather focus on appreciation.

A good supervisor needs to realize that while he himself grows older, the students do not. Therefore, a wise guide allows differences in perceptions and approach. Ideally, he should also change with the times and stay mentally young. When things go wrong, and there can be many reasons for this, the guide must assume responsibility to take necessary corrective actions. The students often need emotional support and often it is enough for the guide to be a good listener. Thus he needs to be available. A good supervisor knows that not all students are alike. Some may be good in mathematics while some others excel in experimentation, some are good in analyzing data and some are simply good integrators. A good guide encourages his students to excel in the area that suits him best.

Research work is not everything in life, neither for the students nor for the guide and, therefore, the student must be given his free space. The ultimate test of excellence, said the Persian poet Hafiz, is sacrifice. A good mentor sacrifices something for each student may be time, comfort or even credit for some work done.

Not all research students are angels and, of course, there are times when a guide has to stand firm and take some hard decisions, particularly when the students do something unethical.

How a guide treats a student when the student fails is a test for the guide himself. It needs to be emphasized that in research efforts alone are not enough, one needs positive findings and conclusions. Research planning is the guide's job primarily and the idea should be to derive maximum amount of conclusions from the minimum amount of data and not the other way round.

A mentor must help a researcher improve his communication ability, both spoken and written. For this, the mentor has to open up opportunities for the student as frequently as possible. To generate new ideas continuously, frequent dialogues and group meetings are a must. This is where team coffee breaks have a great role to play. Group meetings help the young to come out of their shells. In such get-togethers every achievement, no matter how small, should be celebrated jointly.

Unexpected results are often the biggest gains in research projects and, therefore, no researcher should be induced to confirm to well known ideas. In fact, some guides actually discourage their students to go through literature survey in the very beginning because the literature may induce in the young minds a bias. A mentor always tells his student that all researchers get sudden new insights into the problems if they are fully immersed in their studies.

It helps if the mentor first ensures some small successes that spur on the young researcher. The student's progress will depend on push of assignments and pull of his dreams. It is advisable to allow the researcher to stray into other areas occasionally so that he can broaden his horizon and learn to explore.

In a recent book entitled 'The case of a bonsai manager', R. Gopal Krishnan says something about alligators that should be more widely known amongst scientific circles. It seems that if an alligator, that would normally grow to a length of 5-7 metres, is confined in a small pond or swimming pool for the initial 2-3 years, then its growth is stinted. It becomes a bonsai alligator. It may enjoy normal diet and freedom, but since it perceives a limited horizon it normally would grow to be only one metre long even if it is released eventually in a river or a wide lake after the initial years. Similarly, if the young researcher finds himself or herself in a situation where the horizon is limited, then he or she is doomed to be a bonsai scientist. The initial years are critical. It is known that some groups of chimpanzees have learnt to crack nuts using stones. If a normal (not trained) grown up chimpanzee is introduced into this skilful group, then it never learns the trick. If it produces a baby then, of course, the baby learns.

Every Ph. D. student is a responsibility and obligation for a mentor whose duty is not to produce a bonsai scientist. Bonsai trees decorate homes, but bonsai scientists do not decorate scientific establishments.

Readers of *Everyman's Science* are invited to express their views on this subject.

Hem Shanker Ray

A mind is a fire to be kindled, not a vessel to be filled.

—Plutarch

PRESIDENTIAL ADDRESS

FOOD PROBLEMS OF INDIA

Prof. M. Afzal Husain, *M.A., M.Sc., F.N.I.

INTRODUCTION

I am most grateful to the scientists in India for the honour they have done me in inivting me to preside over the thirty-third Session of the Indian Science Congress.

This is the fourth time that we have assembled in Bangalore. The warmth of our hosts' reception and their lavish hospitality are overpowering attractions ; but perhaps even stronger than these is the magnetic force of the scientific spirit that pervades this city. May I remind you of His Highness the Maharaja of Mysore's message to the 11th Session of the Indian Science Congress, which met here in January, 1924 :

> ".... it will be evident," His Highness said, "to even the most sceptical mind that wider interest in scientific enquiry is the surest foundation of national prosperity and well being that can be laid ..."

The spirit of this message has guided the policy of this State. Mysore was the first to develop hydro-electric power in India, and thus made possible the development of several industries—iron and steel, cement, chemicals and fertilisers, textiles, paper, leather, porcelain, oil, soap, matches, tobacco, and electric goods, to mention but a few. Again it was in Bangalore, that through the cooperative efforts of a philanthropic benefactor, Mr. J. N. Tata, the Mysore Durbar and the Government of India, a national organization the Indian Institute of Science—was established. This institute has rendered valuable services to India during peace and war, and has won approbation as a center of training and research in Pure and Applied Sciences.

The year that has just closed has witnessed substantial progress in the scientific development of this country. The Government of India has given official recognition to the National Institute of Sciences of India. This is an appreciation of the ever-increasing importance of Science in the life of this country. The question of a Royal Charter to the Institute is receiving consideration. As devotees of Science it is our sacred duty to do all we can to further the cause for which this Institute stands, viz., the development of Science in India. It is only through the whole-hearted co-operation and good-will of every scientific worker in this country, that our National Institute can attain the eminence in the World of Science that it deserves.

During the next few years international cooperation among scientists is sure to develop greatly, because, it will be realized, the cooperation of scientists and not the wranglings of politicians can rehabilitate this stricken world. It will also be realized that scientists alone can stop future wars by producing such abundance of the necessities of life, that the needs of the whole of mankind will be abundantly met, and thus the *casus belli* will disappear. Or, if necessary, by the discovery of more frightful weapons of destruction, such

* General President, Thirty Third Indian Science Congress held in January, 1946 at Bangalore.

conditions would be produced that no nations would dare to settle disputes by an appeal to the arbitrament of the atomic bomb. Atomic energy can be utilised for both purposes. The National Institute, as an organization of scientists in India, is sure to play an important role in furthering such cooperation.

I know I am voicing your feelings when I say that we in India welcome to the fullest extent this international cooperation, because we know we have a contribution to make to the development of the world and to the common heritage of all mankind. As time goes on, we shall be able to develop our scientific institutes more and more and take a full share in the advancement of human knowledge and its application to the affairs of man. The Tata's have given us a National Institute of Fundamental Research. The Department of Scientific and Industrial Research has gone from strength to strength. We welcome the Indian Institute of Glass Technology, and expect an early establishment of National Physical Laboratory, and a National Chemical Laboratory.

We hope to see the extension of existing research facilities and the establishment of further teaching and research institutes for Pure and Applied Science, and in the fields of agriculture and industry. There are several schemes for all-round post-war development in India and in their planning and materialization scientists have to play an important part. We look with satisfaction at the schemes of training and scholarships initiated by the Central and Provincial governments, and several States.

All this progress is most encouraging, but it must be realized, that glorious edifices, excellent equipment, abundant staff do not make a research institute, if the true spirit of research is not there. Research atmosphere develop from selfless devotion to the cause of Science. Teachers and pupils, old and young, must work together for the glory of Science. Now that we have a chance to develop Science in our country, let us establish honourable traditions worthy of a great cause—the advancement of human knowledge.

THE FOOD PROBLEM

Famine and pestilence have always followed wars ; and this is happening today. Of the problems of peace, perhaps, there is not one so important and so pressing as that of the food supply of the people of the world. In the United Kingdom control over food continues, and rations, of certain food stuffs and lower than they were during the war. In the United States of America—that land of plenty—butter are sugar were severely rationed during the later part of last year. The people of Europe are facing starvation. In the Far East, there is a serious food shortage. The Indian food situation has not improved, and food controls are likely to continue for a period which it is not possible to determine at present. "The food situation in India," said Mr. Arthur Henderson in the House of Commons, On December the 19th, "gives no grounds for complacency and substantial assistance in the form of cereal imports from abroad is still necessary."

A study of the problem of nutrition has revealed that, even during peace and prosperity, nutritional standards have been grossly unsatisfactory for a large proportion of the population.

For the first time in the history of the world, a Conference of United Nations was called, in 1943, at Hot Springs, signifying that the true status of the food problem was at last recognized. The declaration of this Conference runs.

> "There never has been enough food for the health of all people. This is justified neither by ignorance nor by harshness of nature. Production of food must be greatly expanded ; we now have the knowledge of the means by which this can be done. It requires imagination and firm will on the part of each government and people to make use of that knowledge."

This Conference made the following recommendation.

> "That the governments and authorities here represented—immediately undertake the task of increasing the food resources and improving the diets of their people in accordance with the principles and objectives outlined in the findings of the Conference, and declare to their respective people and to other governments and authorities here represented their intention of doing so."

As a result of the Hot Springs Conference, a Food and Agriculture Organization has been set up. A conference of this international body met at Quebec in October, 1945, and was attended by a strong contingent of representatives of India. In his address, Sir John Boyd Orr, the, first Director General of FAO, stated that the signatory nations had not only accepted the responsibility to provide as far as possible food and health standards for all the people they governed, but they had also agreed to cooperate in a great world scheme which would bring freedom from want of food to all men, irrespective of race and colour.

The practical programme for immediate action as recommended by the Committee on Nutrition and Food Management includes the following items :

> "FAO must employ all the means at its disposal to relieve, existing hunger and malnutrition. A rapid survey should be made of available food resources and the supplies and requirements of necessitous countries assessed. Every effort must be then made to have supplies of food directed where they are most needed, to stimulate the production of food in short supply, and to ensure that the utmost value, in terms of nutrition, is obtained from available food by all known means..."

Such being the position, no apology is needed for placing before the scientists of India the very mundane problem of "our daily bread." It will be recognized that the Food Problem of India is of fundamental importance and of very great urgency, not only for this country but for the entire world, because the population of India represents one-fifth of the human race.

STATISTICS : INDIA

What is the problem ?

One is, at the very outset, faced with several serious difficulties when enunciating the Food Problem of India. For a scientific appreciation of any phenomenon and for the formulation of a policy, certain fundamental data are essential ; moreover such data must provide a realistic statistical expression of the material under study. For instance, to appreciate the food position of a country and to formulate a food policy for a nation, it is necessary that the data regarding the total requirements, available quantities of different categories of food and potentialities of increased production be ready to hand. In the case of India, lack of this precise information is the first difficulty. The importance of agricultural statistics was emphasized by the Indian Famine Commission of 1880, and since then the necessity of accurate statistics has been stressed by every committee and commission that has dealt with agricultural production. The Royal Commission on Agriculture in India recommended that the whole basis of statistics in India urgently required broadening, and laid emphasis on the fact the modern statistical methods were to make "indispensable contribution to the successful development alike of agriculture and of social administration." And yet, 18 years afterwards, the Famine Inquiry Commission of 1945 recorded :

> "Problems arising out of the production and distribution of food-grains during the war, have emphasized the need for accurate

> statistics of acreage and yield of crops ; schemes, largely experimental in character, are now in operation with the object of securing improvements in these statistics."

Without an accurate and precise assessment of food requirements and agricultural production, no agricultural planning is possible. In countries where literacy is wide-spread the farmers themselves help to supply the required information ; but in this country statistics of every type must be collected by a suitable agency, having adequate and well-trained staff.

It has to be recognized that to be useful an agricultural survey must be comprehensive, accurate, and quick, and it must at the same time be cheap. These opposing tendencies make the task difficult. There is firstly need for a carefully developed technique. Aerial survey for crop acreage prove in the long run comprehensive, accurate, quick and cheap. The present is a suitable time for undertaking such an experiment, as trained personel and up-to-date equipment are available, and the technique of aerial photography has greatly developed. To obtain figures of yield special equipment will have to be designed. It should be possible, for instance, to devise a harvester which would reap a narrow strip of wheat, thresh and clean it and give the weight of grain.

If it is proposed to plan on a sound basis then the development of the Science of Statistics must be an important item in the post-war programme. Ignoring this branch of Science will mean building the post-war edifice of progress on a foundation of sand.

POPULATION

What are our present requirements of food ? And what will they be in the immediate future ?

The census returns for 1941 gave the population of India as 389 millions, an increase of 51 millions over the 1931 figures, or, an increase of 1.5 per cent, per year. It will not be incorrect to say that, at this rate of increase, India starts the year of grace 1946 with a population approximating to 415 millions. Even if there is no acceleration in this speed, the population of India will exceed 500 millions before 1960.

From 1901 to 1940 the recorded birth rate has shown a slight decline, but during the same period the death rate has shown a marked fall. Ignoring the years of war as exceptional, the excess of births over deaths has been increasing steadily and for the decade 1931–1940, the excess of births over deaths was 11 per mille. If this tendency, whatever its causes might be, continues, the rate of increase of the population will be progressively faster. Hill estimates that the population will be 650 millions by 1970. This is by no means an over-estimate. In other words in twenty-five years we shall have 235 million extra mouths to feed. Past experience justifies such an assumption. The country must be prepared to face this situation unless some calamity befalls us, reduces our population, and solves the problem for us.

FOOD RESOURCES

The questions that arise are : What are our food resources today ? And further : what are the possibilities of our food resources keeping pace with the increase in population ?

One answer to these questions is :

"All the available evidence goes to show that the average duration of life in India is about half what it might be and that this abbreviated existence is lived at a very low level of health and comfort. There is some difference of opinion as to whether the conditions of life have improved or deteriorated during the past fifty years, but even if some slight improvement may have taken place, the existing state of affairs is still so profoundly unsatisfactory that it demands investigation and redress.

Even more disquieting is the forecast for the future ; there is every reason to believe that the maximum increase which can be hoped for in the production of the necessities of life will not keep pace with the growth of the population, so that there is a prospect of a steady deterioration in the state of the nutrition of the people."

Major-General Sir John Megaw

Birth and death rates			
Period	Per mille		Remarks
	Birth rate	Death rate	
1901-1910	38	34	Decline in death rate due to decline in infantile mortality and decrease in mortality from epidemics of cholera and plague.
1911-1920	37	34	
1921-1930	35	26	
1931-1940	34	23	
1941	32	22	
1942	29	21	Increase in death rate probably due to famine.
1943	26	23	

A distressing picture !

The position taken up by the Royal Commission on Agriculture in India is

> "That production has increased is beyond dispute ; some part of this increase is due to the enhancement of yield resulting from the expansion of irrigation, but a far larger part is due to the spread of cultivation. Only a small proportion of it can be attributed to the introduction of the higher yielding varieties of crops and it is doubtful if any appreciable increase in yield can be attributed to the adoption of better methods of cultivation or the increased use of manure."

Thus the expansion of cultivation and the extension of irrigation are the two factors of increased food production.

What has been the contribution of these factors ?

Since 1911, 7 million acres have been added to the area under cultivation in British India, but in spite of this addition the area sown per capita has declined from 0.9 acre to 0.72 acre, i.e., by 25 per cent. During the 30 years ending 1941, the area, of land under irrigation increased by 14 million acres **Table–1**. If it be accepted that an irrigated area gives double the yield of an unirrigated area, then, in terms of unirrigated area, the total extension of cultivation may be computed at 21 million acres. On this basis the area sown per capita has decreased from 1.079 acres in 1911 to 0.916 acre in 1941, i.e., by 18 per cent. Therefore, 18 per cent, increased production is necessary to maintain consumption per capita at the level of 1911. This increase could only be attained by the increased use of manures and fertilizers, extensive use of better varieties and increased application of methods to reduce wastage. It can hardly be denied that the use of manures and fertilizers has not increased and no large scale measures to reduce wastage have been effected. The proportion of better-yielding varieties is indeed very low. It is a little over 22 per cent in the case of wheat, 6.2 per cent in the case of rice and 1.1 per cent in the case of jowar. At a most liberal estimate all the improvements effected in the yield of cereal crops still leave a deficit of 15 per cent in the quantities necessary to provide the same rations per capita as were available in 1911.

Table–1 : Area shown per capita : British India

Year	Population (Million)	Average Net Area Sown			Acres sown per capita (acres)	Area In Terms of Unirrigated Area		Percentage increase in yield per acre to maintain 1911 standard
		Irrigated (Million acres)	Unirrigated (Million acres)	Total (Million acres)		Total (Million acres)	Per Capita (acres)	
1911	231.6	42	166	208	0.90	250	1.079	—
1921	233.6	46	159	205	0.88	251	1.074	0.5
1931	256.8	49	162	211	0.82	260	1.012	7.0
1941	295.8	56	159	215	0.72	271	0.916	18.0

Reduction in the export of food grains and increase in imports of rice together amount to a 5 per cent increase in the available supply. Even then India is short of food grains by a least 10 per cent per capita when compared with conditions which existed thirty-five years ago, and at that period food was by no means plenty, and famines were not unknown. There is thus not the slightest doubt that the food position has been deteriorating.

Let us compare, our position with that of the United States of America, which shows a higher yield per acre of all crops when compared with India. Baker calculated that for a "liberal" diet containing meat, fruits and green vegetables in maximum quantities and a quart of milk per day, 3.1 acres of land were required per capita. For an "adequate" diet this area would vary from 1.8 acres to 2.3 acres per capita, according to the quantity of milk and other nutritious foods included in the diet. An "emergency restricted diet," which contained mainly cereals and was designed to tide over difficult times and short periods of privation, 1.2 acres per capita was the minimum required. Even this is 33 per cent more than the area per capita available in India. This comparison is enough to show the low nutritional standard of the population in this country.

DEFICIENCIES AND THEIR CONSEQUENCES

It has been estimated that to feed a population of 400 million, India needs an increase in cereals to the extent of 10 per cent, in pulses to the extent of 20 per cent, in fats and oils 250 per cent, in fruit 50 per cent, in vegetables 100 per cent, in milk 300 per cent, and in fish, flesh and eggs 300 per cent. These figures are staggering, because first of all these deficiencies have to be made up for the proper nutrition of the existing population, and a further increase has to be assured to meet the demands of the increasing population. For instance, to provide adequate nourishment for a population of 500 milion in 1960, the production of cereals will have to be increased by 37.5 per cent, pulses by 50 per cent, fats and oils by 337.5 per cent, milk and fish, flesh and eggs by 400 per cent. With such deficiencies in food resources, it is not surprising that the Nutrition Advisory Committee, have found from the results of actual "Surveys of both typical urban and rural groups that the calorie intake of some 30 per cent of families is below requirements and that even when the diet is adequate it is almost invariably unbalanced, containing a preponderance of cereals and insufficient protective foods of high nutritive value." There cannot be any disagreement on the point that "malnutrition promotes a state of ill-health and lower physical efficiency, short of actual disease, which are perhaps more important because more widespread than disease itself." Therefore, the Nutrition Advisory Committee correctly lays stress on the fact that "freedom from disease is one thing, abundant health is another" and "the goal to be aimed at is the creation of a healthy and vigorous population."

SOLUTION OF THE PROBLEMS

How to attain this goal ?

The solution of the complex problem of providing adequate food for our population lies in the increase of the supply and, if possible, the decrease of demand.

CHECK ON THE GROWTH OF POPULATION

At one extreme we have these who maintain that India is greatly over-populated and that her food resources have not kept pace with the rise of population and are progressively falling short of the minimum requirements and, therefore, "our present, need is that the growth of population should be checked and even its decline welcomed !" They say "Judged from any point of view a check on the growth of the population of India is an urgent necessity." (Chand). There can be no doubt about the urgency of such an attempt as it would bring about a measure of relief and allow scope for adjustment. A stationary population for some years would avoid "futility and frustration" which the present situation strongly suggests. However diserable, a check on the growth of population may be, it is difficult to attain. Nevertheless, we may look at this problem from another point of view. The United Nations have now accepted the responsibility for meeting the food requirements of all people. They must, therefore, determine the production of food and control its distribution. We are already hearing of world's wheat pools. The necessary corollary to this responsibility is that the United Nations will have to watch the population trend of various countries. What will be the attitude of the nations with a low or controlled birth rate towards another nation with an uncontrolled and very high birth rate ? Will not the United Nations Organization be justified in exercising some control over population ? Having accepted membership of the community of nations, India will have to fall into line with the rest of the world. The solution of the population problem is not easy and at any rate it will be many years before a satisfactory solution can be found. In the meantime an increase in population will continue.

INCREASE IN FOOD PRODUCTION

On the other hand there are these who firmly believe that "Nations can live at home" (Wilcox), and see in the development of the modern Science of Agrobiology the possibility of a manifold increase in the produce from land. They claim that the problem is not of *over-population* but of *under-development* of the natural resources and inadequate utilization of human knowledge to develop these resources. For instance, Wilcox places the theoretical limit of the yield of wheat at 171 bushels and of potatoes at 1,330 bushels, while the average in the U.S.A. is only 8.4 per cent, of this "penultimate" limit in the case of wheat and 8.6 in the case of potatoes.

IMPORTANCE OF THE TIME FACTOR

We have seen that there is immediate need to improve our food position. Neither the policy of population reduction nor the magic wand of Agrobiology can bring forth immediate results. The time factor is important. The Bengal Famine and insecurity of the food position are clear warnings. A sound policy would be to base our programme on the results previously achieved and attempt to evolve a scheme of increased food production from existing resources, leaving future enhancement of production for the increased population.

CEREAL MENTALITY

Unfortunately, determining food requirements by calories has poduced an attitude more in favour of quantity than quality, and this has made it difficult to arrive at a scientifically correct food policy, Cereals have assumed unnecessary importance at the expense of "protective" foods. All those, who have studied the food problem of India have emphasized this point. Colonel Macay held that with a low protein consumption deficiency in stamina, moral and physical, must be expected. According to John Russell the well-balanced diet for India "does not require more but less cereal than at present, but it includes more of everything else, especially vegetables, fruit and milk, and one great need for the food supply is to increase the production of these three." He advocated an increase in the yield of staple crops so as to liberate land for the cultivation of supplementary foods, India's ill-balanced diet, which has let to extensive malnutrition, is a far more serious national problem than more deficiency in the quantity of food. The population is degenerating in physique and in stamina. How else can one explain the curious phenomenon that lakhs died in Bengal without attempting to obtain food by fighting for it ! To arrive at a correct appreciation of the food situation, it is necessary to deal with the various constituents of the diets, and not talk of calories, however, convenient the slogan may be.

Let us shake off the cereal mentality and the talk of carbohydrates, fats, proteins, minerals, vitamins and so on, and make, an attempt to evolve a scheme of a "balanced diet" containing as far as possible all the ingredients in their correct proportions.

I shall first deal with the carbohydrates, which form the greatest bulk of food.

Requirements of Carbohydrates : The present position is that over 72 per cent of the carbohydrates of human food are derived from cereals, about 20 per cent, from sugar-cane, and the balance mainly from pulses. India with 90 per cent, of her cultivated area under food crops and 64 per cent under cereals, is short of rise and is barely self-sufficient in other cereals. In spite of an intensive "Grow More Food" campaign, increased production has not kept pace with increased demand, and India is seeking imports at least at the pre-war level. It does not seem likely that India will obtain rapidly enough such a phenomenal rise in her soil fertility, such colonization of vast tracts of land, such rapid extention of irrigation[1], as to make up the existing deficiencies and provide for the future population, from a cropping scheme built round 64 per cent, area under cereals.

In the circumstances India must produce, per acre, quantities of carbohydrates much in excess of what cereals can possibly yield. Because, if the required quantities of fuel can be produced from a smaller area, it would be possible to release land for the increased production of pulses, fats and oils, and "protective" foods of vegetable and animal origin, in which India is greatly in deficit. Tubers will satisfy this requirement.

Tubers : No statistics are available which will give information about the production of tubers in India, except that potato is grown over 0.5 million acres, and sweet-potato and cassava are grown on what is described as an "enormous area." In densely populated tracts the farmers have developed a farm economy with practical results in view, and in this tubers have an important place for instance, sweet-potato in Bihar and cassava in Travancore. During the war the area under these two tubers has increased, not on account of any special propaganda, nor through financial aid or efforts of administration, but almost entirely because of the well-established efficiency of these crops to provide cheap and abundant food, and the ease with which they can be grown under diverse climatic conditions and soils of varying potentialities. The Indian cultivator is more realistic than he is often credited to be.

In all countries where the population has increased, cereals have been increasingly replaced by tubers **(Table–2)**. For instance in Germany, area under potatoes is 25 per cent of that under all cereals. In England, it is 17.8 per cent. Even U.S.S.R. has 17.6 million acres under potatoes. In Java, one of the most thickly-populated parts of the globe, there has been, since 1916, a great increase in the cultivation of cassava, and sweet-potato. In

Table–2 : Area under potatoes, wheat and all cereals. Average of 5 years ending 1938 or 1939.

(Modified from the Famine Inquiry Commission Report, 1945)

	Area in thousands of acress			
	Potatoes	Wheat	All Cereals for grain	Per-centage of 1 & 3
	(1)	(2)	(3)	(4)
India	440	34,485	1,79,276	0.3
Germany	7,054	5,175	28,176	25.0
France	3,511	12,904	25,864	14.0
United Kingdom	733	1,863	4,124	17.8
U.S.A.	3,276	55,557	2,15,066	1.5
U.S.S.R.	17,601	85,802	2,44,222	7.2

1. Irrigation is faced with the serious problem of waterlogging and development of salts. It is estimated that in the Punjab an area approximating to 2 million acres has gone out of cultivation, and to this 30 to 40 thousand acres are being added every year.

many countries of Europe potato shares with cereals, more or less, on a basis of equality, in the carbohydrate supply of the human diet. Even in the United States, in spite of the availability of land, the ratio of cereals and potatoes in the diet of a household of the lowest income is 79.8 to 64.4 **(Table–3)**.

Table–3 : Quantities (Kgs.) of cereals and potatoes consumed per year per unit of consumption, for a household of lowest income
(Workers' Nutrition and Social Policy published by International Labour Office, 1936)

	Cereals	Potatoes
Germany	138.5	147.8
Belgium	225.54	230.19
Poland	198.63	175.14
Czechoslovakia	197.89	118.01
Sweden	112.9	101.1
Finland	129.9	110.35
United Kingdom	97.3	78.1
United States	79.8	64.4

Note : Difference between the consumption of potatoes and cereals from country to country is because of other items of food.

Food Value of Tubers : As regards their food value ; reduced to the same standard of moisture, tubers are richer in carbohydrates, mineral matter and calcium than cereals ; they are, however, poorer in proteins and deficient in fats **(Table–4)**. The great advantage of tubers over cereals is the yield per acre. If the average yield of rice and wheat in India be taken as 10 maunds per acre (although it is less), and the average yield of potatoes be taken as 75 maunds per acre (although it is more than 100 maunds), the per acre yield of various constituents of food will be very much higher in the case of tubers, except fat in potato and protein in cassava **(Table–5)**.

Table–4 : Comparative food values with approximately the same amount of moisture

	Rice, raw home-pounded	Whole wheat	Potato	Sweet	Topioca
			Dehy-drated to 12.2 mois-ture %		
Moisture %	12.2	12.8			
Protein %	8.5	11.8	5.6	3.1	1.5
Fat (ether extractives) %	0.6	1.5	0.35	0.78	0.43
Mineral mater %	0.7	1.5	2.1	2.6	2.16
Carbohydrates %	78.0	71.2	79.5	81.2	83.7
Calcium %	0.01	0.05	0.03	0.05	0.01
Phosphorus %	0.17	0.32	0.01	0.13	0.08

Table–5 : Quantities of different ingredients per acre

	Rice at 10 maunds	Wheat at 10 maunds	Potato at 100 maunds	Sweet-Potato at 100 maunds	Cassava at 100 maunds
Proteins (lb.)	68	94	128	96	56
Fats (lb.)	4.8	12	8	24	16
Carhohydrates (lb.)	624	570	1,832	2,480	2,296
Mineral Matter (lb.)	5.6	12	48	80	80
Calcium (lb.)	0.08	0.4	0.8	0.16	4.0
Phosphorus (lb.)	1.36	2.56	2.4	4.0	3.2
Calories (in thousands)	1,280	1,258	2,584	4,776	5,760

With a reasonable standard of cultivation, a yield of 200 maunds per acre is not difficult to attain in the case of potato, sweet-potato and cassava. With this yield the potato will provide a quantity of carbohydrates at least four times that of wheat, and sweet-potato and cassava about five times.

The superiority of rice and wheat in contrast to tubers is their high protein content. There seems no reason why India should persist in obtaining her protein supply from cereals. She must obtain the various ingredients of diet from sources from which they can be produced most efficiently and economically. In other words, carbohydrates must be obtained mainly from tubers and cereals, if possible in equal proportions ; proteins from pulses and animal sources, such as milk, fish, flesh and eggs ; fats and oils from milk and oil seeds ;

minerals, vitamins and other ingredients from such sources as supply them most economically.

In addition to providing large supplies of carbohydrates, minerals, calcium and phosphorus per acre, tubers can be used as fodder for live-stock, as a source of starch for food products, such as biscuits, and as a raw product for the manufacture of dextrine, glucose and sizing for the textile industry. In these respects they outstrip cereals. From the agricultural point of view, they loosen the lower strata of soil and lead to soil improvement. Potatoes respond to better cultivation and provide increased occupation for the farmer. There are some varieties of tubers that yield two and three crops a year, in which case the yield per acre is exceedingly high.

Potato : As an illustration of the tremendous potentialities of tubers and the part which they are destined to play in the food resources of mankind, the present world position of potatoes—the favoured tuber of Europe and America—may be cited. What applies to potato will apply with equal force to sweet-potato and cassava. Potato is one of the cheapest and commonest sources of carbohydrate food. The average annual pre-war world production of potato was about 6 million bushels, which very nearly approximated to wheat in value. The comparative annual production of the three chief food crops of the world is as follows :

	World production *(million maunds)*	Quantity of carbohydrates *(million maunds)*
Potato	6010	1376
Wheat	3534	2517
Rice	2411	1880

Nixon said in 1931 ; "The part that the potato plays at the present time in maintaining life, through supplying food to the most densely populated continent, serves to direct our attention to the part it is destined to play as the source of food in our own country (U.S.A.) and in our own continent (America) in years to come. The famines which normally devastated Europe became much less frequent after the potato was cultivated as a field crop ...." He added, "We need only ask what the universal adoption and the scientific production of potato would mean to the starving millions of China." What applies to China applies with equal force to India.

In Germany, before the present war, the area under potatoes was 7 million acres. This exceeded that under wheat by 2 million acres and was about 25 per cent of the total area under cereals. According to Wallace (1938) "Without the potato ...... the great war could not have been fought : certainly it furnished a great reservoir of power and food for the German people and occupied a very prominent place in the dietary of our own folk." Nixon describes the potato as "truly ..... the greatest public servant in the world."

The greatest obstacle in the extension of the area under potatoes in India is the non-availability of sound, healthy seed in adequate quantities, at the right time and at a resonable price. The crop grown in the plains gets diseased and, therefore, seed has to be brought from the hills or imported from abroad. Researches have shown that healthy seed can be produced in India, and according to Burns, "given disease-free seed-potatoes and suitable manuring, the production of potatoes on the existing acreage can be doubled." Steps have been taken by the Imperial Council of Agricultural Research for the production and distribution of healthy seed. There are vast areas which provide suitable soil and climatic conditions for potato cultivation and in many parts of India two crops can be raised in a year.

Sweet-Potato : If potato is the tuber of the cooler regions, sweet-potato may with greater justification claim to be the tuber of the warmer regions of the globe. If potato is the tuber of the West, sweet-potato is the tuber of the East. "The Chinese cultivate sweet-potato on a very large scale and it enters into their diet, in some parts even more than rice." During 1943 the U.S.A. had 900,000 acres under sweet-potatoes, mainly in the Southern States. Some varieties of sweet-potatoes are only three-month crops. Even two crops a year, each yielding 200 maunds of tubers, grown over a moderate area, would convert Bihar and Bengal from deficit to surplus provinces, not only for carbohydrates but by releasing area for fodder, which will also increase the supply of milk.

Sweet-potato has this advantage over potato that it can be grown from stem cuttings and the seed problem, the greatest obstacle in the extension of area under potato, does not arise. Again its demands for soil, manure and irrigation are not exacting either.

Cassava : Now I come to the third tuber—cassava. Here I am on difficult ground, because our nutrition experts have given their verdict and condemned it. The accusation is, that people who begin to eat cassava, eat too much of it and suffer from protein deficiency. Like every thing else too much cassava is bad ; but there is not the slightest doubt that it has saved millions of people from starvation and death during famines.

There is the testimony of Yegna Narayana Aiyer as to the value of this plant which should dispel all doubts. He says, "The crop is comparable with the sweet-potato ... but the produce is more abundant, the cultivation less laborious and the soil and other requirements less exacting. As a poor man's food there are few crops to equal it. Its introduction to South India, specially in Travancore, was made with the object of relieving distress and as a substitute for rice ; its immediate popularity, which it continued to maintain, shows how well it is adapted for this purpose. Its cultivation deserves to be extended largely in the country."

Tradition has it, that the introduction of cassava into Travancore was due to the efforts of one of the rulers, who wisely foresaw its great potential usefulness as a food crop. True to this tradition, early during the present war, the Tavancore Durbar stopped all export of cassava and its products, encouraged increased cultivation of this tuber and thus saved the population from starvation.

It is a high-yielding tuber. A yield of 15 tons per acre has been obtained in certian trails in the West Indies. As a high yielder of starch it has no rival. It has been shown that 30 per cent of cassava flour mixed with white wheat flour will give bread of as good eating quality as, if not better than, pure wheat bread.

Copeland (1924) gives an interesting **Table–6** indicating the importance of cassava in the solution of the food problem of Java, a thickly-populated island, where the area under cassava rose from 639 to 1140 *bouws*, i.e., by over 75 per cent, in five years. And Copeland remarks, "..... cassava yields more starch to the acre than any other known plant, and is the most likely recourse to supplement rice wherever future increase of population makes an adequate rice supply impossible. At present Java has been forced further in this direction than has any other land. Among the "other food crops" ..... another root crop, the sweet-potato, is the most extensively planted."

Table–6 : Area under food crops in Java : Thousands of bouws—(The bouw is 1.73 acres)

	1916	1917	1918	1919	1920
Lowland rice	3724	3836	4058	4198	3952
Upland rice	550	560	555	640	644
Maize	2230	2138	2167	2728	2762
Cassava	639	718	1052	1023	1140
Others	1036	1118	1362	1235	1207

PROPOSALS

The problem is : Must India continue in the tradition's rut, and obtain her requirements of calories and nitrogen from excessive quantities of cereals, or must she break away from tradition and follow the sounder food policy of obtaining a well-balanced diet from sources which provide it best. If India could grow cereals and tubers in the same proportion as the pre-war Germany, i.e., in the proportion of 4 : 1, India could supply in full her present requirements of carbohydrates from an acreage equal to 60 per cent, of what is under cereals now., Even if 10 per cent, of the acreage now under cereals be diverted to tubers, India's carbohydrate suply will be increased by 33 per cent. By following such a policy, land could be relased for pulses, oil-seeds, fooders, and a more balanced diet obtained.

All tubers are bulky and present difficulties of transport and storage. It should not, however, be difficult to employ modern methods of dehydration and cold storage to overcome these difficulties.

So far practically no research, work has been done on tubers in India, with the exception of potatoes, on which work on a small scale has been started recently. Elsewhere it is different. "The Louisiana Agricultural Experiment Station has recently developed methods of handling plants that result in profuse flowering and seed production, thus making possible large-scale plant-breeding work with sweet-potato in this country. In 1939 the Department initiated extensive cooperative breeding and adaptation investigations on sweet-potatoes with half a dozen southern experimental stations."

The proposal, I place before you, is, that if the area under cereals is reduced from the present 64 per cent, of the total sown to 45 per cent, or so, and of the area thus released 5 per cent, of the total sown be planted with tubers, and the acreage of pulses be increased by 20 per cent, the outturn of carbohydrate will be much in excess of the present quantity. I have taken tubers as an instance of high-yielding crops. Equally satisfactory results can be obtained from plantains, which yield over 200 maunds of fruit per acre, and produce as much carbohydrate as sweet-potato or cassava with 100 maunds to the acre. They are also decidedly richer in proteins. Another high-yeilding crop is carrot, which has the added advantage of being a rich source of carotene.

REQUIREMENTS OF FATS AND OILS

India's requirements of fats and oils have been placed at 250 per cent in excess of the available supply. The area released from cereals could permit the acreage under edible oil-seeds being doubled. This would also double the quantity of concentrates for feeding milch-cattle, and if a reduction in the number of bullocks can be bought about simultaneously, as suggested later on, there will be a further improvement in the food resources of milch-cattle. The introduction of soya bean, a legume rich in oils, will greatly enhance the supply of edible oil. In planning the nutrition of the whole world, the advisability of exporting oil-seeds from a country grossly deficient in fats and oils, will, we hope, be determined by the FAO.

PROTEIN DEFICIENCY

Deficiency in total proteins, and more particularly in the proteins of high biological value, is India's most serious nutritional problem. This deficiency may not mainfest itself in mortality and disease, but is evident in the slow rate of growth, reduced size of body, lack of efficiency and vitality. That this is actually the case is abundantly manifested by the condition of both men and cattle. Dr. Burns has correlated the amount of food and body weight in cattle of the different regions of India, and Radhakamal Mukherjee has made similar studies in human groups **(Table–7)**. It is evident that where cattle are ill-fed and small in size, and milk production per head of human population is low, the human physique, is poor. Average live weight of cattle and man is fairly closely correlated.[2]

2. Lack of adequate amount of calcium is also a contributory cause.

<table>
<tr><th colspan="10">Table–7</th></tr>
<tr><th rowspan="3">Rainfall in inches</th><th rowspan="3">Regions</th><th colspan="3">CATTLE [3]</th><th rowspan="3">Daily milk production per head human population</th><th colspan="3">MAN [4]</th></tr>
<tr><th rowspan="2">Average live weight</th><th>Daily requirements per head</th><th>Quantity available</th><th rowspan="2">Regions</th><th rowspan="2">Average body weight</th><th rowspan="2">Calories intake</th></tr>
<tr><th>Roughages dry</th><th>Concent rates</th></tr>
<tr><td></td><td></td><td>lb.</td><td>lb.</td><td>lb.</td><td>oz.</td><td></td><td>lb.</td><td></td></tr>
<tr><td>Over 70</td><td>Assam
Bengal
Madras—(C)
Malabar
S. Kanara
Bombay—(A)
City
Suburban
N. Kanara
Kolaba
Thana
Ratanagiri</td><td>500</td><td>$\frac{11}{7.37}$</td><td>$\frac{0.5}{0.14}$</td><td>3.01</td><td rowspan="2">Assam
Bengal
Madras

Bihar
Orissa
Eastern
U. P.</td><td rowspan="2">100
to
120</td><td rowspan="2">2,000
to
2,500</td></tr>
<tr><td rowspan="2">30 to 70</td><td rowspan="2">Bihar
Orissa
U. P.
C. P.
Bombay—(B)
Ahmadabad
Baroch
Panchmahal
Surat
Madras—
Major part
excluding
C & D</td><td rowspan="2">600</td><td rowspan="2">$\frac{13}{9.52}$</td><td rowspan="2">$\frac{0.75}{0.19}$</td><td rowspan="2">6.18</td></tr>
<tr><td rowspan="2">Western
U. P.

Bombay</td><td rowspan="2">120
to
150</td><td rowspan="2">2,500
to
3,000</td></tr>
<tr><td rowspan="2">Below 70</td><td rowspan="2">Madras—(D)
Anantpur
Bellary
Cuddapah
Kurnool
Bombay—
excluding A & B
Sind
Punjab
N. W. F. P.</td><td rowspan="2">700</td><td rowspan="2">$\frac{15}{15.7}$</td><td rowspan="2">$\frac{1}{0.38}$</td><td rowspan="2">12.22</td></tr>
<tr><td>Punjab
N. W. F. P.</td><td>150
to
170</td><td>3,000
to
3,500</td></tr>
</table>

3. Adpted from Dr. Burns : *Technological Possibilities of Agricultural Development in India.*

4. Adapted from Dr. Radhakamal Mukherjee, *Population and food Supply*.

Pulses and cereals are the chief source of vegetable proteins. Reduction in the area of cereals will reduce the quantity of proteins of this source slightly, but a 20 per cent increase in pulses will make up the deficiency.

It is, however, the increase of proteins of high biological value, which is India's greatest need.

The Nutrition and Food Management Committee of the FAO have recognised that "the primary objective of the nations united in the Food and Agriculture Organization is to raise the level of nutrition throughout the world, to ensure not only that all people are freed from the danger of starvation and famine, but that they obtain the kind of diet essential for health." Our Food Policy should aim at "abundant health," and our goal should be "the creation of healthy and vigorous population," able to shoulder the burdens of peace and war.

PROTECTIVE FOODS

Let us now deal with tile foods of animal origin, "protective foods" and proteins of high biological value, provided by fish and flesh, eggs and milk. The requriement of these foods for 400 million human beings is estimated at 300 per cent over and above the present supply.

The most improtant of the food resources of this category are fish. The extensive waters around the coast of India, vast esturian areas, numerous rivers and canals, tanks and tanks provide almost unlimited possibilities for the production of fish. Fish may be described as the food ready-made for man to collect. The neglect to develop, nay even to control, the fisheries in India has been colossal. It is only under the stress of war-time food scarcity that the necessity of developing this valuable source of food has been recognized. It is encouraging to find that several Provinces and States as well as the Central Government have taken steps to develop the fishery resources of the country. Programmes of development include all aspects of the fish industry, and teching and research. We can look forward with confidence to the full development of this source of food. An abundant and cheap supply of fish will solve the problem of a balanced diet for the enormous rice-eating population. No effort, should be spared to develop fisheries.

Sheep, goats, pigs and poultry are well-known sources of food. The Imperial Council of Agricultural Research are financing research on these animals, with a view to improving breeds and increasing the quantity of food produced from these sources. Among the smaller animals, a useful source of wholesome flesh is the rabbit. It multiplies very rapidly and grows quickly. In other countries rabbit breeding is an importing industry, and it is a pity that in India nothing has been attempted so far, and this excellent source of very good food is being ignored.

In a country so short of food of animal origin as India, every source, however small, has to be tapped and the best use made of it. What is the place of wild life—birds and mammals, in the food resources of India ? Several wild birds and mammals are eaten, and some are regarded as delicacies, but there is complete absence of information as to the volume of this source of food. Even the wildest guess is not possible. The only thing one is aware of being that the damage caused to cultivation by wild pigs and deer of sorts, is so serious in certain localities that, vast areas have gone out of cultivation. Protection of crops and fruit against the ravages of birds is one of the difficult responsibilities of the farmer. This may be taken as an index of the quantity available.

Investigations carried out in America indicate the importance of wild life. It has been shown that where marshes have been reclaimed for cultivation, the benefit gained has not compensated for the loss sustained, through the destruction of water fowl. We have approximately 2,00,000 sqare miles of forests. Can they not be stocked with eatable birds ? There is immediate need for a thorough survey and population study of the wild life of India as a preliminary to a national planning of game improvement.

CATTLE PROBLEM

Of the live-stock the most important are the cattle, and they occupy a unique position in the rural economy of India. They provide the draught animal for cultivation, contribute to the fertility of soil by providing farmyard manure—the only manure readily available to the farmer. Cattle dung makes up the deficiency of fuel resources for household needs. Cows and buffaloes provide milk—a perfect, food—and is a country where a large section of the population in vegetarian, the milk supply is of great importance. The cattle, finally, provide flesh for human consumption, and their hides, bones and horns are products of considerable value in industry[5]. Indeed the place of cattle in the economy of Indian farming is so fundamental that the ancients considered that the bull carried the earth on its horn, and they deified the cow. Paradoxical though it may appear, yet it is a fact that a stage has been reached when on the one hand cattle provide food for man and on the other compete with him for food. It is true that cattle mostly live on straw and stock—by-products of grain production—yet the pressure of population has forced man to encroach upon pastures and break land for the cultivation of food crops with loss of fodder for cattle. The result is that today there is great scarcity of cattle feed. Cattle are underfed, inefficient, and too large a number has to be maintained. India possesses one-third of the world's cattle population. Without adequate feeding, improvement in breeds is a hopeless task.

Burns estimates that the total number of bovine adults in British India is 107 million and the total feed available is 175 million tons of roughages and less than 4 million tons of concentrates. Ignoring the requirements of young stock, the deficiencies are : 50 million tons of roughages and 9 million tons of concentrates. Of the available food, work-cattle get the larger share, and milch-cows are starved.

The position is that in addition to an enormous human population the Indian soil had to carry a very heavy load of a large cattle population. Ill-fed and consequently inefficient cattle are a terrible drain on our resources. The Chinese and the Japanese have mostly eliminated cattle from their farm economy., They have replaced bullock labour by human labour ; milk and milk products do not enter into their dietary and their protein requirements they satisfy by feeding on all sorts of animals.

What is the solution ?

In 1940, there were in British India 49 million working bullocks and uncastrated males over three years of age, kept for work. All these who have studied the food and agricultural problem of India have advocated the urgent need of reducing the number of bullocks, so that the cows are better fed and the milk supply is thus increased. For instance, the Royal Commission on Agriculture In India, emphasized the "necessity of attention on all matters that will tend to decrease the number of bullocks required for cultivation." Sir John Russell followed in the same strain and said, "If it were feasible, the best course would be a large reduction in numbers of animals so as to bring live stock population more into line with the supplies of food, but this cannot be done rapidly. Some gradual reduction will no doubt come about by economic pressure as the grazing grounds become more, closely settled for cultivation, and so the castration of scrub bulls becomes more commonly practised. Improvements in farm implements and particularly in the bullock cart, would reduce the need for so many bullocks in the village." Prof. Radhakamal Mukherjee also

5. In actual value (including the value of dairy product) the (livestock) industry contributed at a rough estimate about 1,000 crores of rupees to the agricultural income of the country, which has been assessed at a total of 2,000 crores of rupees.

advocates the adoption of a definite programme of reduction of cattle numbers ....."

The problem is how to reduce this number.

Improvement of farm implements, or bullock carts with ball bearings and pneumatic tyres, do not even scratch the surface of the problem. Cooperative use of inefficient bullocks is not a practical proposition, when on account of the shortness of season for the preparation of land, the available period for cultivation is limited. Small holdings will continue as long as there is no outlet for the rural population in industry. Utilising animal labour for cultivation and transport is a most wasteful method. It has been estimated that in many parts of India the work-cattle are employed for half the year, and yet they have to be maintained and fed throughout the twelve months. The Royal Commission have stated that bullock labour is a heavy item in crop production.

MECHANIZATION

The *only* effective measure that will reduce the number of work cattle is mechanization.

Mechanization of agriculture has made revolutionary changes during the last few years. Here is a picture of a fully mechanized cotton farm in the U. S. A.

"Tractor-drawn equipment plants and cultivates the crop. Flame throwers kill the weeds. Airplanes dust the cotton with insecticides, and, a week before the cotton is mature, they apply a cynamide compound which makes the leaves drop off. When the leaves are gone, the cotton picking machine moves in. A cotton picking machine can pick a thousand pounds of cotton per hour, instead of 15 pounds a man can pick. Such a machine works all day and then with headlight on it works all night."

The progress of mechanization of farming in Russia is a well-known story.

Mechanization in farming is usually associated with scarcigty and high cost of labour. It has, however, another, and for India a more important aspect. Mechanization may be adopted as a device to reduce demand on food resources. A bullock or a horse is to be fed from the produce of the land. A tractor runs on petrol or crude oil.

At the present time the aim in India should be to replace animal labour by machine and thus save food which is now consumed by the work-bullocks. What would be achieved as a result of such mechanization may be illustrated by taking an example from the U.S.A. "About 1920 there were 26 million horses and mules in the United States of America, and by 1940 there were less than 16 millions. In 1919, there were 1,60,000 tractors, and by 1939, they had increased to 16,00,000. This has meant a release of 35 million acres of land the production of which was required to support work stock." Imagine what similar reduction in the number of bullocks would mean to the human population of India. The fodder thus saved and fed to cows, would bring about an immediate increase in the milk supply. Do we not know that a 60 per cent, increase in milk yield can be obtained by good feeding ? Further with an assured supply of fodder the breeds can be improved, resulting in increased efficiency of milch-cattle.

One of the post-war development plans is to take motor transport right into the heart of rural India, this will mean the replacement of bullocks now used for transport. There are schemes of hydro-electric development which will provide motive power for water-lifting, cane-crushing, corn-grinding, for which bullock power is being used at present. A very real step towards the reduction of the number of bullocks will be the introduction of tractors.

The present is the most appropriate time for launching a campaign for the mechanization of agriculture. The price of bullocks is high. There are thousands of trained mechanics, familiar with tractors and other power-driven mechinery, who will be released from the army. The chief difficulty, however, is that tractors are not available, and designs suited to Indian conditions have not been determined.

In my opinion the first step that should be taken is to hold an exhibition of tractors and farm machinery on a very large scale, to which tractor manufacturers and producers of farm machinery should be invited from all over the world. This would enable agricultural experts and manufacturers to determine which models are most suited to conditions obtaining in India. The next step would be to establish a tractor manufacturing industry and a fully-equipped Institute for Research on Tractor Designs to guide such an industry. The first need of India is not luxury motor cars but sturdy tractors, of moderate size and moderate price, which run on cheap fuel.

It will not be possible for every individual farmer to own even a small tractor and have the minimum number of implements required for cultivation. The only possible method would be to undertake cultivation on contract basis. There may be difficulties in the beginning but if the charges are moderate and the work is done efficiently and expeditiously the cultivators will soon appreciate the advantages. The cost of cultivation could be substantially reduced by providing cheap fuel. For instance, no tax should be levied on petrol or crude oil or any other fuel used for agricultural purposes. Further it would be necessary to establish chains of repair stations.

It is a mistaken idea that cooperative farming should precede the use of tractors and other power machinery. In fact the introduction of tractors will inevitably result in cooperative farming. When a small holder finds that his land can be cultivated cheaply and efficiently without his keeping bullocks, he will join in a cooperative scheme of farming. The farmer is not as conservative as he is imagined, but is alive to gains that he can get.

INCREASED PRODUCTION OF VEGETABLES AND FRUITS

The consideration of increased production of vegetables and fruit need not delay us. By proper management, use of good seed, and plants of high-yielding varities, production of these useful and necessary foods can be greatly enhanced from the existing area. A system of cropping in which orchards are intercropped, with fodder or vegetables, will mean better use of the land. For instance, fodder could be grown in a vineyard, an orange grove or a mango orchard. Carefully-planned trails alone will determine the most rational use of land, as various conditions will determine what can be achieved, and these conditions vary from locality to locality.

CONCLUSION

To sum up : A national crop planning should be based on the best and most efficient utilization of land and other resources for social needs. The first social need is food. It is possible to envolve, for the various parts of the country, cropping schemes which will result in greater production of carbohydrates from smaller areas, than is the case at present. In any such scheme tubers will play an important part, and the area under cereals will have to be reduced. Acreage released from cereals can be devoted to pulses, oil-seeds, fodders, an increased production of milch is necessary for obtaining well-balanced diet. The increased food for milch-cattle, both in roughages and concentrates, which will result from such a cropping scheme, will make up our existing deficiencies in milk—a most, necessary "protective food". The introduction of more legumes, i.e., pulses as well as fodders, will enrich our soils. A reduction in the number of bullocks by encouraging the use of tractors and motor transport, and the introduction of machinery driven by cheap electric power, will release much fodder and enable us to improve our breeds of milch-cattle, with a consequent increase in milk production.

All this is possible and we have the knowledge to do it, but as the Hot Springs Conference stated, "It requires imagination and firm will on the part of each government and people to make use of that knowledge."

FOOD TECHNOLOGY

The available resources of food can yield better results, if their nutritional values are conserved, and not destroyed in processing and preparation for consumption, One need only mention the case of eating over-milled rice. There is not only loss of valuable food rich in proteins, but the additional disadvantage of the consumer suffering from deficiency diseases. Preservation of food, in a satisfactory manner, is an essential part of food enconomy. A great deal of wastage, which can be avoided, occurs during transit, particularly in the case of fruit, fish, and such articles of diet as putrefy quickly. Large quantities of food grains and other food products are consumed and spoiled by rodents and insects. It is necessary that our transport system be improved through refrigeration, and cold storage developed extensively for all types of foods, which must be kept at a low temperature for safe preservation. Improved storage is one of the methods of avoiding damage to grain : Dehydration of food products is of incalculable value in food preservation and distribution. It is particularly necessary for bulky foods, such as tubers. It reduces bulk and makes for low cost of transport and distribution. From liquid milk to potatoes every type of food can be successfully dehydrated. As the technique improves it will be possible to preserve all the good qualities of fresh food in dehydrated commodities.

As far as India is concerned, fortification of the common articles of diet, with all the ingredient necessary for full health is an urgent necessity, Starch from cassava, fortified with proteins, vitamins, minerals and other useful ingredients, and pre-cooked to a suitable stage, may greatly help to solve the nutritional problems of, for instance, Travancore. Modern development in food technology has shown what can be done with cotton-seed meal in making it aceptable to man as a highly nutritional food. Cotton-seed flour is being used in America in such quantities that the supply cannot meet the demands of bakeries and biscuit firms. Cotton-seed flour is twenty times as nutritious as potato, and contains 50 per cent of proteins.

Chemists have produced rayon, nylon, plastics, and there seems to be no reason why they cannot produce artificial rice from tuber starch. This rice may be a perfect food containing all the necessary requisites of an excellent diet, it may have a flaour which appeal to the human palate, and it may be cheaply produced in such form that it can be prepared for a meal in an easy manner.

Food yeast from molasses is known to contain 50 per cent proteins of high biological value and the important vitamin B_1. Our sugar industry can supply huge quantities of molasses for the manufacture of yeast. Yeast mixed with flour will add valuable protein to a diet containing starch. Yeast can be grown on several other media and there are tremendous possibilities of large-scale production.

Much headway has been made during the war in the production of shark liver oil which satisfies a great demand. Further increased production is awaited.

It is a now possible to produce vitamin concentrates and synthetic vitamins on a commercial scale, it should be possible to make them available to people of the lowest income group.

The production of amino acids, satisfying demands of the human body, is an achievement of modern Science, and paves the way for further ahcievements in this direction. The day is not far off when, in the words of the Earl of Birkenhead, "Synthetic foods and the production of animal tissue *in vitro* will finally set at rest these timid minds which prophesy a day when the earth's resources will not feed her children." This is possible, but much research is needed to attain such an end. For our immediate needs there is a strong case for a fully-equipped National Institute of Food Technology.

THE FARMER

National crop planning should be based on the, best and most profitable utilization of land and other resources for social needs, and the individual profit motive should be eliminated. That would be the ideal condition. But as things are, the object of the farmer, in his own interest, is *not* to obtain the largest yield possible per acre, but to obtain the largest *economic* yield. As elsewhere in business, there is a clash between social needs and individual interests. There have been several instances when valuable foods have been destroyed to serve economic ends, and to make it worthwhile for the farmers to grow certain essential crops. A new orientation is needed in our rural economy.

So far the farmer has not received the attention he deserves. There is need for a proper sociological study of the Indian village life and the influence of modern trends on this life. The standard of living of the largest body of consumers—the growers of crops—has to be raised. What is this stanadard of living ? Which is the best philosophy ? Plain living and high thinking, or increasing one's wants and seeking the satisfaction of all these ? A man who is a believer in plain living is a poor consumer. What part does he play in a world where circulation of wealth is the test of a progressive civilization ? It is not possible to go into all these questions, but the questions are important. There is a need for an Institute of Sociology to study rural problems.

FUNDAMENTAL IMPORTANCE OF PURE SCIENCE

Before I close, I feel that it is necessary to sound a note of warning. It is necessary, because I have laid stress on the application of scientific knowledge to food production—the primary need of man. I am aware that much agricultural improvement has resulted from empirical methods of practical farmers and stock breeders. Many useful varieties of crops, fruit trees and vegetables have been produced, many well-known breeds of animals evolved. Nevertheless, today it is the scientific method which will give results of value. The preliminary stage of simple human effort has long past. The scientific method aims at "studying the soil, the plant and the animal in order to learn as much as possible about them, not with the idea of greater production but of gaining new knowledge" (Russell). It is on this foundation of sound knowledge that the structure of practical achievement can be raised. There is a tendency to expect of scientists *quick results of practical* value. We are often accused of carrying on pure research. Even the Imperial Council of Agricultural Research has brought "Development" within its orbit and there is a danger that this "development" may sound the death knell of "research". It will be a sorry day for this country when the tradition of knowledge for the sake of knowledge disappears. We must safeguard ourselves against such a tendency. There should be abundant opportunities for scientific workers in India to build up a sound body of knowledge, and then results of practical value will necessarily follow. It is rare to find a man who will pursue a line of research for the sake of enlarging the bounds of knowledge, but there are many who are keen to apply what is already known in order to achieve result of use to man.

REFERENCES

1. Birkenhead, World in 2030.
2. Burns, Technological Possibilities of Agricultural Development in India, 1944.
3. Chand India's Teeming Millions, 1939.
4. Copeland *Rice*, 1924.
5. Hill *International Affairs,* Vol. XXI, 1945.
6. Mahalonobis National Institute of Sciences of India, Vol. X, 1944.
7. Mukherjee, Radhakamal Food Planning for Four Hundred Millions, 1938.
8. Nixon The Principles of Potato Production, 1931.
9. Roonwal Science and Culture, vol. XI, 1945.
10. Russel Report on the work of I.C.A.R. in applying Science to Crop Production in India, 1937.
11. Russell etc. Agriculture Today and Tomorrow, 1945.
12. Wallace Bull. No. 94, Ministry of Agric, and Fish., England, 1938.
13. Wilcox *Reshaping Agriculture*, 1934.
14. Wright Report on the Development of Cattle and Dairy Industry in India, 1937.

INFLUENZA : SOME BIOCHEMICAL PERSPECTIVES

Jyoti D. Vora, Mansa Gurjar

Influenza is a viral disease that may fade away in 2 weeks of bed rest or be fateful. This article examines the disease ; its history, its causatic agent—the influenza virus, diagnosis, prevention and treatment. It is inevitable to talk of a possible pandemic and threat of avian influenza as well as the recent advances in research.

INTRODUCTION

Everybody at some point of their lives has got the "flu"-a common term for influenza and influenza-like diseases. It has been around for ages with the symptoms of influenza first being described by Hippocrates in 412 B.C. Influenza comes from the French word, "influentia", which refers to the belief that epidemics were caused by the influence of the stars. It is commonly seen in local outbreaks or epidemics throughout the world. Epidemics occur explosively with little or no warning. The number of people affected can vary from a few hundred to hundreds of thousands. Epidemics may be short-lived, lasting days or weeks but larger epidemics may last for months. There have been 31 definite or probable pandemics in the past 400 years. No apparent seasonality was observed, but they occurred more frequently in spring and summer than in autumn and winter. In the 20th century alone, there were three overwhelming pandemics, in 1918, 1957 and 1968, caused by H1N1 (Spanish flu/100 million), H2N2 (Asian flu/1 million) and H3N2 (Hong Kong flu/1 million), respectively. In the influenza–A pandemics of 1957 and 1968, the clinical illnesses were more confined to the respiratory system, while in the 1918 pandemic and human H5N1 infections since 1997, multisystem dysfunction and immune dysregulation developed in infected individuals. Although influenza is a mild disease in most individuals, it is life threatening to elderly or debilitated individuals. Epidemics are responsible for large losses in productivity. The WHO has commissioned an international network of communicating laboratories to monitor the changes in the infecting viruses and the spread of infection.

* Department of Biochemistry & Food Science & Quality Control, Ramnarain Ruia College, Mumbai, Maharashtra. Email :

SYMPTOMS

Influenza is characterized by fever, pain in muscles, headache and pharyngitis (inflammatin of the fauces and pharynx). In addition, there may be cough and in severe cases, dizziness, nausea and weakness caused by depletion of body fluids and electrolytes. Usually people do not have a runny nose which is characteristic of common cold.

DIAGNOSIS

Diagnosis is commonly made on the basis of epidemiological characteristics during epidemics, but sporadic cases can be identified only by loboratory tests. Laboratory diagnosis depends upon the demonstration of the virus by culture, RT-PCR, or immunofluorescence using monoclonal antibody to the virus, or a rising antibody titre between acute and convalescent sera.

COMPLICATIONS

Build up of fluids and lack of mucociliary clearance provides good breeding grounds for bacteria. Complications often occur in patients with underlying chronic obstructive pulmonary or heart disease. The underlying problems may not have been recognized before the influenza infection. The major causes of influenza-associated death are bacterial pneumonia and cardiac failure. Ninety per cent of deaths are in people over 65 years of age. Complications in case of influenza include bronchitis, primary viral pneumonia, secondary bacterial pneumonia, myositis, myoglobinuria, Reye's syndrome, acute viral encephalitis and Guillain-Barre syndrome. These are more pronounced in subjects that are smokers, substance abusers and those with one or more chronic diseases.

DISEASE POTENTIAL

True influenza is an acute infectious disease caused by a member of the orthomxyovirus family (influenza virus A, B or to a much lesser extent influenza virus C). However, note that the term 'flu' is often loosely used for any feverish respiratory illness with symptoms that may be caused by many different bacterial or viral agents.

Influenza A viruses infect a wide variety of mammals, including man, horses, pigs, ferrets and birds. Pigs and birds are believed to be particularly important reserviors, generating pools of genetically or rather antigenically diverse viruses which get transferred back to the human population via ressortment (close contact between pigs and man in the Far East ; ducks due to migration). On the basis of the antigenicity of the surface glycoproteins, haemagglutinin (HA) and neuraminidase (NA), influenza A viruses are further divided into sixteen H (H1-H16) and nine N (N1–N9) subtypes. Currently, only viruses of the H1N1 and H3N2 subtypes are circulating among humans. Of the hundreds of strains of avian influenza A viruses, only four are known to have caused human infection : H5N1, H7N3, H7N7, and H9N2.

Influenza B viruses infect humans and birds. They cause human disease but generally not as severe as A types. They are believed to be epidemiologically important—reassortment with type A leads to epidemics.

Influenza C viruses infect only humans, but do not cause disease. They are genetically and morphologically distinct from A and B types—little studied.

ORTHOMXYOVIRUSES

The virus is generally round but may be long and filamentous. A single-stranded RNA genome is closely associated with a helical nucleoprotein (NP) and is present in eight separate segments of ribonucleoprotein, each of which has to be present for successful replication. The segmented genome is enclosed within an outer lipid bilayer envelope. An antigenic protein called the matrix protein (M1) lines the inside of the envelope and is chemically bound to the ribonucleoprotein. The internal antigens (M1 and NP proteins) are the type specific antigens and are used to determine whether a particular virus is type A, B or C.

The envelope carries two types of protruding spikes which elicit an immune response in the body and determine the strain of the virus :

1. Haemagglutinin (HA or H) : It is a trimeric protein. There are 16 major antigenic types of HA. The haemagglutinin functions during attachment of the virus particle to the sialic acid linked galactose receptor on the cell membrane. Antibody to the HA protein is most important since this can neutralize the virus and prevent initiating the infection.

2. Neuraminidase (NA or N) : It is a box-shaped protein. There are 9 major antigenic types of NA. It digests sialic acid (neuraminic acid)—which most cells have on their surface. Since sialic acid is part of the virus receptor, when the virus binds to the cell, it will be internalized (endocytosed). After infection, the sialic acid will be removed from the infected cell surface by the

neuraminidase making it is easier for the progeny virions to diffuse away on exiting the cell. Neuraminidase is also involved in penetration of the mucus layer in the respiratory tract. Antibody to the NA protein has some protective effect since it seems to slow the spread of the virus.

The lipoprotein envelope makes the virion rather labile—susceptible to heat, drying, detergents and solvents.

ANTIGENIC DRIFT

When RNA is replicated it tends to have more errors than when DNA is replicated. This means that they have a high mutation rate and can evolve quickly. The gradual accumulation of new epitopes on the H (and N) molecules of flu viruses is called antigenic drift. Spontaneous mutations in the H (or N) gene give the viruses a selective advantage as

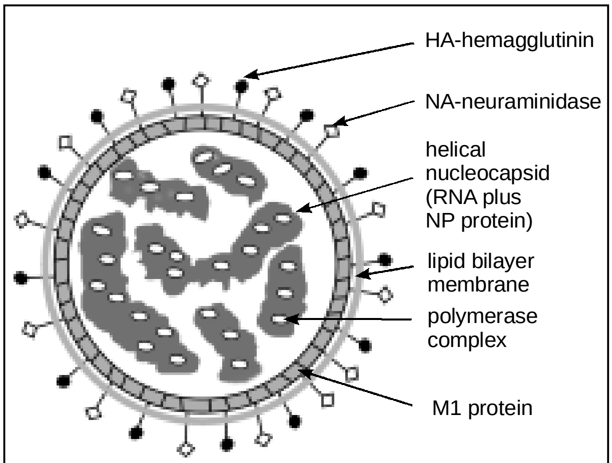


***Fig. 1 :** Structure of Influenza virion is to be inserted here.*

the host population becomes increasingly immune to the earlier strains. Eventually they drift so much that the original antibody can no longer bind to it. That means you can become infected with this newly evolved virus. Antigenic drift is responsible for many of the localized outbreaks of different strains of influenza, especially influenza B.

ANTIGENIC SHIFT

The encoding of H and N by separate RNA molecules probably facilitates the reassortment of these genes in animals simultaneously infected by two different subtypes. For example, H3N1 virus has been recovered from pigs simultaneously infected with swine flu virus (H1N1) and the Hong Kong virus (H3N2). Probably ressortment can also occur in humans with dual inflections. All eight segments may take part in the reassortment. These newly created mixed genomes are very different from their parents and present us with such a unique strain of virus that our immune system has to start all over to make new antibodies to combat it. This is known as antigenic shift and it is a primary cause of pandemics.

PREVENTION

Prevention is better than cure and in case of influenza, simple good habits of washing your hands, covering your mouth when sneezing or coughing can make the difference. Vaccines against influenza have been around for 50 years. Despite this, the efficacy of influenza vaccines is still questioned and the ability of vaccines to limit epidemic infection has not been proven. Depending on the worldwide monitoring of influenza, new vaccines are generated every year with two strains of influenza A and one strain of influenza B. The contemporary vaccine production process takes 6–8 months and is produced using chicken's eggs. Majority of the vaccines available have the killed form of the virus either whole, split or a subunit of the virus particle with or without adjuvants (additives that enhance the effectiveness) and are administered intramuscularly. Recently, a vaccine commonly known as FluMist has been in the markets which contains live attenuated influenza virus (LAIV) and is available as a nasal spray. It has advantages over the traditional vaccine in that it develops local, neutralising and longer-lasting immunity.

On going research in cell culture techniques hopes to enable faster, less labour intensive and mass production of vaccines. Reserve genetics can aid in manipulating the influenza genome and develop plasmid based vaccines. DNA vaccines that inject "naked" viral DNA directly in the cells to stimulate an immune response are also being explored. Instead of targeting H and N proteins, some scientists are targeting the more conserved influenza proteins like NP and M2 so as to produce a "one size fits all" vaccine. Attenuation of viruses by genetic manipulations is also being studied.

TREATMENT

In uncomplicated cases, staying at home, rest and drinking a lot of fluids is key. If needed, treatment with acetylsalicylic acid may be considered. However, salicylates must be avoided in children of 18 years or younger because of the association of salicylate use and Reye's syndrome. In these cases, acetaminophen or ibuprofen are common alternatives.

Antibiotic treatment should be reserved for the treatment of secondary bacterial pneumonia. In more severe cases, supportive treatment includes fluid and electrolyte control and finally supplement oxygen, intubation and assisted ventilation.

Antiviral treatment is available in the form of neuraminidase inhibitors namely, zanamivir and oseltamivir and adamantane derivatives that inhibit one of the matrix proteins namely, amantadine and rimantadine. Oseltamivir is indicated for the treatment of uncomplicated acute illness due to influenza infection in patients aged 1 year and older, who have been symptomatic for no more than 2 days. Zanamivir is indicated for the treatment of uncomplicated acute illness due to influenza infection in patients aged 7 years and older and who have been symptomatic for no more than 2 days. Rimantadine and amantadine are ineffective against the influenza B virus and are, therefore, indicated for prevention and treatment of illness caused by influenza A virus only.

AVIAN INFLUENZA

It has been almost 40 years since the last pandemic in 1968 and history teaches us that it just might be repeated. The three pre-requisites for a pandemic to start are :

(i) A highly virulent organism
(ii) Lack of human immunity to the organism
(iii) Ability to easily transmit from human to human

The H5N1 strain of a avian influenza has already fulfilled the first two conditions. This virus has not only led to loss of poultry in millions but has also exhibited cross-species transfer and infected the people in close vicinity to the infected poultry. The primary target of human strains of influenza viruses has been 2-6 linked sialic acids found on cell membranes of non-ciliated cells of respiratory tract. The avian strains target 2–3 Linked sialic acids, which recent studies suggest, can be found on cell membranes of ciliated cells of respiratory tract and cells of the human eye, though infection would be limited due to their non-optimal positioning on the cell surface. The H5N1 strain stands out by the fact that viruses isolated from fatal cases have been shown to target both types of sialic acids making the jump from birds to humans easier for them. As said earlier, the influenza virus is heat labile and hence consumption of cooked eggs or birds does not cause infection in humans. As a general rule, the WHO recommends that meat be throughly cooked, so that all parts of the meat reach an internal temperature of 70°C. At this temperature, influenza viruses are inactivated, thus rendering safe any raw poultry meat contaminated with the H5N1 virus.

We deal with many strains of influenza every year, then why are we so concerned about this particular one ? For starters, H5 was characteristic of avian influenza strains and a strain with H5 has been able to infect humans. The mortality rate among people infected with H5N1 is very high—as of June 20, 2006 the WHO has reported 228 cases of H5N1 in humans with 130 of them resulting in death. The lack of human immunity or vaccines to aid to dosen't help either. Of the antiviral drugs available, oseltamivir is the drug of the choice but there have been reports of resistant strains. In addition to that, the dosage and duration of treatment appear to be different in severe H5N1 cases.

Now for some good news, successful initial trails of H5N1 vaccine were reported on August 7, 2005. The limited number of human cases reported worldwide means that the H5N1 has not completely adapted to sustain in humans baying us some time to develop better vaccines and other prevention strategies. Reserves of vaccines with H5 or H7 and different N variants are being maintained in case of an emergency, when they might give us a better chance of fighting the disease. Genetic sequencing of influenza virus and other genetic and proteomic engineering methods have provided us with better insight on the working of the virus and contributed largely to the efforts for making new vaccines and drugs.

CONCLUSION

Our struggle against lethal viruses continues. In case of influenza it is capable of masquerading as the harmless common cold, spreading like fire to an entire population and eluding us like a master escape artist. The lingering threat of a pandemic is the engine of innovation. We can only hope that evolution which seems to have been honed by viruses gives us enough time to prepare for any future calamity. We need nature on our side ; we need time, science and sheer luck. The cliche that man has visited the moon, yet the sustained cure for influenza continues to elude him is an adage worth reflecting on.

DO YOU KNOW ?

Q1. What is agnotology ?

Q2. Which disease is named after the Greek word meaning 'half brain' ?

Q3. What is Spelunking ?

MERCURY POLLUTION : THE PROBLEM STILL PERSISTS

Subarna Bhattacharyya, Sayan Chatterjee, Srabanti Basu*

A recent study has reported Minamata disease, a neurological disorder caused by mercury poisoning, in the Amazonian villages. It is not a stray incidence since studies have shown high levels of mercury in several places of India and other countries including the United States. Mercury is released from rocks by geothermal and volcanic actitivities and 10–50 per cent of the available mercury is contributed by human activities. Chloralkali plants and electrical industries are two major sources of the metal in the environment. Mercury toxicity can be characterised by loss of coordination, slurred speech, loss of sensation at the extremities of limbs and mouth, construction of visual field and loss of hearing. Severe poisoning can cause blindness, coma and death. Microbial bioremediation and phytoremediation are two approaches that can be used for removal of mercury from industrial wastes. Relying on the genes of mer operon, bacteria convert the mercury compounds to metalic mercury. The latter, being a liquid, is eliminated by the cell in vapour state. Genetically engineered plants with bacterial mer operon also seem to be promising for mercury removal.

INTRODUCTION

A recent report of mercury (Hg) poisoning in the Amazon rainforest has once again brought the metal under spotlight. Maszumi Harada of Kumamoto University and Junko Nakanishi from the Yokohama National University have reported Minamata disease, a debilitating illness of the nervous system caused by Hg toxicity, in remote villages at Amazonian region. The team has examined 50 people, from 10 villages around San Luis do Tapaj's, who had high methylmercury (the most toxic form of Hg) in their blood. Three of them showed tremor and other nervous symptoms peculiar to Minamata disease[1]. First reported by M-Harada in 1955, the disease took toll on around hundred people at Minamata City in Japan[1]. Around 1,500 people suffered from uncontrollable tremor, muscle wasting and produced appalling deformities in children. The sufferers used to eat fish from Minamata Bay which had been contaminated with mercury released by Chisso Corporation, an industry that produces fertilizers, petrochemicals and plastics. Apart from the nervous system, high levels of Hg can damage vital organs like lungs and kidneys.

Donna Mergler of the University of Quebec at Montreal has also found similar neurological symptoms in the Amazonians. According to the researchers of both Harada's and Mergler's team, the victims have consumed Hg-contaminated fish from the Amazon, However, they disagreed on the sources of Hg. Harada proposed that the river had been contaminated by Hg used in gold mining, whereas according to Mergler, contamination in fish has due too leaching of mercury from natural soil caused by deforestation[2].

However, all the forms of Hg are not toxic. Hg exists in four major chemical froms : (i) elemental Hg (Hg^0) in vapour state which is the least toxic form, (ii) mercuric ion (Hg^{2+}), (iii) alkylated Hg, mainly monomethylmercury and dimethylmercury

* Department of Biotechnology, Heritage Institute of Technology, Chowbaga Road, Anandapur, Kolkata-700 017, e-mail : srabanti_b@yahoo.co.uk

—the most toxic of Hg compounds and (iv) as ligand with sulfide which is extremely insoluble in water and non-toxic[3]. Toxicity of different forms of Hg has been given in **Table–1**.

Table–1 : Different Forms of Mercury

Form	Source	Transport & Fate	Toxicity level
Elemental mercury (Hg^0)	95% of atmospheric Hg is Hg^0 vapour	Tends to remain airborne, not easily deposited, may travel long distance before conversion to other forms	Minimum, almost non toxic
Inorganic mercury, mostly in divalent form (Hg^{2+})	Comprises only 5% of atmospheric Hg, mostly found in soil and water as complex ions	Easily deposited to earth's surface in dry form or in precipitation. Once in water may volatilise or partition into particles and may be transported to sediments	High
Organomer-curials (eg. Methyl-mercury)	Lipid soluble ion produced by bacteria in water or sediment, nearly all mercury in fish is methylated	Enters food chain through aquatic biota and uptake into fish, accumulates as it travels up the food chain, reaching highest concentrations in organisms at the highest trophic level	Maximum

MAJOR SOURCES

Most of the world's Hg is stored in the bedrock and deep-sea sediments. Hg is found at several places on earth surface as cinnabar (HgS). Hg gets volatilised from rocks, soil and water due to geothermal and volcanic activities. The total global input of Hg has been estimated to be 10^{10} g. About 10–50 per cent of this flux originates from anthropogenic sources. Indiscriminate use of Hg compounds in industries and agriculture leads to an increase in Hg level. The highest amount of Hg comes from the chloralkali plants which use Hg electrodes in manufacturing Cl_2 and NaOH. The second largest users of Hg are electrical industries making Hg vapour lamps, electric switches, batteries, etc. The third largest consumers are the agricultural industries with Hg^- based pesticides and fungicides[3, 4, 5].

The increasing prevalence of electrical and electronic manufacturing industry as a user and contributor of Hg in Asia is also worrying. Specifically, disposal of obsolete electrical and electronic wastes increases Hg load in ecosystem and biota. A single PC with recent technologics contains 500 mg of Hg. After disposal, the entire amount comes to environment since the recycling efficiency is zero[6]. All these increase the load of Hg waste in environment and pose a severe threat to living systems.

Elemental Hg has been found to have a very long life span in environment. It has a residence time of 1 year in the atmosphere. Other Hg compunds are washed by rainwater and are ultimately put in oceans where they survive for a long period. Transportation, conversion and fate of Hg compounds have been compiled in **Table–1**.

PERMISSIBLE LIMITS

The Prevention of Food Adulteration Act and Rules, 1955 has declared Hg as a poisonous metal. The Ministry of Commerce has limited its concentration in fish to 0.5 ppm (mg/Kg) and in other food items to 1.0 ppm (mg/Kg). The concentraion of methylmercury, one of the most abundant organomercurials, has been restricted upto 0.25 ppm (mg/Kg). The Bureau of Indian Standards has laid down its safety limits in drinking water at 0.001 ppm (mg/L). The permissible limit of Hg set by the Central Pollution Control Board during discharge of industrial waste in river is 0.01 ppm (mg/L) **(Table–2)**.

Table–2 : Permissible Limits of Mercury Compounds as Directed by the Ministry of Commerce and Ministry of Forest and Environment, Govt. of India	
Component	**Permissible Limit**
Water	1.0 μg/L
Compost	0.15 mg/Kg
Treated leachate	10 μg/L
Fish	0.5 mg/Kg

PRESENT SCENARIO

A recent study conducted by the Centre for Science and Environment has shown that imports of metallic Hg into India have more than doubled between 1996 and 2002, from 254 tonnes per annum to 553 tonnes a year. The study, based on the figures released by the Directorate General of the Commercial Intelligence (DGCI), also found that import of organomercurials, including pesticides and biocides, has jumped from 0.7 tonnes to 1812 tonnes during the same period. India now consumes 50% of global production of Hg. The Global Mercury Assessment Report of UNEP (2002) obtained from the first global study of Hg has said that India could be one of the 12 hot spots for Hg pollution. In India, chloralkali industries are still the major sources for Hg release **(Table 3)**.

Table–3 : Annual Release of Hg by Chloralkali Plants		
Year	**Caustic soda production (MT)**	**Average annual Hg loss by a plant (MT)**
1997-1998	676474	96.1
1998-1999	514852	73.1
1999-2000	475603	67.5
Average values (per year)	555643	78.9

There are 42 major chloralkali plants of which 21 uses Hg cell for their production. They alone contribute 40 per cent of the total Hg pollution in the country. The average Hg-loss from Hg-cell plants in 142 gm per MT NaOH produced. From 1996 to 2000, the average Hg released from chloralkali plants was 79 tonnes. The figure is 50 times more compared to the global best companies. The fall-out of element Hg over the soil horizon in the vicinity of a steel plant was reported to be in the range of 60.36–836.18 gm/km^2/month. The total pollution from coal is estimated to be 77.91 tonnes per anum, assuming the average concentration of Hg in coal as 0.272 mg/Kg. About 59.29 tonnes of Hg per annum is mobilised from coal-based thermal power plants. The five super thermal power plants in the Singrauli area, which supply 10 per cent of India's power, contribute 16.85 per cent of this pollution.

Some major rivers tested for heavy metals by the Industrial Toxicological Research Centre, Lucknow, were found to contain Hg in alarming levels. Several studies revealed presence of Hg in marine organisms collected from different coastal regions of India. The result have been summarised in **Table–4**.

Table–4 : Concentration of Total Hg in Biota Collected from Different Coastal Parts of Peninsular India		
Location	**Hg concentration**	**Organism**
Madras, southeast coast	0.08-0.14 mg/kg wet wt	Fishes
Karwar, west coast	0.03-0.003 μg/g wet wt	Fishes
Mumbai, west coast	0.03-0.82 μg/g dry wt	Fishes
Mumbai, west coast	1.42-4.94 μg/g dry wt	Crabs
Sagar Island, east coast	0.06-2.24 μg/g dry wt	Bivalves

Hg pollution outside India is also quite alarming. Even the US is also not devoid of this scar. Samples collected from sediments of Great Lakes have shown that concentrations of Hg is the highest in the Lake Onterio with the maximum level of 1.4 μg/g. Details of the Hg levels in the Great Lakes are given in **Table–5**. A study carried out by US Geological Survey, Denver, has confirmed Hg pollution in the mines of South Western Alaska. Stream-sediment samples collected downstream from the mines contained as much as 5,500 μg Hg/g. Unfiltered stream-water collected below the mines contained 500–2,500 ng Hg/L whereas, corresponding stream-water samples filtered through a 0.45 micron membrane contained less than 50 ng Hg/L. These result indicate that most of the Hg is transported downstream from the mines as finely-suspended particles, rather than dissolved Hg.

Table–5 : Concentrations of Hg in Sediments of Great Lakes

Lake	Sampling Year	Hg concentrations (μg/g)		Reference
		Maximum	Minimum	
Lake Superior	1994-1996	0.260	0.002	R. Rossmann, Journal of Great Lake Research, ***25***, 683, 1999
Lake Michigan	2000	0.328	0.005	C. H. Marvin *et al,* Journal of Great Lake Research (b), ***79***, 317, 2002
Lake Huron	2002	0.367	0.005	C. H. Marvin *et al,* Environmental Research, ***95***, 351, 2004.
Lake Erie	1997-1998	0.940	0.006	S. C. Painter *et. al.*, Journal of Great Lake Research, ***27***, 434, 2001
Lake Ontario	1998	1.40	0.005	C.H. Marvin *et al,* Journal of Great Lake Research (a), ***28***, 317, 2002

A recent sttudy in New Jersey revealed some alarming facts about the fishes in different lakes and other water bodies in the US. For tuna, sea bass, croaker, whiting, scallops, and shrimp, the levels of Hg were higher than 1,000 ng Hg/g fish-far beyond the safety level set by the US Food and Drug Administration (FDA). Through the food web, these would incorporate into the humans as well. Hg, cadmium and lead levels in water, sediment and fish samples from Izmit Bay, Turkey, have been determined and revealed figures beyond the permissible limits[7, 8].

Guanabara Bay, in Rio de Janeiro state, is impacted by organic matter, oil and heavy metals. Dissolved Hg concentration in esturine water samples collected from this region ranged from 0.72 to 5.23 ng/L. Total Hg in mussel ranges from 11.6 to 53.5 μg/kg wet wt, varied with sampling point and water quality. Carnivorous fish showed higher Hg concentrations (199.5 μg/kg wet wt) than organisms from other feeding habits and lower trophic levels **(Table–6)**.

Table–6 : Mercury Pollution Outside India

Site	Sample	Mercury concentration
United State, Southern Alaska	(a) Stream sediment	(a) 5500 μg/g
	(b) Unifiltered stream water	(b) 500-2500 μg/L
	(c) Filtered stream water	(c) <50 μg/L
New Jersey	(a) Fish	(a) 100 μg/g
Guanabara Bay, Rio de Janeiro	(a) Estuarine water	(a) 0.7-5.23 ng/L
	(b) Mussel	(b) 11.6-53.5 μg/Kg of wet weight
	(c) Carnivorous fish	(c) 199.5 μg/Kg wet weight

A quantitative study of environmental risks due to Hg in Singrauli, a major site of thermal power generation in India, has shown 20 times higher Hg level in blood of exposed person compared to the controls. The exposed persons have shown 10 times higher Hg than normal individuals[9]. High concentration of Hg has been obtained in breast milk and blood samples collected from residents of an integrated steel plant township in Central India. Hg along with lead (Pb) and manganese (Mn) have shown a higher tendency to associate with blood and breast milk than other heavy metals like arsenic and cadmium[10]. Concentrations of Hg in blood and hair have been found to be as high as 100 µg/dl and 8 µg/g in people living near chloralkali plants. These values are 5 µg/dl and 8 µg/g respectively in unexposed population. Hg levels in exposed individuals in India are given in **Table–7**. Hg can

Table–7 : Hg Levels in Body Fluids and Hair in Exposed Individuals in Different Places of India

Source of exposure	Sample	Hg level in exposed population	Hg level in unexposed population
Chloroalkali plants	Blood Hair	100 µg/dl 8 µg/g	5 µg/dl 1 µg/g
Coal-fired industry	Bronchial wash	20-85 µg/ml	
Thermal power industry	Do	16-56 µg/ml	
Cement industry	Do	10-17 µg/ml	
Dental amalgam filling	Blood	20 µg/dl	5 µg/dl

induce hemolysis after in vitro exposure to blood collected from healthy individuals. The effect becomes more pronounced with simultaneous application of selenium[11].

MECHANISM OF TOXICITY

Hg has been recognised as a general cellular poison and effective protein precipitant. Hg vapour is almost completely absorbed through the alveolar membrane and is oxidised in blood and tissues before reacting with biomolecules. After acute administration of Hg salts to animals and man, the highest levels of inorganic Hg are found in kidneys and the second highest concentration in liver. Due to their lipid solubility, organomercurials are many times more toxic to man than the metallic form. The earliest cases of poisoning were due to occupational exposure following the introduction of methylmercury compounds as antifungal seed-dressing agents. Reports of poisoning from non-occupational sources appeared with increasing frequency from 1950 onwards. The primary signs and symptoms of methylmercury poisoning result from damage to the nervous system. It is characterised by ataxia (loss of coordination), dysarthia (slurred speech), paresthesia (loss of sensation at the extremities of limbs and mouth), tunnel vision (constriction of visual field) and loss of hearing. Severe poisoning can cause blindness, coma and death[3].

The neurotoxic effect of Hg can be attributed to the inhibition of acetylcholine esterase activity, an important enzyme involved in neurotransmission. Frasco *et al*[12] have found reduced activity of the enzyme with a direct exposure to Hg. Basu et al[13] have studied the effect of methylmercury and $HgCl_2$ on binding to the muscarinic cholinergic receptor in cellular membranes isolated from the cerebrums of the ringed seals (*Phoca hispida*). Both methylmercury and $HgCl_2$ inhibited binding of ligand to the receptor by more than 50%. Inhibitor constant (Ki) values were found to be same for both the compounds. Methylmercury binds with receptors present on astrocytes resulting in their swelling. It increases the release of excitatory amino acids like glutamate leading to an increased extracellular glutamate levels ensuing neuronal excitotoxicity and degeneration. Mutkus et al have carried out experiments with Chinese hamster ovary cells transfected with glutamate transporter subtypes GLAST and GLT-1 to find out the mechanism of Hg toxcity. According to their report, methylmercury selectively increases glutamate transporter mRNA expression. Methylmercury treatment at doses ranging from 5–10 µM for 6 hours led no significant changes in expression of GLAST, but GLT–1 mRNA expression was significantly increased. They have also noted selective changes in expression of glutamate transporter proteins. GLAST transporter protein levels were significantly increased whereas GLT-1 transporter level was decreased. Methylmercury also inhibits glutamate uptake by GLAST transporter. Rats injected with methylmercury at a dose of 0.05 mg/kg body wt have shown increased expression of c-FOS protein in cortex and hippocampus after 20 minutes of exposure. The immediate early gene c-fos participates in the process of brain injury due to Hg exposure.

$HgCl_2$ can cause acute renal failure in rats, its main target being the proximal tubules. A single dose of $HgCl_2$ (3.5 mg/kg body wt) induced oxidative damage in kidney. Stress proteins like HSP72, GRP75 and metallothionein were over-expressed in proximal tubules. The treatment resulted in an increased activity of the enzyme inducible nitric oxide synthetase (iNOS) in kidney. Mice receiving a subcutaneous injection of $HgCl_2$ (4.6 mg/kg body wt) showed an increased level of non-protein thiols in their kidney.

Sutton *et al* have exposed human liver carcinoma cells (HepG2) to different concentrations of $HgCl_2$ for 10 and 48 hours. A gradual increase in early and late-stage apoptosis was observed with increased concentrations of Hg. A dose response relationship was also observed between Caspase activity and dose of Hg. Exposure of Hg salts to bovine endothelial monolayer caused profound cytotoxicity detected by increased lactate dehydrogenase leakage. Depletion of glutathion and ATP and complete inhibition of thiol enzyme activities were observed due to Hg exposure.

REMEDIAL MEASURES

Treatment of Hg toxicity involves removal of the metal by administering chelating agents, either orally or by injection. Frequent gargling wth alum and potassium chlorate or borax can be useful against acute exposure. Low-molecular-weight organic compounds like dimercaprol (BAL), unithiol (DMPS), N-acetyl D-penicillamine (DPA) chelate the metal ion in blood and favour excretion through kidney. Another group of drugs chelates Hg from liver excretes through feces[3]. The common therapeutic agents have been listed in **Table–8**.

Table–8 : Common Therapeutic Agents used Against Mercury Toxicity

Compound used against mercury toxicity	Chemistry	Mode of adminis-tration	Mode of action
Quinoline derivatives	Sufficiently high molecular weight and contain both polar and non polar part	Oral	Disturb filtration through the glomerullus and induces billiary excretion
Analog of bile salts	Resembles sodium tourocholate and change the corresponding charge upon binding with metal ions	Oral	Hinder reabsorption in kidney and favour elimination of the metal via feaces
Fatty acids analog	Resembles fatty acids but contained polar end groups that are resistant to normal metabolism of fatty acid.	Oral	Prevent absorption of metal from the stomach
Indigestible polymers	Contain characteristics for divalent metal ion	Oral	Remove metal ions from enterohepatic circulation via formation of stable complex
Sulfhydryl (-SH) compound	Substitute polystyrene polymer with -SH group	Injection	Bind with metal ions with SH groups
Chelating agent (BAL, DPA & DNPS)	Contain COOH groups for chelating	Injection	Chelate metal ions from blood only

Removal of Hg from polluted sites includes incineration at high mercury concentrations, and safe storage in landfills or in underground storage at low concentrations. Bioremediation is one of the potent methods that can be used for Hg reduction. The method relies on the potential of the mer-operon-based resistance mechanism in bacteria, which functions by enzymatic breakdown of organomercurials and reduction of mercury ions (Hg^{+}, Hg^{2+}) to water-insoluble metallic Hg. The enzymes involved in this process are organomercurial lyase and mercuric reductase. The former converts an organomercury compound to mercuric ions (Hg^{2+}) and the latter reduces Hg^{2+} to metallic mercury (Hg) with the help of NADPH. Hg thus produced diffuses out of cells and accumulates in pure form in the medium. The high vapour pressure of Hg ultimately results in its volatilisation from media. von Canstein *et al* have used a Hg-resistant bacterial strain, *Pseudomonas putida* Spi3, isolated from river sediment for treatment of chloralkali wastes, Biofilms of *P. putida* Spi3 were grown on porous carrier material in laboratory column bioreactors and fed with chloralkali waste water with 7-9 mg/L Hg. The bacteria carried out Hg reduction with 90-98 per cent efficiency.

Ravel *et al* have isolated two actinomycete strains, CHR3 and CHR28, from metal-contaminated sediments from Baltimore Inner Harbour which were found to be resistant to $HgCl_2$ and phenylmercuric acetate (PMA). Hybridisation experiments indicated that genes homologous to mercuric reductase nad organomecurial lyase of *Streptomyces lividans* were present in the strains.

Pahan *et al* have isolated broad-specrum Hg-resistant *Bacillus pasteurii* strain DR2 from industrial effluent of Durgapur Steel Plant. The strain grew in presence of PMA as the sole carbon source and could tolerate phenylmercuric acetate (PMA) upto a concentration of 40 µM. The enzyme PMA lyase synthesised by the bacteria was found to degrade not only PMA but also other organomercurials like methylmercuric chloride and methoxyethylmercuric chloride[14]. Mercury resistant bacteria isolated from guts and gills of fishes collected from East Kolkata wetland could tolerate high level of Hg. Narrow spectrum Hg-resistant bacteria could reduce $HgCl_2$ from liquid medium in the range of 64-89 per cent. The broad-spectrum Hg-resistant bacteria volatilised $HgCl_2$ at the level of 80–94 per cent and PMA 72-84 per cent[15].

Lemna minor (duckweed) is another prospective tool for absorbing Hg from polluted water. High concentrations of Hg has been found in the plant samples collected from Tiljala wetlands of the eastern fringes of Kolkata that serves as a sink for deposition of urban and industrial wastes. Natural unexposed population of duckweed, when cultivated in laboratory, was also found to accumulate Hg[42]. Bizily *et al* have engineered a model plant *Arabidopsis thaliana* with a bacterial gene merB, the product of which converts organomercurials to inorganic Hg. Transgenic plants expressing the gene could tolerate a wide range of concentrations of monomethyl mercuric chloride and PMA[16].

The usual process for removal of mercury is the safe storage in landfills or in underground sites at low concentrations. In European countries, the process effluent from chloralkali factories is currently cleaned by hydrogen sulfide precipitation, hydrazine precipitation or ion exchange columns[17]. The processes ultimately lead to confined dumping of mercury instead of its removal. A representative plant for removal of mercury from industrial wastes using a bioreactor is shown in **Fig–1**.

The technologies related to chemical engineering for Hg removal are expensive and disruptive. Excavation and roasting of soil in the Hg-contaminated sites is considered as the best demonstrated treatment technology[17], but it is impractical for very large sites and requires a high amount of energy. Vitrification and concrete capping, which aims to stabilise Hg, render the site uninhabitable for plants, insects and other organisms. Bioremediation seems to be an ideal treatment that would degrade organomercurials, sequester other Hg forms and convert Hg to the least toxic chemical species without disturbing biological productivity.

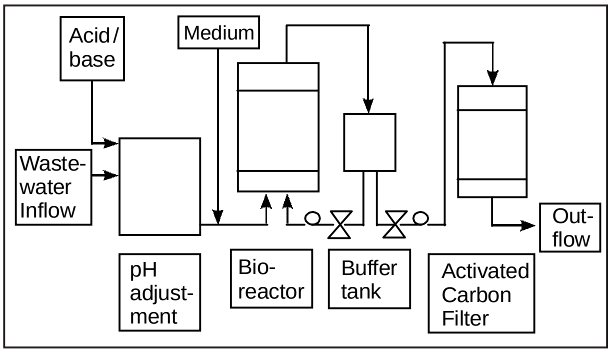


Fig. 1 : *A schematic diagram of a mercury removal plant using a bioreactor*

REFERENCES

1. M. Harada. *Crit. Rev. Toxicol.,* **25**, 1, 1995.
2. F. Pearce, *New Scientist,* **February 6,** 1999.
3. S. Mitra, Mercury pollution : Poisoning and Therapy, in Mercury in the ecosystem, 1986, p. 195, (Transtech Publications, Switzerland).
4. N. Gupta and A. Dua, Bull, *Environ. Cotam. Toxicol.,* **74,** 1105, 2005.
5. M. Lenka, K. K. Panda, B. B. Panda, *Arch. Environ. Contam. Toxicol,* **22,** 195, 1992.
6. C. S. Wang, N. S. Duzgoren-Aydin, A. Aydin M. H. Wong, *Sci, Total Environ*, **15**, 268, 2006.
7. F. Kucuksezgin, A. Kontas, O. Altay, E. Uluturhan and E. Darilmaz, *Environ. Int.* **32**, 41, 2005.
8. K. Taymaz, V. Yigit, H. Ozbal, A. Ceritoglu and N. Muftugil. *Int. J. Environ. Anal Chem.,* **16**, 253, 1984.
9. Industrial Toxicology Research Centre, Lucknow, Monitoring and analysis of mercury contamination in Singrauli region, 1998, p. 73, (National Thermal Power Corporation Ltd, New Delhi).
10. R. sharma and S. Pervez, *Environ. Geochem. Health,* **27**, 39, 2005.
11. R. Brandao, F. S. Lara, L. B. Pagliosa, F. A. Soares, J. B. Rocha, C. W. Nogueria and M. Farina, *Drug Chem. Toxicol.*, **28**, 397, 2005.
12. M. F. Frasco, D. Fournier, F. Carvalho and L. Guilhermino, *Biomarkers,* **10**, 360, 2005.
13. N. Basu, M. Kwan, H. M. Chan, *J. Toxicol Environ Health,* **69**, 1133, 2006.
14. K. Pahan, R. Gachhui, S. Ray, J. Chaudhuri and A. Mandal, *Ind J Exp Biol*, **29**, 1147, 1991.
15. P. C. Sadhukhan, S. Ghosh, J. Chaudhuri, D. K. Ghosh and A. Mandal, *Environ. Pollut.* **97**, 71, 1997.
16. S. Mukherjee, S. Mukherjee, P. Bhattacharyya and A. K. Dattagupta, *Environ. Int.,* **30**, 811, 2004.
17. S. P. Bizily, C. L. Rugh, A. O. Summers and R. B. Meagher, Proc. *Natl Acad, Sci. USA,* **96**, 6808, 1999.

DO YOU KNOW ?

Q4. You weigh 60 K. on earth. How much would you weigh in Mars and Moon ?

Q5. The weighing balances weigh what–mass or weight.

Q6. Which present day district came to West Bengal only in 1956 from Bihar :

THREATS OF INSECT EXTINCTION : AN OVERVIEW

Sheela Thakur* and Priti Kumari*

In recnt years, threats of insect extinction have increased rapidly due to human interference in natural ecosystem. The most affected groups of documented insect extinctions are Lepidoptera and aquatic insects. The need of the hour is to create awareness among the people about the importance of conserving the biodiversity and its impact on the stability of the ecosystem which is vital for our very sustenance and survival on the earth. The time is now to focus more research and funding on conserving insects alongwith suitable laws and regulations to protect the insect biodiversity.

INTRODUCTION

Extinction is a natural feature of evolution because for some species to succeed, others must fail. But the extinction rate is increasing rapidly today as a result of human interference in natural ecosystem. For the foreseeable future, this decline is set to continue because evolution generates new species far more slowly than the current rate of extinction. The majority of animals on the planet are insects. If 57 per cent of metazoan species are insects, Pimm and Raven's (2000) estimate equates to 57,000 insect extinction per million species on the earth in the next 50 years. Other estimates[1] would yield higher values of insect extinctions. Despite the ecological benefits of insects as pollinators, weed killers, parasites, predators and detritivores and their role in food chain and in improving the soil quality, the majority of human population does not even imagine their importance and the threat they face through extinction. As Harvard Biologist E.O. Wilson (1992) wrote, "so important are insects and other land dwelling arthropods, that if all were to disappear, humanity probably could not last more than a few months"[2].

* Department of Entomology and Agril. Zoology, Rajendra Agricultural University. Pusa (Bihar), Samastipur—848125, India.

THE "DATA SET" OF EXTINCT INSECTS

The international Union for Conservation of Nature and Natural Resources (IUCN) lists 72 insects as extinct worldwide. In the United States, the Natural Heritage Programme lists 160 insect species either as presumed extinct or as missing and possibly extinct. The loss in tropical areas has probably been much greater. According to the IUCN (1987) in the United Kingdom, a mid 1980s survey revealed that 13 per cent insect population was in decline and 4 per cent was considered to be endangered (Fig. 1).

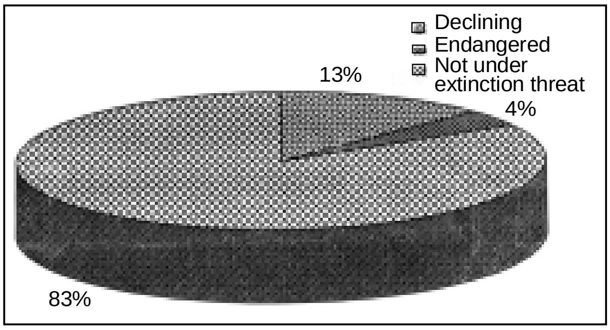


Fig. 1. *Pie diagram showing the proportion composition of insects in UK based on IUCN 1987.*

The "data set" of extinct insects highlighted that little has been recorded about the demise of extinct insect species, even for observed extinctions. The only information in the IUCN database for extinct insects is from the country and region in which it lived and some times the year in which it was recorded. More than half of all recently documented insect extinctions are of Lepidoptera (37 species ; IUCN, 2002), arguable the best-studied insect taxon. Aquatic insects are particularly at risk, with four mayflies likely extinct from the United States alone[3].

CAUSES OF EXTINCTION

Humans appear to have intentionally extinguished a variety of insect species, including several species of Hawaiian moths. Intentional introductions of biocontrol agents appear to have led to the local, if not global, extinction of a variety of insects[4]. Because most insect species are parasites, the most restricted habitat occupied by many insects is arguably their host. Stork and Lyal highlighted[5] the possibility that many parasites may go extinct when their hosts go extinct. Recently, reportedly, no fewer than 100 species of beetles, lice and butterflies alone are likely to have gone extinct because of the extinction of their hosts during the last 200 years[6]. Social insects appear to be disproportionately susceptible to extinction because of their small effective population sizes[7]. Besides, pesticides and other pollutants are implicated in the decline of many native bees and some aquatic insects.

CONSERVATION EFFORTS

The need of the hour is to create awareness among the people about the importance of conserving the biodiversity and its impact on the stability of the ecosystem. It is vital for our very sustenance and survival on the earth. Conservationists have concluded that the current, widespread destruction of the earth's biodiversity must be matched by a conservation response in an order of magnitude greater than currently followed.

In these efforts, habitat selection appears as one of the important steps needed to preserve any species. For the preservation of species, management staff should have an appropriate idea about the exact habitat which the specific species needs. One important caveat for seeting aside land for insects is that species often have subtle habitat requirements, and can be lost even from reserves because of appearently minor habitat changes. In the long run, more emphasis needs to be placed on survey, systematics, taxonomy, and population ecology so that these species can be identified, catalogued, and their life histories understood. Research needs to go hand in hand with conservation, as there is little use for a catalogue of extinct species. To conserve beneficial insects from the impact of insecticides, the insecticide selectivity has to be achieved in relation to the tritropic biochemical interactions between host plants, pests and natural enemies by incorporating natural toxicants, antifeedants, suppressants, juvenoids or antijuvenoids into crop plant tissue by genetic engineering[8].

Legislative efforts is another vital step for the protection of endangered insects. Acts like the United States Endangered Species Acts (ESA) are said to be the effective biodiversity legislations to protect endangered or threatened species and propose a recovery plan. For most developing countries in the world, protective legislation for insects is either lacking or only sporadically applied. The Indian Wild Life Protection Act, 1972 and amended in 1991 provides protection to wildlife including insects particularly the endangered species and stringent punishment for its violation. India has enacted its Indian biodiversity Act in 2002. It prohibits unauthorized exploitation of biological resources of Indian origin and also proposes to constitute a National Biodiversity Authority (NBA) at Chennai, South India which ensures equitable sharing of biological resources, protection of traditional knowledge, promotion of State Biodiversity Boards (SBB) and Biodiversity Management Committee (BMC) for better conservation, sustainable use and documentation of biodiversity at grass root level[9].

The Zoological Survey of India survey the faunal resources of the country. Centre for ecological studies at the Indian Institute of Science, Bangalore; Wild Life Institute of India, Dehradun ; Bombay Natural Histroy Society, Mumbai ; National Museum of Natural History, New Delhi and many other similar institutions promote conservation of Indian fauna. Captive breeding of endangered species and reintroduction of captive bred individuals to wild are suggests for insects.

CONCLUSION

To conserve insects sucessfully, the general public, scientists, land managers and conservationists need to understand the extraordinary value that these organisms provide. Realizing the extent of extinction threat of insect species and the need to conserve the extant species, we need to focus more funding and research on conserving insects alongwith suitable laws and regulations to protect the insect biodiversity. Besides, the awareness has to be created with formal and non-formal education programmes ; through curriculum changes in the educational institutions and through mass media such as newspapers, magazines and televisions, internet, etc. Finally, the time is now for agencies, scientists, conservationists, and land managers to promote the conservation of imperiled insects.

REFERENCES

1. C.D. Thomas. *Nature*, **427** : 145-148, 2004.
2. E.O. Wilson. The diversity of life. W.W. Norton company. Inc., New Delhi, N.Y., 1992.
3. W.P. Mc Cafferty. *Entomologist*, **77** : 210-218, 2001.
4. F.G. Howarth. *Entomology*, **36** : 485-509, 1991.
5. N.E. Stork and C.H.C. Lyal. *Nature*, **366** : 307, 1993.
6. L.P. Koh, R.R. Dunn, N.S. Sodhi, R.K. Colwell, H.C. Proctor and V.S. Smith. *Science* **305** : 1623-1634, 2004b.
7. R.E. Chapman and A.F.G. Bourke. *Ecology Letters*, **4** : 650-662, 2001.
8. B.A. Croft. Arthropod biological control agents and pesticides. New York : John wiley & sons, 1990.

DO YOU KNOW ?

Q7. What is Phycology ?

Q8. What is Cacaphobia ?

MATHEMATICAL MODELLING IN SOCIAL PSYCHOLOGY : SOCIAL NETWORKS : PART II

Belmannu Devadas Acharya* and Shalini Joshi**

Continuing our exposition to some elementary aspects of combinatorial graphs that serve as 'structural models' for certain cognitive processes involved in the dynamics of social groups, we embark here to introduce some fundamental notions about 'cognitive balance' in social systems.

INTRODUCTION

In the ambisidigraph S of Figure-2 in the first part of this article (Everyman's Science **40**, 2, 124-128, 2005), we had considered the two triangles $T = (A, (A, C)^{-}, C, (C, B)^{+}, B, (B, A)^{-}, A)$ and $T' = (A, (A, C)^{-}, C, (C, B)^{+}, B, (B, A)^{+}, A)$ and desired to see if there is any interesting difference between these two triangles. As read from *T*, *A* dislikes *C*, *C* likes *B* and *B* dislikes *A* whereas in T′, we have the situation in which *A* dislikes *C*, *C* likes *B* and *B* likes *A*; we raised the question : ***what can one infer from the situation presented by T′ about C's disposition towards A?***

DISCUSSION

There could be many practically appealing interpretations of the situation. First of all, considered on their own right as triads, one may easily identify some straightforward features in which they differ : (i) in *T* the mumber of negative arcs is even whereas in *T′* this number is odd ; (ii) there is exactly one vertex in *T* at which both 'incoming' arc and the 'outgoing' arc are negative whereas in *T′* there is exactly one vertex at which both incoming and the outgoing arcs are positive.

One of the principal concepts in soical psychology in analyzing such situations is that of *reciprocity.* The behavioural phenomenon of *reciprocity* is well imbedded in the so-called 'Dyadic Interaction Paradigm' (DIP) according to which[1] 'The defining hallmark of interaction is *influence;* each partner's behaviour influences the other partner's subsequent behaviour...within a single interaction episode and each interaction episode influences future episodes. ...dyadic relationships are maintained by two individuals... the nature of their interaction is determined not by one partner's properties but by the interaction of the properties of both partners, by the social and physical environments in which they interact, and by how all these causal conditions interact with each other. ...'.

In this light, one can define *reciprocity* as the *behavioural tendency* of an individual (or even a 'group') to respond to another in a manner consistent with the nature of the latter's displayed behaviour or actions; in literature, this defintion appears to have been taken as granted[2]. However, in *real-life,* it is not difficult to notice situations in which *response* of an individual (or group) need not be 'consistent with' *stimulus* in general, but it could be even 'inconsistent with' the nautre of the stimulus ; for example, *aiding a habitual cheater may not bring any benefit.* In effect, we need to modify the above definition of the term *reciprocity* to mean just a behavioural tendency of an individual

* Department of Science & Technology, Government of India, "Technology Bhawan", New Mehrauli Road, New Delhi–110 016 ; E-Mail : bdacharva@vahoo.com.

**Liaison Office, DST-RMS LNSM Field Office, 8/1, 13th Cross, Aadipampa Road, V.V. Mohalla Mysore–570 002. E.Mail: shalinijoshi2000@yahoo.com.

(or group) to respond to another whenever the latter displays certain behaviour or action towards the former. From the broad points of view mentioned above, we now get back to analyse the situations presented and mentioned earlier in the question raised about the inherent differences in the two traids. *T* and *T′*. Applying the notion of reciprocity to the dyadic relations imbedded in these two triads, we may deduce the following analysis assuming that in each case expressed attitudes or behaviours of one are noticed by the other in each dyadic interaction and may or may not cause a response by the other.

Situation present by the structure of T : *A* dislikes *C* whence *C* may or may not respond to *A*'s dislike for him. If, however, *C* decides to respond, his response to *A* may either be positive or negative or both ('mixed' or ambivalent reaction). If it is positive or even mixed, then it would represent somewhat unnatural situaton in which *C*'s liking *A* even to a limited extent, despite the fact that *C* knows *A*'s dislike for him, would create *tension* not only between *A* and *C*, but also between *B* and *C* since *B*, who may have responded positively to *C* due to *C*'s liking for *B*, would not like *C*'s liking *A* whom *B* doesn't like. Since so much tension in the triad would render the triad {*A, B, C*} *unstable*, and since the stability of a larger social group is perceived to be a commonly felt need for accommodating well being of its individuals and subgroups, *C* would find it beneficial (or safe!) to maintain status quo with regard to his being disliked by *A*. Similar arguments in respect of other dyadic interaction existing in *T* would lead to the same conclusion. Thus, *there is no motivation to change the pattern of existing interrelationships among the members of T.* Such a structural state of a social group is termed *strucutrally stable* and hence the triad is said to be *balanced.*

Situation presented by the structure of T′ : Here, *A* likes *C* whence *C* may or may not respond to *A*'s like for him. If, however, *C* decides to respond, his response to *A* may either be positive or negative or both ('mixed' or ambivalent reaction). Negative response to a positive stimulus is unnatural and hence unlikely; however, it may be mixed sometimes, as for instance in the initial or in a fleeting episode of encounter, expression of *A*'s liking for *C* may be met with a response by *C* inhibited by suspicion or distrust! But, in any case, some amount of positivity in the reaction of *C* towards *A* in response to *A*'s expression of liking for *C* must exist, and this may be *full* in the sense that *C*'s response to *A* may be fully positive too. However, since *C* likes *B* and *B* does not like *A*, *C* would not tend to be fully positive with *A* for otherwise it may alienate him from *B*, who may show his displeasure about *C*'s noticeable positvity with *A* whom *B* does not like. Thus, *C* would have to keep his positive inclinations, if any, towards *A* to an extent not noticeable by B! This would cause tension in *C* which would force him to alienate from *A* enentually. On noticing such a subdued and negatively inhibited response from *C* would then prompt *A* to switch his liking for *C* to dislike, whence the triad {*A, B, C* would eventually become identical to *T* which represents a stable state of the traid. Since in *T′* there is such a *tendency towards transition into a stable state* as described above this *structurally unstable state* presented by *T′* qualifies *T′* to be called an *unbalanced* triad.

The kind of socio-psychological arguments to decide whether a given social group is structurally stable or unstable would become extremely complex and formidable when the number of individual members in the group, referred to as *order* of the corresponding social network, increases and generally the ground situation being so in practice, we need to appeal to mathematical representation of the essential ideas involved in the analysis. Next, given any signed digraph *S* (that is, an ambisidigraph in which every pair of distinct vertices (*representing individuals in the social* *group*) is interconnected by at the most one arc (*representing evaluative relation existing between the individuals)* which may be either positive or negative; in socio-psychological literature, such configurations are called *sociograms*. Given a sociogram S of order p, one can associate with S a $p \times p$ matrix whose elements are from the set {–1, 0, 1}, called the ***adjacency matrix*** of S and denoted $A(S) = (a_{ij})$, defined as follows : Let the vertices of S be labeled as $v_1, v_2, v_3, ..., v_p$. Then, let a_{ij} = –1, 0 or 1 according to whether the arc (v_i, v_1) is negative, (v_i, v_1) is not an arc in S or (v_i, v_1) is a positive arc in S. For example, $\boldsymbol{A}(T)$ and $\boldsymbol{A}(T')$ obtained in this manner are given below.

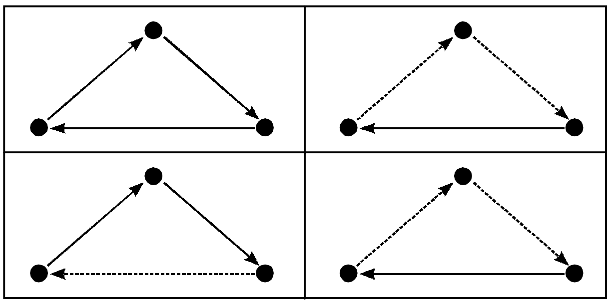
$$A(T) = \begin{pmatrix} 0 & 1 & -1 \\ -1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \quad A(T') = \begin{pmatrix} 0 & 0 & 1 \\ -1 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix}$$

Conversely, given any *square (–1, 0, 1)–matrix* $\boldsymbol{A} = (a_{ij})$ of order p one can construct a signed digraph $S(A)$ uniquely as follows : Take *p vertices* $v_1, v_2, v_3, ..., v_p$ and *join* the vertex v_i to the vertex v_j by a positive (negative or no) arc whenever $a_{ij} = 1$ (respectively, –1 or 0). Thus it is easily seen that *signed digraphs are uniquely represented by their adjacency matrices*. This is mathematical representation of a signed digraph. In particular, the 'three-by-three' (–1, 0, 1)-matrics $\boldsymbol{A}(T)$ and $\boldsymbol{A}(T')$ shown above uniquely represent the triads T and T', respectively. So, what next? Using this representation, can we show somehow that T and T' are *mathematically different in some nontrivial sense?* Such a conclusion, as mentioned already, is essential if we want to derive meaningful inferences about larger soical systems using available mathematical methods. In this particular case, we expect to use methods of matrix theory to analyse states of *socio-psychological stability* of a social group. This, obviously, would need a proper mathematical representation of the aforesaid socio-psychological notion of structural stability of a social group of an arbitrarily given order as, in practice, we may encounter social groups of any order. Hence, in what follows, we shall introduce this notion.

THEORY OF BALANCE IN SOCIAL SYSTEMS

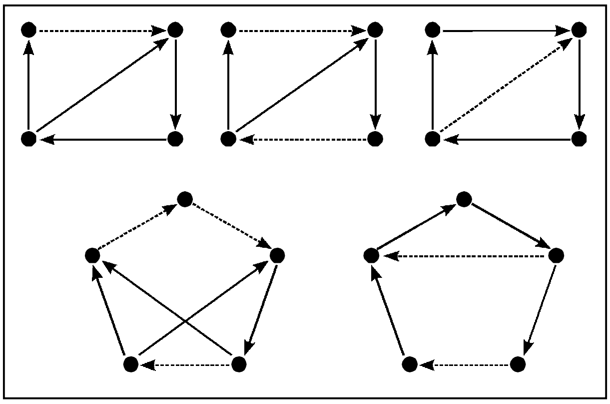
It is now well established that *effect* (attitude) has a direct influence on behaviour. Further, the different *attitudes* which an individual holds are *consistent* in his or her mind when they do not cause a state of *psychological tension* to the person. *Psychological consistency* of a person, therefore, depends on holding of attitudes which are not contradictory with one another. Based on this fundamental notion in *personal psychology, interpersonal interaction* between two individuals has been defined as being in a state of *balance*[3] whenever there is no conflicting attitude noticed betwen them, expressed by one and felt by the other, and described the notion also in the case of a *triad,* viz., a social group consisting of three person. Later this notion has been extended to social groups consisting of any number of persons thereby laying the foundation of the theory of balance in *social system*[4].

Figure-1(a) depicts some distinct balanced as well as some unbalanced sociograms in a traid and



1(a) *: Some sociograms on a triad*

Figure-1(b) depicts some other such 'higher order' sociograms.



1(b) : Some sociograms of higher order

REFERENCES

1. H.T. Reis, W.A. Collins and E. Berscheid, *Psychological Bulletin,* **126,** 3, 844-872, 2000.

2. A. Ramachandra Rao and S. Bandyopadhyay, *Reciprocity in a village social network : Graph-theoretic analysis using survey data,* India Statistical Institute, Calcutta, 1987.

3. F. Heider, *J. Psychology*, **21,** 107-112, 1964.

4. F. Harary, *Mich. Math. J.,* **2**, 143-146, 1953.

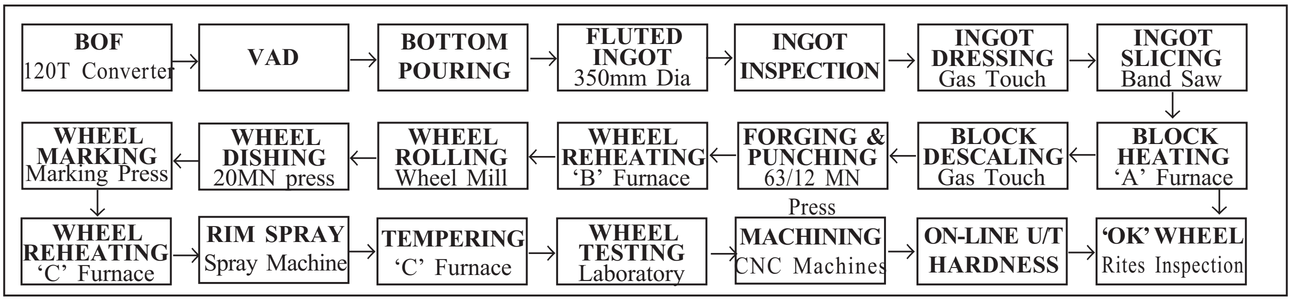
RAILWAY WHEEL MANUFACTURE

D. K. Jain

Wheels perform an important function in railway transport. The major properties of railroad wheels for improved performance are higher wear resistance, internal fatigue damage resistance, toughness, plastic deformation resistance and lower residual stresses. The forces transferred by the wheel to the rail, such as axle loads, track guidance, acceleration and deceleration, results in very high dynamic stresses, large deformations and strain hardening of the wheel steel within the contact zone. The force between rail vehicles and track are transmitted through the wheel/rail contact patch. For small area of about 100 mm^2, contact stresses can exceed 200 MPa. Thus especially in the contact zone, wheel steel should have good mechanical properties like yield strength, tensile strength, strain hardening behavious and deformability. Wheels are designed to resist wear and folling contact fatigue and thermal stresses caused due to sudden brake.

Over the years wheel steel making has progressed from open hearth to BOF and EAF. Continuous cast rounds are replacing ingot route.

Cleanliness and quality have been continuously improved. Sophisticated inspection procedures ensure that modern wheels are almost free of defects.



* Steel Product group, RDCIS, Ranchi

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WHEEL MANUFACTURE AT DURGAPUR STEEL PLANT

The wheels manufactured by SAIL at Durgapur Steel Plant primarily meet the requirements of broad gauge (BG) coaches and BG locomotives of Indian Railways. The wheels are supplied as per the Indian Railway Specification R-19-93 for BG coaches and R-34-99 for BG locomotives. The chemical composition of wheels is given in Table I. The hydrogen content value is for liquid steel.

TABLE I : CHEMICAL ANALYSIS OF WHEEL STEEL

Wheel Grade	C %	Mn %	Si %	S %	P %	H ppm
R-19 BG Coach	0.52 max.	0.60-0.80	0.15-0.40	0.03 max.	0.03 max.	<3
R-34 BG Loco	0.57-0.67	0.60-0.85	0.15 min.	0.03 max.	0.03 max.	≤2.5

TABLE II : MAJOR PROPERTY REQUIREMENT OF WHEELS

Mechanical	R-19-93 BG	R-34-99 BG
UTS (N/mn^2)	820-940	980 min.
YS	50% of UTS min.	
El (%)	14 min.	8 min.
Hardness (BHN)	241-277	300-341
Impact (St. U notch)	15 J/cm^{2}min.	10 J Min.

STEEL MAKING

Fine chemistry control through steel making process is prerequisite for optimising the mechanical properties of finished wheels. Vacuum degassing is essential to lower the hydrogen content in the liquid steel which helps in preventing the formation of hydrogen flakes or shatter cracks in wheels. Heats are made through BOF-VAD-Bottom Poured Ingot route. Hydrogen in steel is primarily controlled through deep degassing at VAD.

INGOT CASTING

Wheel heats are cast in fluted moulds with hot tops in a rake of 64 moulds arranged in 8 sets. Production of sound ingots is ensured by use of antipiping compound and bottom pouring flux during teeming.

SAW CUTTING

The bottom portion of the ingots is dressed with the help of oxy-acetylene torch. The dressed ingots are cut to the required length to obtain blocks from each ingot. The block weight is different for different grade of wheels. The top portion containing the hot top and the bottom portion are removed.

PRESSING

Blocks are heated in a computer controlled rotary hearth furnace with a capacity of 144 blocks. The blocks, after descaling, are pressed in 63/12 MN Oil Hydraulic Press. Both the top tool frame and bottom sliding table movement are longitudinal. The centering device ensures placement of the wheel blanks at the centre of the press. Pressing is carried out in 3 steps : (i) Upsetting, (ii) Forming, and (iii) Punching, Die positions and pressing operation are ensured by different pre fixed programmes. Reduction ratio of 4 : 1 is maintained.

ROLLING AND DISHING

The forged wheel blanks are reheated in a box type furnace having capacity of heating 9 blocks. Heated blanks are rolled in Vertical Wheel Rolling Mill. The Mill has 2 power driven web rolls, 2 friction driven edge rolls and 1 tread roll with automatic charging and discharging arrangement. The rolling operation is controlled by computers with arrangement for visual display of rolling parameters and dimensions.

Combination of forces from the tread roll, web rolls and edge rolls and rotation of the wheel act to thin the plate and rim and increase the diameter. Various dimensions, i.e. web thickness, rim thickness, rim width, ID and OD are controlled during the rolling process by the computer program. Web position relative to the wheel rim front or back is adjustable by movement of the web rolls relative to the wheel centerline. The Mill allows the web rolls to move in two directions, i.e. axially and laterally. By adjusting the position and size of the rolls, plate position can be moved to improve the stress characteristics of the wheel.

The rolled wheels are dished in 20 MN Oil Hydraulic Press. The dished wheels are subsequently stamped in a hydraulically operated marking press on the back side of the rim. Forging and rolling sequence used is shown in **Fig. 2**.

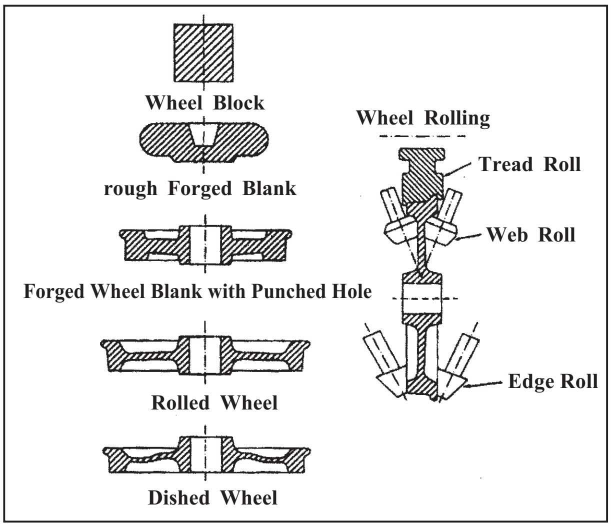

Fig.2. *Forging and rolling sequence*

HEAT TREATMENT

Wheels are heated in a rotary hearth type gas fired furnace. These wheels are rim sprayed in a rim quenching machine for preset duration and pressure. Wheels are placed with the help of mobile chargers on a guide cone in the centre of a disc rotating at 16 rpm. Hardening is done by means of a stationary spray ring with flat jet nozzles. Arrangement of 16 nozzles and rotation of the wheel provides a uniform spray of water upon the tread. Wheels are subsequently tempered in a tempering furnace and then air cooled to ambient temperature.

MACHINING

The wheels after heat treatment are machined in CNC machine. These machines have semiautomatic wheel handling system. The complete machining of the wheel is carried out to meet the balancing requirement of wheel sets.

TESTING

A number of tests are carried out to ensure that the wheel conforms to the stringent product specification. On-line magna-flux and ultrasonic testing is done to detect surface and internal defects. Falling weight test, closer test, tensile and hardness tests, impact and macro examination, surface condition and wheel dimensions measurement are carried out at Durgapur Steel Plant. Fracture toughness and fatigue strength are determined at RDCIS, Ranchi. For ensuring desired quality control, inclusion rating, ferrite volume fraction and oxygen and nitrogen analysis are regularly carried out.

DEVELOPMENTAL TRENDS PROCESS IMPROVEMENT

- Use of computerised production, planning and control system for shorter throughput times, reduced stock levels and higher yields.
- Rolling of low stress 'curved' or 'S' shaped wheels.
- Contact-less measurement of the geometry of the wheel by means of laser probes.
- Automatic ultrasonic testing device for the detection of internal defects such as pin holes, segregation, flakes and macroscopic inclusions in wheel rim and hub.

MICRO-ALLOYED WHEEL STEELS

Micro-alloyed steel wheels can give superior service performance. Micro-alloying of steel with niobium, vanadium and titanium improves the strength characteristics of heat treated wheels mainly due to reduction of inter-lamellae spacing of pearlite and, to a lesser extent, due to precipitation hardening. The basic structural characteristics responsible for the change of the impact toughness is the cementite lamellae thickness. The wheels made of steel with vanadium shows the most favourable properties and the best service durability.

LOW CARBON BAINITIC STEEL FOR WHEELS

Although wheels are designed to have a very extended life, they need to be replaced frequently as they are susceptible to the formation of flats and martensitic heat affected zones on the running surface, which cause cavities and crack networks to develop on the tread. A low carbon bainitic steel has been developed which will not be transformed to martensite but has similar mechanical properties to conventional grade steel. Although the low carbon bainitic steel may not prevent the formation of flats, it would prevent the development of cavities and crack networks. It is expected to improve wheel life by reducing the amount of material, which has to be removed during re-profiling.

USE OF NICKEL AND NICKEL-IRON BASED SUPERALLOYS

Nickel/Nickel-Iron based superalloys do not form martensite and have excellent high temperature strength. They are unlikely to form flats during wheel slide or wheel slip because of high temperature strength. They have a stable austenitic matrix that is strengthened by the formation of coherent intermetallic precipitates during heat treatment. The heat-treated microstructure is extremely stable and is not affected by rapid heating and cooling. Both type of material can be made into wheels or tyres using traditional process routes. However, it has been observed that superalloys are more difficult to forge and machine than conventional wheel steels. Although monobloc wheel could be produced, the use of tyres or coatings is likely to be more cost effective.

GLOSSARY

Closer Test : This test is done to ascertain the compressive nature of residual stresses in rim.

Axle Loads : Total mechanical load in railway transport transmitted through wheel to rail is called axle load.

Rolling Contact Fatigue : Fine transverse crack network developed around wheel tread where the wheel runs on the rail.

Hydrogen Flakes : Flaky appearance on the surface when the entrapped hydrogen in the metal escapes.

Shattered Cracks : These cracks are typically initiated from aluminium oxide inclusions in forged wheels or voids in cast wheels.

Friction Driven : No power is given to the rolls, but due to friction with other rotating part, these rolls also rotate.

Web Rolls : These are the power driven rolls at web position which is mainly responsible for reduction of web thickness and increase in diameter of the wheel.

Edge Rolls : Two side rolls at rim position driven by friction.

CNC Machine : Computerised Numerically Controlled machine used for machining the wheel to final dimension.

Dishing : Giving desired profile at web by pressing.

Flats : Formation of flat surface on the circular rim due to breaking.

SUGGESTED READINGS

Proceedings of the 13th International Wheelset Congress, Rome, Sept. 17-21, 2001, Vol. 11.

(Contributed by Sri D. K. Jain, PRM, Shape Rolling Group, RDCIS, Ranchi)

SHORT COMMUNICATION

PEPTIDES THAT PUNCTURE THE BODIES OF BUGS

D. Balasubramanian*

Come summer and complaints of stomach-aches and gastrointestinal infections shoot up. In trying to beat the summer heat, many tend to quench their thirst with the first available mouthful of water. Little thought is given to the cleanliness of the cup or the purity iof the water. And the result is stomach cramps at the mildest to severe diarrhoea and dehydration at the worst. The culprits are of course the germs—viruses, bacteria and protozoa—that abound in the unclean water.

Not that we do not fight these invading germs. Over a period of time, we do get used, to some extent, to these microbes and fight them effectively. The immune system of the body offers an excellent defence mechanism that gets rid of the infecting germs by a variety of means. A set of special cells engulf the bacterium, take it inside and pulverize it into bits. The grand names given to the cells that do this awesome task are macrophages and polymorphonuclear leucocytes. Other cells generate special protein molecules called antibodies, each one of which is tailored to grasp a specific invader in a lock and key fit and knock it out. Such a double barrel attack on the invading microorganism, using cell mediated and antibody mediated modes, effectively protects us from the ill effects of the infection.

The remarkable point about the immune system of the body is its memory. When we encounter the invading germ for the first time, we suffer badly. But such close encounters of the first kind prime our bodies in a grand fashion for future. When the same germ attacks us the second time, our immune system recognizes the invader in terms of its cell size, shape and outer surface features, recalls the first battle we had with it, and mounts the defence reaction. The specific antibody to this bacterium, which was produced during the first encounter is mass-produced in abundance, as also the phagocytic cells. The defence reaction is more prepared, more elaborate and more successful and the 'memory' is long lived. We have now developed immunity to the invading germ. This, of course, is the basis of vaccines. Edward Jenner, two centuries ago, noted that dairymaids exposed to the cow pox had developed resistance or immunity to the disease. From there to actually inject a (killed or attenuated) virus or bacterium into the body so as to prime it to develop the immune reaction has been a logical step. During the first encounter with the microbe, the body cells generate the gene for the specific antibody. When the microbe strikes again, this gene goes into action and produces the knock-out antibody in quantity. There are few better well-tuned systems in our body !

Immunology is not the only mode of tackling the infecting organism. Medication is another. Antibiotics, whose history does not go beyond two generations, are very effective. Penicillin, tetracyclines and sulfadrugs are some successful

* 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.

examples. The curious thing is that many of these chemicals are produced by bacteria, fungi, insects and similar forms of life, and are used by these organisms as defence chemicals in order to fight those that invade them. Unlike antibodies, these antibiotics are less specific and more general purpose in nature, hitting out at most invaders. It is this broad-spectrum feature that helps us when we take these drugs to fight microbial infections in our bodies. These are medium size molecules, of molecular mass in the range of 400–4,000, and come in a variety of sizes, shapes and chemical formulae. There is generally nothing common in their chemistry or even in their modes of action.

Designing an effective antibiotic is thus a difficult task since there are no well-formulated guidelines, hints or principles to guide us in the synthesis. What one would like is to have the grammar or the syntax of the process understood. The diversity is too large to offer either a structural clue or a functional unifying principle. Besides, while these antibiotics are effective against many fungi, protozoa and bacteria, they are not generally as good in fighting viruses.

It is here that the peptide antimicrobials appear to present hope. First of all, peptides are simple in construction. The building blocks are twenty different amino acids that can be strung together, as in a necklace. If the chain gets long, it is no longer called a peptide but given the name protein. The twenty amino acids fall into two broad categories. Some of these contain electrical charges (ions) or polar groups which let them interact with water and aid the peptide to dissolve in water. These amino acids are thus hydrophilic or water-loving. The other class is the opposite or hydrophobic (water-repellant) and aid the peptide to attach itself to cell membranes and other similar oily surfaces. A peptide chain generally contains both types of amino acid residues, and will thus have a varying degree of ambivalence in its interaction with water or with membrane surfaces ; the term given is amphipathic.

Over the years, the way a peptide chain can shape itself into various molecular architectural motifs has been well studied. It is possible now by looking at the sequence of the amino acids strung up in a peptide chain, to make a good guess about what shape the molecule will take—the shape of a spiral staircase, a pleated sheet, a wet noodle, or whatever. Pioneering work in this area has been done by Professor G. N. Ramachandran and his students at Bangalore, and the graphical representation of the shapes that the peptide chain takes is termed the "Ramachandran Plot".

Thus, two leads are available with respect to peptide antimicrobials—their tendency to dissolve in water or to seek membrane surfaces, and the shapes they can adopt. Both these leads are important in helping us understand the possible made of action of these molecules. Some clue into the mode of action of such peptide toxins comes, of all places, from the skin of the frog. The frog sweats out a small peptide molecule called magainin, which protects its skin from invading bacteria. Quite an appropriate name, given by its discoverer, Dr Michael Zasloff of the National Institutes of Health, USA, since the Hebrew word *magain* means shield. Made of up 23 amino acids strung together in a screw-like helical chain, magainin is a general purpose antibacterial or germicide, which also effectively fights invasion by fungi and protozoans like amoeba.

The mechanism of how it shields or protects the frog has now become clear from Zasloff's work. The magainin molecule seeks out and anchors itself on the surface of the invading microbe, quite like the molecules of soap that seek out and attach themselves to the oily grime on our clothing during washing. Often, such attachment does not happen just by one, but by several peptide molecules, which assemble themselves on the membrane into a bracelet or a hollow cylindrical tube. Once this is done, the interior contents of the bacterium can simply spill out and kill the bacterium. Alternately, a lot of water can rush into the bacterium from the outside through this peptide channel or pore and burst the microbe outwards into smithereens. Either way, it is the osmotic imbalance across the cell membrane that causes its death.

The mechanism of the frog peptide self-assembling on the membrane of the bacterial cell and causing osmotic lysis appears to be general. Dr. H. Boman of the microbiology department of the University of Stockholm in Sweden finds that the cecropia moth secretes a 37-amino acid residue peptide (which he has named cecropin), which behaves similarly in protecting the moth from microbial attack. Certain types of fish secrete a very potent membrane-active peptide toxin called pardaxin, which acts by the same mechanism, as does melittin which is a 26-amino acid peptide of the bee venom. Even some of our own body cells generate a class of peptides called defensins, whose name is eloquent enough. The cobra venom contains, among other things, a peptide that hits at heat muscle membranes.

Peptide antimicrobials thus appear to be better candidates for laboratory synthesis and design. They are simple, they are general purpose, and they can be designed using well-known methods of peptide synthesis. Yet there are problems in this approach, which relate to the very generality of action of these peptide toxins. Ideally, one would want them to act on the invading microbes only and not on our body cells. It would be no good if they puncture the microbe cells and also our own stomach cells or blood cells; we want to throw the bath-water out and keep the baby! How then does one build in this antimicrobial selectivity?

Some insight into the basis of such selectivity comes from the work of Dr. R. Nagaraj and his colleagues at CCMB, Hyderabad. They were concerned with why the bee venom (melittin) is a non-discriminating toxin, attacking and breaking down both bacterial cells and human red blood cells; while the death toxin from the bacterium *Staphylococcus aureus* (a rather common and nasty microbe that abounds in the hot Indian climate and infects a good many of us) is particularly deadly towards human blood cells but is hardly antibacterial. Both melittin and delta toxin are of the same size (26 amino acids long). They also have the same shape, adopting the amphipathic helical aggregate forms and the channel motif in membranes. They differ only in the number of electrical charges that they have. Melittin, with its five lysines in the sequence, has a surfeit of positive charges while delta toxin, with its near-equal number of acidic (asp) and basic (lys) amino acids residues, has but one positive charge. Dr. Nagaraj suggests that it is this difference that can make a peptide selectively antimicrobial, or hemolytic, or both. Vishnu Dhople and Nagaraj have seen that the 16-amino acid long mid-region of delta toxin is not toxic to bacteria or to blood, but if they chemically change the asp residue to a lys, the resultant mutant fragment is rich in positive charge and bnecomes strongly antimicrobial, but does not affect red cells that efficiently. In other words, changing the electric charge on the molecule can kill a bug or cause anaemia! It appears that this charge difference can dictate the efficiency and avidity with which the toxic peptide can bind to the (usually negatively charged) outer surface of most bacteria. The red blood cell offers a markedly different surface for the peptide to interact with.

This work suggests the possibility of designing peptide toxins that are specifically germicidal and antibacterial, by judiciously positioning acidic and basic amino acid residues in the chain. Peptide synthesis is now a fairly routine procedure, thanks to the solid-state method introduced by Bruce Merrifield who won a Nobel prize for it, and the more recent tea-bag method of Richard Houghton, both of which involve stringing amino acids one after another in the chain. Automated peptide synthesizing machines are available, literally molecular sewing machines for making peptides and proteins. The era has dawned for designer peptide toxins that are venom for the invading germ and safe for the person using it. Lastly, isn't it interesting that some of the ideas in the area have come from people with rather appropriate names, Nagaraj (the king of snakes), Vishnu (resting on Adisesha) Dhople, Sitaram (synonym for Vishnu) and Krishna (dancing on the snake Kaliya) Kumari ?

ANSWERS TO "DO YOU KNOW ?"

A1. Study of ignorance.

A2. Migraine.

A3. Habit of exploring caves.

A4. Moon (One Sixth) so 10Kg. and in Mars (One Third) so 20 Kg.

A5. Mass.

A6. Purulia District.

A7. The Study of Algae.

A8. Fear of Ugliness.

KNOW THY INSTITUTIONS

CENTRAL INSTITUTE OF FRESHWATER AQUACULTURE BHUBANESWAR

INTRODUCTION

The Central Institute of Freshwater Aquaculture (ICAR), Kausalyaganaga, located at about 10 kms from Bhubaneswar on Bhubaneswar—Puri highway is the Premier Research Institute on Freshwater Aquaculture in the country. The Institute had its beginnings in the Pond Culture Division of the earstwhile Central Inland Fisheries Research Institute which was established at Cuttack, Orissa, in 1949. The Division was later upgraded as Freshwater Aquaculture Research and Training Centre (FARTC) established at Bhubaneswar in 1976 with UNDP/FAO assistance.

Further, the Centre attained the status of an independent Institute during 1986 and the functional existence of the Institute came into effect on 1 April, 1987. The Institute presently has six regional centres at Rahara, West Bengal ; Bangalore, Karnataka ; Vijaywada, Andhra Pradesh ; Akola, Maharashtra ; and Ludhiana, Punjab along with the Krishi Vigyan Kendra (KVK)/Trainers' Training Centre (TTC) at Kausalyaganga, Orissa, and also ten ORP centres located in ten states of the country. The Headquarters of the Institute has nine sections, viz., Production Technology, Soil-Water Environment, Fish Genetics, Fish Nutrition, Fish Physiology, Fish Pathology, Aquaculture Engineering, Aquaculture Economics and Statistics, and Aquaculture Extension.

The Central Institute of Freshwater Aquaculture (CIFA) under the aegis of Indian Council of Agriculture Research is the Premier Institute of Research and Training in the country.

INFRASTRUCTURE

The Headquarters of the Central Institute of Freshwater Aquaculture has a sprawling campus with an area of 147 ha. It is housed in a three-storeyed building with laboratory facilities for different specialisations in carps, catfish, prawn and pearl mussel, fish breeding and culture, fish genetics, fish nutrition, fish physiology, soil and water chemistry, aquatic microbiology, weed management, fish pathology and aquaculture engineering.

The Institute has well equipped laboratories for researches on differnt aspects of freshwater aquaculture like production technology, aquatic environment, fish genetics, fish nutrition, fish physiology, fish pathology, aquaculture engineering, aquaculture economics and statistics, and aquaculture extension.

The fish farm with a total water area of about 50 ha comprises over 500 ponds of assorted sizes. The facilities in the farm include a carp hatchery with a production capacity of 50 million spawn, giant freshwater prawn, Macrobrachium rosenbergii hatchery of 10 million post-larvae, backyard hatchery for magur, (Clarias batrachus) and Indian river prawn (M. malcolmsonii), a wet laboratory (2 units of 30 mx 10 m), facilities for running water fish culture, paddy-cum-fish culture, sewage-fed fish culture, Azolla and algal culture, integrated fish farming, yard facilities, feed mill, etc.

The Institute has a specialised library to serve different disciplines of freshwater aquaculture. The library possesses about 2000 volumes of books and subscribes of 20 foreign journals and 42 Indian journals, A CD-ROM facilities for specialised aquaculture journals is also available at the Institute. The FAO has recognised the library as Depository Library for FAO publications.

The Institute has a computer centre, radio-isotope laboratory, tissue culture laboratories, central instrumentation laboratory and a workshop for plasticraft.

KRISHI VIGYAN KENDRA

The Krishi Vigyan Kendra (KVK) under the administrative control of CIFA was established at Kausalyagana is January 1977 with a separate budget of its own under the plan scheme of ICAR. The KVK functions as a part of the front-line extension wing of the ICAR basically to bridge the technological gap between the scientists and the practising farmers through need-based raining and field demonstrations. Started intially as the KVK specialised in Aquaculture, it has developed over the years into a composite extension centre with six disciplines, *Viz*., Fisheries, Crop Production, Plant Protection, Animal Sciences, Horticulture and Home Science. The institutional farm facility available in the KVK is being used to conduct on-campus skill training for farmers identified through village surveys on the principle of learning by doing and teching by doing. In addition, the KVK renders farm advisory services in different villages as off-campus extension acitivites to complement the transfer of technology efforts. The clientele include practising farmers/ farm women, school drop-outs and rural youths.

The basic mandate of the KVK is on-farm testing, refining and documenting technologies for developing region-specific sustainable land use system, organising training to update the extension personnel within the area of operation with emerging advances in agricultural research on a regular basis, organising long-term vocational learning by doing for generating self-employment through institutional financing and organising front-line demonstrations in various crops to generate production data and feed-back information.

KVK conducts the regular training programmes in the various aspects of **fishculture** (Composite Fishculture, Common Carp breeding, Nursery pond management, Breeding of Indian major carps, Stocking density and species composition in composite fish culture and brood stock management of common carp for seed production), **Animal Sciences** (Cleaning and disinfection of poultry house with appropriate tools for disease prevention, Brooding of day-old broiler chicks by artificial brooder, Care and maintenance of milch animals, Rearing of Khaki Cambell ducks for egg production), **Home Science** (Skill and art of Knitting for self-employment, Applique for rural women, Preparation of nutrious food from ragi and other cereals for small children, Balanced diet for pregnant women and lactating mothers and wearing practices), **Horticulture** (Planting of tissue-culture banana (Robusta), Paddy-straw mushroom management, Package of practices of planting of tissue culture banana (Robusta), Management practices in marigld cultivation as a commercial enterprise), **Plant Protection** (Insect pest/disease management of some summer vegetables (brinjal, okra, cucumber, pumpkin, sweet melon), Integrated disease and pest management of some vegetable crops, Integrated pest/disease control measure in groundnut and mushroom crops, Use of seed treating chemicals for seed, suckers, cuttings, leaves and rizomes, Insect pest and disease management of cauliflower, cabbage, knolkhol and potato), Crop Production (Improved cultural practices and management of summer paddy), Cultivation of *Azolla* Spp : Management and practices, and as application in paddy field, Fertiliser application in transplanted paddy crops, Seed treatment and balanced dose of chemical fertiliser application of rice crops in *Kharif* season, Cultivation of arhar (UPAS-120) and blackgram using improved technology, Improved techniques for cultivation of pulse crop, greengram and blackgram).

EXTENSION FUNCTIONARIES IN-SERVICE TRAINING

(Farm management in pisiciculture : Management of nursery pond, rearing pond, fish breeding and seed production, Insect pest and disease management of pulse crops, Eco-friendly nutrient management in rice production). Other extension activities carried out by KVK through participation in Kishan Matsya Mela, Exhibition, world Environment Day, World Food Day celebrations.

TRAINERS TRAINING CENTRE

The Trainers Training Centre (TTC), Kausalyaganga, is a subject-specific training/ extension unit under the ICAR specialised for Aquaculture discipline. It was established in January, 1997 and is under the administrative control of CIFA, Kausalyaganga. The major thrust in its programme is to import training in the latest technologies in the frontier areas of aquaculture production system of KVK techers, in-service technical personnel of fisheries departments, extension professionals, etc. so as to strengthen the aquaculture extension system in the country with qualified and better-equipped professionals who themselves take up the responsibility as trainers.

Courses covered in the training include Freshwater Aquaculture, Nutrition in Freshwater acuqculture, Aquatic microbiology, Carp breeding, Hatchery management, Nutrient management, Catfish breeding, Integrated fish farming, Genetic upgradation of carp, Hatcher management and culture of Freshwater Prawn, Fish disease and diagnosie and control, Breeding and culture of ornamental fishes, Design and construction of Freshwater hatchery and farm, Aquaculture extension, Quantitative techniques in aquaculture economics and Networking and biological data analysis.

RESEARCH PROJECTS

INSTITUTE BASED PROJECTS

1. Standardisation of multiple spawning programme, improvement of hatchery technology and cryopreservation of male gametes for seed production of Indian carps.

2. Optimization of carp production through intensive aquaculture and multiple cropping.

3. Development of models for peninsular aquaculture breeding and culture of peninsular fishes.

4. Wastewater aquaculture resources in India and optimum production of fishes through multiple cropping and harvesting.

5. Sewage based integrated aquafarming and culture of minor carps and other economically important fish species.

6. Mass production of fry and fingerlings and culture of Clarias batrachus.

7. Standardisation of Technologies of large scale seed production and grow out culture of Indian river prawn, Macrobrachium malcolmsonii.

8. Captive culture of freshwater mussels.

9. Genetic upgradation of Indian major carps and exotic carps through genome manipulation.

10. Genetic improvement of rohu for growth through selective breeding.

11. Nutrition and dietary studies with carps, catfish and prawn.

12. Studies on the physiological mechanism of reproduction and digestion in cultivation fishes.

13. "Pathomorphology and immunopathological studies on important microbial diseases of fish and shellfish."

14. Management of diseases and health condtions of fish under cultivation through application of herbal materials.

15. Studies on myxosporidiasis and fungal diseases of shelfish and finfish.

16. Management of pond productivity through efficient use of macro and micronutrients in the form of inorganics and organics for sustainable aquaculture.

17. Study on the water budgets for different freshwater aquaculture practices.

18. Optimum planning models for fish farming systems.

19. Breeding and Culture of some non-conventional food fishes like Anabas testudineus, Labeo calbasu, Mystus vittatus, Ompok pabo, etc.

20. Random amplified polymorphic DNA (RAPD) analysis in freshwater fishes.

21. Multivariate study on the gowth of freshwater carps in relation to biotic and abiotic factors.

EXTERNALLY FUNDED PROJECTS

1. Biotechnology Information System of Aquaculture.

2. Development of Flow-thru' Systems for industrial aquaculture.

3. Application of Plastics in Agriculture—Plant environment control and Agricultural processing.

4. Centre for Advanced Studies on Post-graduate Agricultural Education and Research.

5. Mission Mode Project on Freshwater Prawn Culture.

6. Aquaculture as a tool for utilisation and treatment of domestic sewage.

7. Operational Research Project on "Processing and utilisation of organic wastes in aquaculture".

8. Recycling of processed lignocellulose wastes and cattleshed refuse in aquaculture.

9. Microflora and quality of fish culture in sewage-fed waters with reference to shelf life and public health.

10. Populations of the probable microbial pathogens posing a threat to brakishwater aqua-farming in Sundarbans and their occurrence in the form of released and unused wastewater.

11. Investigations on characterisation of sex pheromones and their role in reproduction and breeding of carp (Labeo rohita) and catfish.

(Heteropneustes fossilis)

12. Hormonal control of breeding and seed raising in selected cultivable carps and catfishes.

13. Development of phosphatase producing bacterial biofertilisers for aquaculture.

14. Immunopathological and toxin neutralisation studies of aflatoxicosis in fishes.

15. Role on environmental factors on immune reaction of freshwater fishes.

ACHIEVEMENTS

Since its establishment at Cuttack in 1949, the Pond Culture Division had made epochmaking contributions to the development of fish culture especially in carp breeding, seed raising and table-fish production. In fact, two major technologies of induced carp breeding and composite carp culture that laid the foundations of the modern Indian aquaculture were developed at this Division. This has led to a virtual change in the scenario of fish seed production in the country from total dependence of riverine seed collection to production of over 15,000 million of farm-bred fry at present. The Division had several credits in terms of development of specific packages of freshwater aquaculture technologies like sewage-fed carp culture, peninsular tank fisheries, integrated fish farming with agriculture and livestock, etc.

As a reorgnised Institute, CIFA has made several outstanding contributions such as multiple breeding of carps, gamete cryopreservation, intensive carp culture with production rates of 10 and 15 t/ha/yr, breeding and hatchery management of catfishes, Clarias batrachus and Heteropacustes fossilis, and freshwater prawns, Macrobrachium rosenbergii and M. malcolmsonii, production of cultured freshwater pearls through nuclei implantation in freshwater mussels, aquatic biofertilization with Azolla and utilisation of biogas slurry as organic farming practices, production of sterile triploid grass carp, formulation of diets for fish and prawn species (CIFACA a commercial carp diet), formulation of CIFAX as a control meausre for epizootic ulcerative syndrome, packages of practices for sewage-fed fish culture and cage culture, breeding and rearing of commercially important frog species etc. are a few to name. Ornamental fish breeding and culture is a new area that is being addressed to by the Institute in view of their high export potentials.

The Institute has hosted three UNDP/FAO programmes and the project on Centre of Advanced Studies (CAS) in Freshwater Aquaculture, in collaboration with the Orissa University of Agriculture and Technology, Bhubaneswar, provides for M.F.Sc. and Ph.D. degrees, Besides undertaking the Institute-based research projects, the Institute has operated as many as 23 externally funded projects. The Institue has active research collaboration and extension linkages with many national and international institutions. The UNESCO-MIRCEN has recognised the RLCI as a Microbiological Resource Centre in Aquatic Microbiology.

For Details kindly contact :

Dr. K. Janaki Ram
Director, CIFA
Kausalyaganga, Bhubaneswar 751002, Orissa, India
Tel : 0674-465421, 465446, 465430
Telex : 0675-6443 CIFA IN
Fax : 0674-465407,
E-mail : cifa@ori.nic.in, cifa@hubl.nic.in

95th Indian Science Congress

ISCA AWARDEES : 2007-2008

ASUTOSH MOOKERJEE MEMORIAL AWARD
Prof. S. S. Katiyar, Kanpur

C. V. RAMAN BIRTH CENTENARY AWARD
Shri M. Natarajan, New Delhi

SRINIVASA RAMANUJAN BIRTH CENTENARY AWARD
Prof. L. M. Patnaik, Bangalore

P. C. MAHALANOBIS BIRTH CENTENARY AWARD
Prof. P. V. Arunachalam, Tirupati

J. C. BOSE MEMORIAL AWARD
Dr. P. C. Kesavan, Chennai

P. C. RAY MEMORIAL AWARD
Dr. P. K. Seth, Lucknow

H. J. BHABHA MEMORIAL AWARD
Dr. V. S. Ramamurthy, Delhi

B. P. PAL MEMORIAL AWARD
Prof. Akhilesh Tyagi, Delhi

VIKRAM SARABHAI MEMORIAL AWARD
Prof. Vasant Gowariker, Pune

JAWAHARLAL NEHRU BIRTH CENTENARY AWARD
Dr. U. R. Rao, Bangalore
Dr. S. K. Chopra, New Delhi

PROF. R. C. MEHROTRA MEMORIAL LIFE TIME ACHIEVEMENT AWARD
Dr. S. Z. Qasim, New Delhi

MILLENNIUM PLAQUES OF HONOUR
Prof. Geetha Bali, Bangalore
Dr. V. R. P. Sinha, USA

EXCELLENCE IN SCIENCE & TECHNOLOGY AWARD
Prof. P. Balaram, Bangalore

B C GUHA MEMORIAL LECTURE
Prof. R. C. Sobti, Chandigarh

RAJ KRISTO DUTT MEMORIAL AWARD
Prof. B. Satyanarayana, Hyderabad

G. P. CHATTERJEE MEMORIAL AWARD
Prof. Vijaylakshmi Ravindranath, Manesar

PROF. SUSHIL KR. MUKHERJEE COMMEMORATION LECTURE
Prof. P. K. Chhonkar, New Delhi

PROF. S. S. KATIYAR ENDOWMENT LECTURE
Dr. Ravishankar, Mysore

PROF. HIRALAL CHAKARVARTY AWARD
Dr. Padmanabh Dwivedi, Varnasi

PRAN VOHRA AWARD
Dr. Kajal Chakraborty, Cochin

PROF. UMAKANT SINHA MEMORIAL AWARD
Dr. Amit Sharma, New Delhi

PROF. K. P. RODE MEMORIAL AWARD
Dr. Dalim Kumar Pal, Kolkata

DR. B. C. DEB MEMORIAL AWARD FOR SOIL / PHYSICAL CHEMISTRY
Dr. Siba Prasad Datta, New Delhi

DR. (MRS.) GOURI GANGULY MEMORIAL AWARD
Dr. Mohan Mondal, Nagaland

PROF. R. C. SHAH MEMORIAL LECTURE

Dr. D. K. Mohapatra, Pune

ISCA YOUNG SCIENTIST AWARDEES

AGRICULTURE AND FORESTRY SCIENCES

G. Manjunath, Mysore

ANIMAL VETERINARY AND FISHERY SCIENCES

Shrikant Deorao Kalyankar, Maharashtra

ANTHROPOLOGICAL AND BEHAVIOURAL SCIENCE (INCLUDING ARCHAEOLOGY AND PSYCHOLOGY & EDUCATIONAL SCIENCES

Purnima Parashar, Chandigarh

CHEMICAL SCIENCES

P. Lakshminarayanan, Kolkata

EARTH SYSTEM SCIENCES

Ravi Prakash Srivastava, Hyderabad

ENGINEERING SCIENCES

J. Ramkumar, Kanpur

ENVIRONMENTAL SCIENCES

Bidisha Majumder, Kolkata

INFORMATION AND COMMUNICATION SCIENCE & TECHNOLOGY (INCLUDING COMPUTER SCIENCES)

Ankush Mittal, Roorkee

MATERIAL SCIENCES

Padip Paik, Kanpur

MATHEMATICAL SCIENCE (INCLUDING STATISTICS)

Avishek Adhikari, Kolkata

NEW BIOLOGY (INCLUDING BIO-CHEMISTRY, BIOPHYSICS & MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Renu Mohan, Mumbai

PHYSICAL SCIENCES

Netam Kaurav, Indore

Kalpana Awasthi, Varanasi

PLANT SCIENCES

Mukesh Jain, New Delhi

ISCA BEST POSTER PRESENTATION AWARDEES

AGRICULTURE AND FORESTRY SCIENCE

B. Krishna Rao, Rajahmundry

D. Martin, New Delhi

ANIMAL, VETERINARY & FISHERY SCIENCES

K. Vijaya Kumar, Visakhapatnam

K. R. Shanmugan, Tirupati

ANTHROPOLOGICAL & BEHAVIOURAL SCIENCES (INCLUDING ARCHAEOLOGY AND PSYCHOLOGY EDUCATIONAL SCIENCES)

Dr. D. J. Bhatt, Rajkot

Ms. V. Jayasri, Visakhapatnam

CHEMICAL SCIENCES

Devendra Singh, Jhajjar

Sadananda Pandey, Allahabad

EARTH SYSTEM SCIENCES

Ms. V. Swaroopa, Hyderabad

Mr. Satyaban Bishoyi Ratna, Visakhapatnam

ENVIRONMENTAL SCIENCES

Srabanti Basu, Kolkata

R. A. S. Kushwaha, Imphal

INFORMATION & COMMUNICATION SCIENCE & TECHNOLOGY (INCLUDING COMPUTER SCIENCES)

G. V. V. Gridhar Rao, Visakhapatnam

Subash Chandra Yadav, Varanasi

MATERIALS SCIENCE

S. N. Sarangi, Bhubaneswar

MEDICAL SCIENCES (INCLUDING PHYSIOLOGHY)
Triparna Sen, Kolkata
Pinky Choudhury, Kolkata

NEW BIOLOGY (INCLUDING BIOCHEMISTRY BIOPHYSICS & MOLECULAR BIOLOGY AND BIOTECHNOLOGY)
Reshma Saga, Kolkata

PHYSICAL SCIENCES
K. Sambasiva Rao, Visakahapatnam
Y. Dwivedi, Varanasi

PLANT SCIENCES
Swarup Roy Choudhury, Kolkata
K. Sowjanya Sree, Visakhapatnam

ISCA-INFOSYS TRAVEL AWARDS TO SCHOOL STUDENTS

Aditya Sinha, Class VIII, Raman Manujal Vidhya Mandir, Sidhrawali, Gurgaon, Haryana

Rajkumar Harris Singh, Class X, Vijnana Vihara Residential School, Gudilova, Andhra Pradesh

Harish Uppa, Class X, Vijanana Vihara Residential School, Gudilova, Andhra Pradesh

Sneha Madabathula, St. Joseph's Secondary School, Visakhapatnam

K. Bhavishya Chandra, Class X, Nalanda Vidya Niketan, Vijayawada

Vishala Siriki, Class X, AU English Medium School, Visakhaptnam

Archita G, Class IX, St. Francis De Sales (SFS) High School, Seethammadhara, Viskhapatnam

Rakshita Mundhra, Class IX, MVP Public School, Viskhapatnam

Likhita B, Class VIII, MVP Public School Visakhapatnam

Y. Ravi Shankar, Class X, Sri Satya Sai Vidya Vihar, M.V.P. Colony, Visakhapatnam

Conferences / Meetings / Symposia / Seminars

6th International Conference on Computer Simulation Risk Analysis and Hazard Mitigation, May 5-7, 2008, Cephalonia, Greece.

The theme of the Conference is Risk Analysis and Accounting for Climate Change, Uncertainty in Greenhouse Gas Inventories-Verification, Compliance and Trading.

Contact : **Rachel Creasey,** Conference Secretariat, Risk Analysis 200, Wessex Institute of Technology, Ashurst Lodge, Ashurst, Sothampton, SO 40 7AA U.K., Fax : 44(0)2380292853 E-mail : rcreasey@wessex.ac.uk

10th World Congress in Environmental Health, The International Federation of Environmental Health, Brisbane, May 11-16, 2008, Australia

The Theme of the World Congress in Environmental Health is Environmental Health, a Sustainable Future. The thrust is on Building Global Health for Tomorrow and Health Care Reform.

Contact : **Conference Secretariat,** Conference Management Solutions, PO Box 5739 Cranbourne, Victoria, Australia 3977, E-mail : adam@ifeh2008.org.

4th International Conference on Natural Computation (ICNC 08) and 5th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD 08) August 25-27, 2008, Jinan, China.

ICNN '08-FSKD, 08 aims to provide an international forum for scientists and researchers to present the state of the art of intelligent methods inspired from nature, including biological, ecological and physical systems with applications to Data Mining, Manufacturing, Design and more. It is an exciting and emerging interdisciplinary area in which a wide range of techniques and methods are being studied for dealing with large, complex and dynamic problems. All accepted paper with be published in a special issue of Soft Computing : An International Journal (SCI indexed)

Contact : **Conference Secretariat,** International Conference on Natural Computation, Jinan, China, Email : nc2008@sdu.edu.en

S & T ACROSS THE WORLD

BOEING DREAMLINER

The new 787 Dreamliner family of passenger aircraft which was launched by Boeing in 2003, is in the 200-300 seat class, and can carry passengers non-stop on routes between 6500 km and 16000 km at speeds upto Mach 0.85. First delivery will be to All Nippon Airways in May 2008, and the 787-9 stretched variant is scheduled to enter service in 2010.

The plane comes in three variants : the 787-3, the 787-8, and the 787-9. It is highly fuel efficient, and offers lower cost of travel in terms of seat costs per mile as well as the ability to fly directly to smaller regional airports instead of to larger airports where passengers proceed to transfer flights to the regional destinations.

Each plane costs $60 million, and firm orders have been placed for 584 aircrafts, 43 for the 787-3 ; 426 for the 787-8 and 115 for the 787-9. Nearly two dozen airlines, including Air India, have placed firm orders for this aircraft with the right to further options.

Aircraft assembly began in June 2006 and final assembly in May 2007. The first aircraft rolled out in July 2007, and the first flight was scheduled in September.

First delivery will be to All Nippon Airways scheduled for May 2008, and the 787-9 stretched variant will debut into service in 2010.

(Aerospace Technology, Oct. 17, 2007)

BLUE ENERGY

When a river runs into the ocean and fresh water mixes with salt water, huge amounts of energy are released. Unlike violent torrents in a waterfall or steaming hot geysers, the energy released cannot be easily discerned from the banks of the estuary, but nevertheless the energy is there and is available for being tapped.

There are several ways to tap this energy from the entropy of mixing fresh or river water with salt water.

The two most important ways are pressure retarded osmosis (PRO) and reverse electrodialysis (RED). Both depend heavily on membrane development and a reduction in its price per square metre. Over the last twenty years, membrane technology has become increasingly important in areas such as wastewater treatment, desalination, and drinking water preparation, resulting in a considerable reduction in prices.

This has strongly supported the breakthrough in the development of saline energy, resulting in the development of PRO by Statkraft in Norway in 1998, and Blue Energy, under which name KEMA in the Netherlands started the development of the RED variant in 2002.

Blue energy is able to generate DC power and low voltage output.

(Leonardo Energy, Oct. 18, 2007)

SAFE BRAKE TECHNOLOGY

The first freight train equipped with electronically controlled pneumatic (ECP) brake technology began hauling coal in the USA on the 11th October 2007.

In contrast to the conventional air-brake system which operates sequentially from one rail compartment to the next, ECP technology applies the brakes uniformly and instantaneously on every railway compartment in a train, which makes for better train control, shorter stopping, and a lower risk of derailments.

Since the ECP brake technology provides continual electronic self-diagnostic system checks that inform train crews when maintenance is required, the need to stop for foutine brake tests can also be dispensed with, thereby making for quicker deliveries of the commodities being hauled.

To ensure absolute safety of ECP equipped trains, several processes are being initiated, including requirements that railways clearly define a process for rectifying brake problems is covered enroute; ensuring that ECP brake inspections are performed only by qualified mechanical inspectors, and providing appropriate training to crew members.

(US Dept. of Transportation, Oct. 11, 2007)

EFFICIENCY OF SOLAR CELLS

Dupont Microcircuit Materials, a part of Dupont Electronics Technologies, has introduced a new series of screen printable thick film materials that enable solar cell manufacturers to reduce their costs per watt by achieving higher cell efficiencies, higher production yields and lower material consumption. Key to the new Dupont Solamet thick film metallization product range developments are improvements in n-type emitter front side silver contacts, high coverage solderable tabbing silvers, and silver aluminium inks, and low bow high electrical performing aluminium metallization. For various thin applications, and special applications of crystalline cells, new polymer based conductor materials are available.

The new front side n-type silvers exhibit low contact resistance, high conductivity, high aspect ratio, high print speed, and excellent mechanical properties. Depending on the cell configuration, the new front side silver is also available as in cadmium and lead-free variants. For backside solder applications, DuPont is introducing silver metallisation with significantly lower material consumption and excellent initial and soldered aged adhesion, employing leaded and lead-free solders. DuPont customers can choose solderable pastes with aluminium additions for increased back surface field and enhanced electrical performance. All these new compositions are cadmium and lead free.

(DuPont, Aug. 30, 2007)

भारतीय विज्ञान कांग्रेस संस्था
14, डॉ० बिरेश गुह स्ट्रीट, कोलकाता 700 017, भारत
THE INDIAN SCIENCE CONGRESS ASSOCIATION
14, Dr. Biresh Guha Street, Kolkata-700 017, INDIA

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

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

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

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

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

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

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

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

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

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iscacal_2004@yahoo.com

APPLICATION FORM FOR MEMBERSHIP

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

Stamp Size Photograph

Dear Sir,

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

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

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

SECTIONS

1. Agriculture and Forestry Sciences
2. Animal, Veterinary and Fishery Sciences
3. Anthropological and Behavioural Sciences (including Archaeology and Psychology & Educational Sciences)
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5. Earth System Sciences
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