

CONTEMPORARY WARS AND THE ENVIRONMENT

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War is an on-going activity in human affairs. Since the end of World War II, this activity has, to put it somewhat cynically, been "business-as-usual". A new war started up somewhere at a rate of one every three months and around 140 wars occurred, all told, between 1945 and 1980. Around 80 countries, chiefly in the Third World, have been involved in these wars, in which over thirty million people have died (as against 50 million in World War II).

While man has perhaps always been an aggressive animal (judging from archaeological and even fossil evidence), the armaments and military preparations in the modern world are truly monstrous in scale and refinement.

The human suffering and the economic consequences arising out of conflicts are reasonably well appreciated. However, what is often insufficiently appreciated are the effects (including disruption of eco-systems) of military preparations and activities on the environment.

The Gulf War of 1991, for instance, had a variety of environmental effects which included threats to the wildlife of the area. (The wildlife of the area included the Arabian oryx, dolphins, dugong, green turtles and the sometimes over six-foot-long Tigris salmon in addition to less widely known fauna and flora). The noise alone of well over 25 thousand sorties of military aircraft would have had an impact on wildlife in addition to that, for instance, of the deposition of oil from the wells which were set on fire. The devastation caused by the bombing would have included the release into the environment of toxic PCBs (polychlorinated biphenyls) from damaged transformers and CFC_s (Chlorofluorocarbons) from damaged refrigeration systems. Other environmental problems of the Gulf War which may be referred to include the impacts of 1) over one million armed military personnel stationed in the desert, 2) spills of over eleven million barrels of oil, 3) the destruction of two operational nuclear reactors, 4) the breakdown of sewage treatment and garbage disposal in Baghdad and 5) warfare in an archaeologically- rich area.

While a somewhat different spectrum of environmental effects is occurring due to the on-going conflict in the former Yugoslavia (e.g. the felling of trees to provide fuel), it is instructive at this point to present a more general overview of some aspects of modern military preparations and technologies.

Resource Utilization

A few facts regarding utilisation of resources for war and war-related activities will help to indicate the extent of the cause for concern.

One indication of the exceedingly high level of wastage of resources incurred for war-related purposes is given by considering military expenditures. Global military expenditures around 1981 were variously estimated as being about 400 to 550 thousand million US dollars per year (which is around one million US dollars per minute). According to trends prevailing in 1981, and after taking inflation into account, it was estimated that global military expenditure could reach one million million US dollars a year by the year 2000. Around 1981, probably 20 to 30,000 million US dollars an year worth of arms were traded internationally, while the total expenditure on weapons was about 135,000 million US dollars.

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As regards manpower, personnel occupied in war or war-related work are said to number 60 million. This includes 400,000 scientists or about 40 per cent of all living scientists.

The land used worldwide for military purposes is difficult to estimate. According to one criterion, the land usage per man in the armed services may range from approximately 0.3 to more than 5 hectares. Computations of global land usage for military purposes range from 42 to 174 million hectares.

Deterioration of land may, also, occur, e.g. due to the passage of heavy military vehicles and the explosion of bombs etc. A 250 kg-bomb may, on explosion, produce a scar of about 8 metres diameter and 4 metres depth. About one to ten per cent may remain unexplored, thus constituting a future hazard, whether on the battle field or the practice range. One state has noted that it had cleared nearly 14,500,000 landmines after World War II and that the work was still continuing at that time.

Trees may often be physically removed in wartime due different reasons. Damage including war-related fire damage) to forests in France during World War II amounted to around 500,000 hectares. Again, the approximately 200 immense tractors ("Rome ploughs") used by the U.S. forces in South Vietnam resulted in the removal of the trees of around 325,000 hectares of forest. Trees damaged by shrapnel are, also, liable to decay due to fungal attack. The loss of tree cover leads to soil erosion.

The military utilisation of raw materials, such as that of silver for photographic needs, is considerable. The total military utilisation of oil may be double that of the African continent.

Modern Warfare

There are several different techniques of warfare and each of them has adverse environmental effects of one kind or another.

Of the available options, the public is fairly familiar with the effects of conventional warfare. The scale of destruction due to modern warfare may, however, be gauged by noting that, over around ten years, the U.S. used approximately 14 million tonnes of bombs and other explosives in South Vietnam and that about 100,000 hectares of previously mainly forest land became covered with craters. (The citing of figures relating to the U.S. forces may sometimes mean that figures relating to other belligerents were unavailable for public information).

Chemical warfare agents are of different types. Anti-personnel agents (those used against people) include those used in World War I, such as arsenic compounds and mustard gas (which burns the skin and could blind). Modern anti-person-

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nel chemical warfare agents include sensory irritants, incapacitants, blister gases, blood gases, nerve gases and lethal toxins. Sensory irritants include the "tear gas" or "CS gas" used by the police for mob dispersal. The toxin called botulin is estimated to be lethal at a dose of 0.013 milligram per man. (1000 milligram = 1 gram).

Uses of anti-plant chemical agents include 1) destruction of crops which provide food to sustain the enemy and 2) defoliation of forests which provide concealment. These chemicals are also toxic to soil micro-organisms.

The 90,000 tons of anti-plant agents used in South Vietnam, over ten years, included the chemicals 2,4-D, 2,4,5-T, dimethyl arsenic acid and picloram. The chemical, dioxin, is a contaminant of 2,4,5-T and may cause human birth defects as well as cancer of the liver.

Some of the biological anti-personnel agents which have been examined are the pathogens responsible for brucellosis, tularemia, Q fever, Yellow fever, Venezuelan equine encephalitis and anthrax. Anthrax is an agent which may contaminate the area (for example, a target city) and leave it uninhabitable for well over a decade. A variety of methods have been examined for dispersal of pathogens, including sprays, bullets, missile warheads and cluster bombs.

Biological anti-crop agents which have been studied, include those against rice, potato, tomato, tobacco, sweet potato, soya beetroot and cotton. Methods of distribution of biological agents could include the use of migrating birds (particularly useful for undermining an adversary against whom war has not yet been declared).

Environmental modification or geophysical techniques of waging war is another military possibility. Artificial rainmaking was tried in Indo-China in an attempt to disrupt roads and communications.

Nuclear Conflict

Nuclear war may well be the ultimate environmental horror and irrespective of where a nuclear war may take place the fall-out and climatic effects resulting from a major conflict could be expected to be global in extent.

Some of possible effects of a nuclear war have been discussed in many publications and conferences. For instance, it has been recorded that many of the over quarter of a million people who died in Hiroshima and Nagasaki in August 1945 were simply vaporised. The envisaged medium and long-term effects of a nuclear war suggest that the lucky ones would be those who die in the initial explosion of the bombs. Many others would die soon due to radiation and due to radiation sickness. The breakdown of society would result in hospitals, medicines etc. not being available to treat the sick and injured. Disease epidemics would break out following the breakdown of sanitation and garbage disposal services. Fresh-water reservoirs would be contaminated with radioactivity of several years and rain would be radioactive. It is possible clouds of smoke, dust etc. would block out the sunlight and warmth from large areas of the earth's surface resulting in

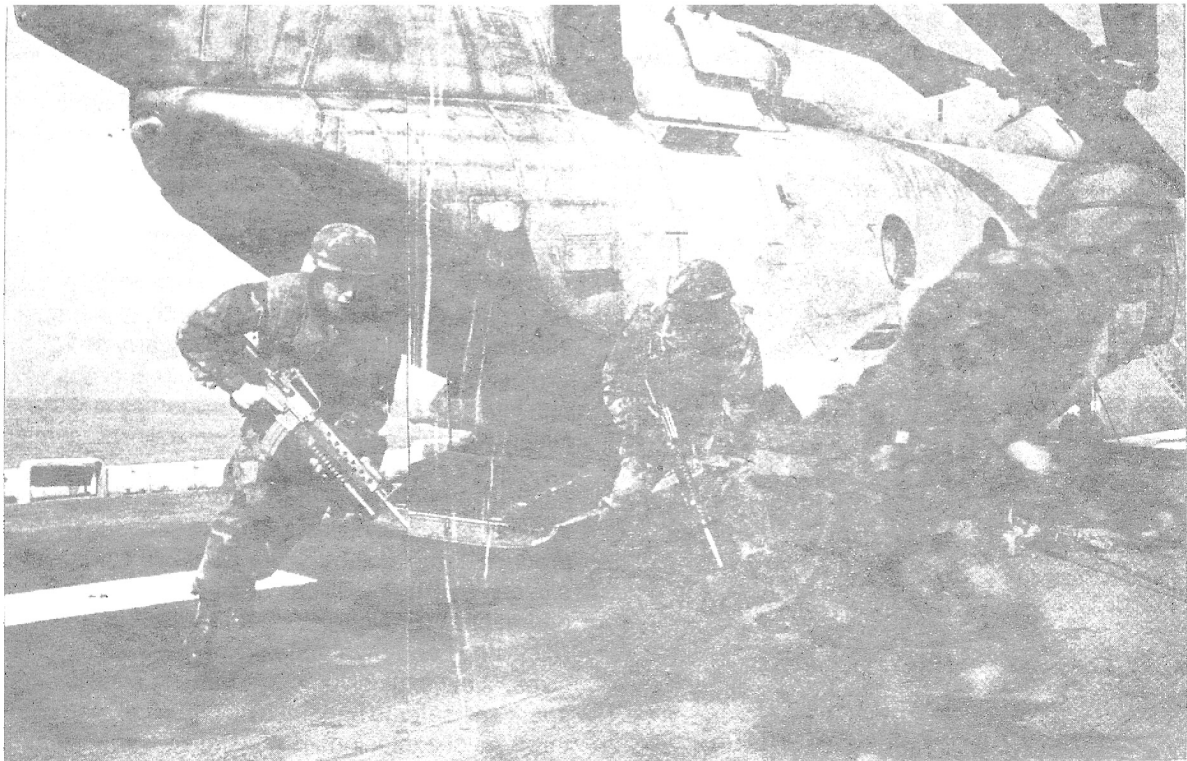
what has been termed a nuclear winter". Food production by agriculture and fisheries would be badly affected as would food distribution. People would develop cancers and (or) become sterile and countless others would, for several decades, be born with genetic defects.

The above are a few of the hypothesized consequences of a nuclear war. The number of nuclear weapons in the world today probably exceeds fifty thousand which are together equivalent in destructive power to approximately one and a quarter million times the bombs used in Hiroshima. One B-52 bomber can transport more explosive power than that used in all of mankind's previous wars and battles put together.

Public Opinion and Treaties

It should be noted that military activity or fear of military activity lead to large-scale human migrations, which themselves create stresses, particularly on the receiving environment.

Treaties relating to the limitation of arms and their use are, however negotiated as one line of defence against the unleashing of modern techniques of warfare. Their success often depends on the public support they receive. (This paper is based on articles published in the "Sunday Observer in 1985 and 1991).



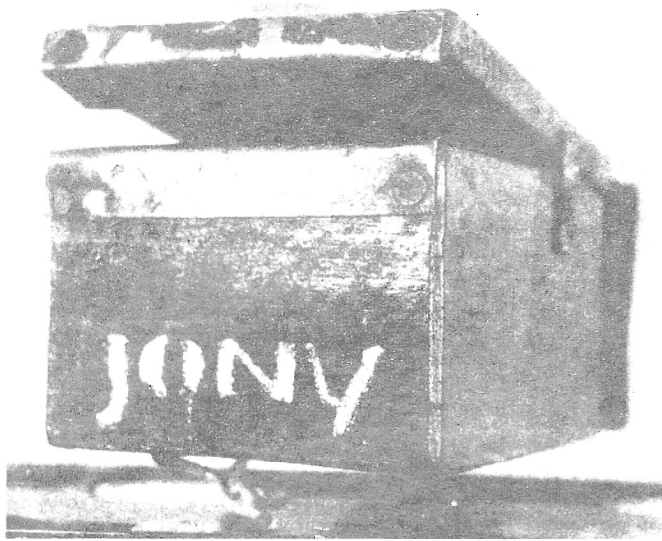
HISTORY CHEMISTRY AND TECHNOLOGY OF EXPLOSIVES

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An explosion occurs, when the energy previously confined is suddenly released to affect the surroundings. It is always associated with the sudden and rapid escape of gases from a confined volume accompanied by high temperature, loud noise and violent shock. Explosions can be classified into three fundamental types: Mechanical, Chemical and atomic. Small harmless explosions such as bursting of a toy balloon are simple mechanical explosions. In this type no chemical reactions are involved. The famous Krakatao Volcanic explosion, the greatest steam explosion in the history occurred on 27th August 1883 as a result of the violent vaporization of an estimated cubic mile of ocean water when the Krakatao Volcano ruptured and spilled a great mass of hot molten lava into the sea. The ultimate result was the loss of about 36,000 human lives which dramatically illustrates the potential of a mechanical explosion. As the name implies the chemical explosions are always associated with chemical reactions. This article will mainly concentrate on this type. Well known widely used explosives such as Gun Powder, Dynamite, Tri Nitro Toluene, Plastic Explosives etc. are chemical explosives. An atomic explosion may be induced either by splitting of the nucleus of an atom or joining together under great force of the nuclei of atoms of certain elements. The atomic bombs dropped on Japan in World War II were rated as equivalent to 20,000 tons of Tri Nitro Toluene in explosive power, yet the amount of fissionable material required to produce the same amount of energy weighed about 2.2 pounds. Also, this type of explosions result long term radiation hazards.

Chemical explosives contain oxidizing and combustible ingredients united in a single molecule or present in different chemicals as a mixture. For example Nitro Glycerine and Tri Nitro Toluene are single chemicals and Gun Powder is a mixture of Chemicals.

All the explosives are not alike, they have different properties. An explosive used as a propellant in ammunition is not effective in breaking boulders in a quarry and conversely, an explosive such as Dynamite used in quarries would shatter gun barrels. According to the properties and the methods of initiation, they can be classified into three main classes; initiating, Low and High Explosives. Initiating explosives are easy to explode and generally sensitive to flame, spark, impact, shock and friction. But they do not necessarily produce large volumes of gases and hence this type of explosives themselves are not suitable in blasting operations. Explosives such as Mercury Fulminate, Lead Azide and Lead Styphnate are considered as initiating explosives. Low explosives are generally sensitive to flame and spark and safer to handle. The chemical reaction involved in this type of explosions is the simple combustion of combustible materials with oxygen.



Jony Mine

The most widely used Low explosive is Gun Powder. Blasting granules also contain the same explosive mixture, but the granules are graphited in order to minimise the absorption of moisture and facilitate filling bore holes. Gun Powder or Black Powder as it is now called was the first explosive used and it was first discovered in the 13th century. Gunpowder consists of a mixture of Potassium Nitrate, Carbon and Sulphur in the approximate proportion of 75:15:10 and it is readily ignited with a spark or flame even in complete absence of air. But if it is not confined, generally it does not explode. When it is burned in a confined space, as in a bore hole or a military shell, then as the pressure increases the rate of burning also increases to a high value resulting a violent explosion. Here, Potassium Nitrate acts as the Oxygen supplier. The rate of flame propagation in Gun Powder is of

the order of hundred metres a second. When Gun Powder explodes it undergoes a combustion reaction with a rapid release of gases and energy. The ultimate explosion products of Gun Powder may be Potassium Carbonate, Potassium Sulphate, Potassium Sulphide, Carbon Dioxide, Carbon monoxide and Nitrogen. This is the slowest acting of all explosives and has a shearing and heaving action tending to blast objects into large fragments. This has very wide commercial applications and also it is very interesting to mention that this is the approved explosive mixture in crackers. Gun Powder is used as the core of safety fuse in explosive industry and also as a propellant in aerial rockets in fireworks industry.

However, it is sad to mention that most of the crackers available in the market now contain a mixture with silvery shiny appearance due to the presence of aluminium powder. The use of aluminium powder mixed with other ingredients in crackers is prohibited under the Explosive Regulations because it enhances the friction and impact sensitivity of Gun Powder making it unsafe, although it produces a louder noise. This may lead to accidental explosions and uncontrollable fires.

Even more rapid reaction can be produced when oxygen and fuel are united in a single chemical molecule. This type of explosives are generally named High Explosives. The chemical reaction involved in this type of explosions is not combustion; it is called "Detonation". Although it is simply defined as "instantaneous combustion", this process of detonation can best be defined as the passage through the explosive substance of a sudden supersonic wave of very high pressure and temperature which causes the molecules to break down into fragments. These fragments later recombine to give the ultimate products. The rate of this reaction is of the order of 8000 metres a second. Since this is independent of the

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pressure of surrounding gases, confinement is not necessary for an explosion. When such an explosive charge is detonated, very hot expanding gases are formed in a period of approximately 1/10,000th of a second. These gases generally exert pressures of about 700 tons per square inch on the atmosphere surrounding the point of detonation and rush away at velocities of up to about 9000 metres per second compressing the surrounding air. This mass of expanding gases rolls outward in a spherical pattern from the point of detonation like a giant wave weighing tons, smashing and shattering any object in its path. This is generally called the blast pressure wave and the further it travels from the seat of explosion, the less power it possesses until, at a great distance it dwindles to nothing. Now it is obvious that the initiation of this type of explosive is not an easy task since a supersonic wave of a suitable strength is necessary. A small device called "Detonator" which can be initiated either by flame or electricity, is used to fulfil this requirement. It has the ability to explode less sensitive high explosives.

Nitro Glycerine is the main active ingredient in most of the dynamites; the commercial high explosive most widely used in blasting operations throughout the World. Pure Nitro Glycerine is a colourless to pale yellow liquid which has a characteristic smell of almond. In 18th century an Italian Chemist named "Ascanio Sobrero" discovered Nitro Glycerine. But this oil was highly explosive extremely dangerous to handle and could be set off by being struck. In 1863 "Alfred Noble" a Swedish Chemist invented a way to control Nitro

Glycerine by treating it with Kieselguhr, an extremely porous earth and hardening into sticks called "Dynamite" creating a new word from the Greek "Dynamis" meaning power. But, unfortunately during period, an accidental explosion in Alfred's Workshop killed his younger brother and critically injured his father. I believe that Alfred Nobel had no idea throughout his life of using his invention for the purpose of killing people. Now this type is widely used by the extremist groups to manufacture land mines, booby trap bombs, time bombs, etc. against human lives. The most common symptom of Nitro Glycerine poisoning is severe headache which is noted upon commencing work but gradually passes off. It can be absorbed even through uninjured skin and may produce eruptions on the palms. However, in normal careful handling of Dynamites the physiological effects of Nitro Glycerine cause only temporary discomfort and are not seriously injurious to health. It is important to note that the possibility of accidental self detonation in handling deteriorated Dynamite is a great risk.

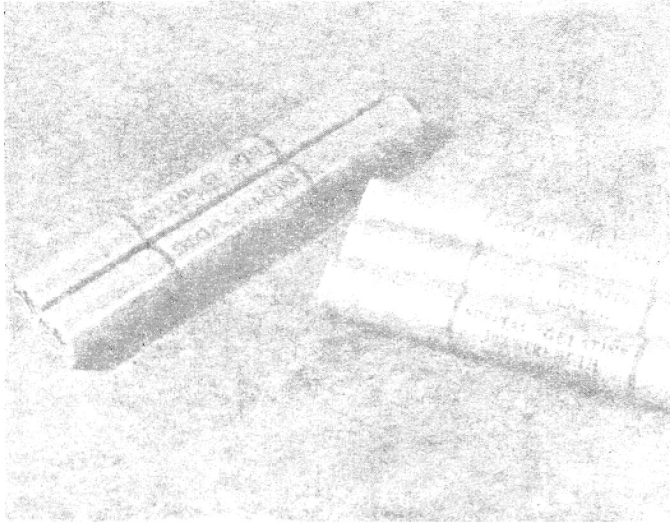
Tri Nitro Toluene (T.N.T.) is a widely used military explosive and it is a colourless to pale yellow solid. This comes as monoclinic crystals, and widely used as the main charge in hand grenades, air delivered bombs, and also in the manufacture of another useful high explosive called :Composition - B" which is mainly used in mortars, R.P.G. rockets, anti-tank mines, torpedoes and grenades. Tri Nitro Toluene is also used locally in the manufacture of "JONY" mines in the



Anti Personal Mine



"ARGES" Grenade



High Density Gelatinous Explosive

northern part of the island which has become a major threat to the security forces.

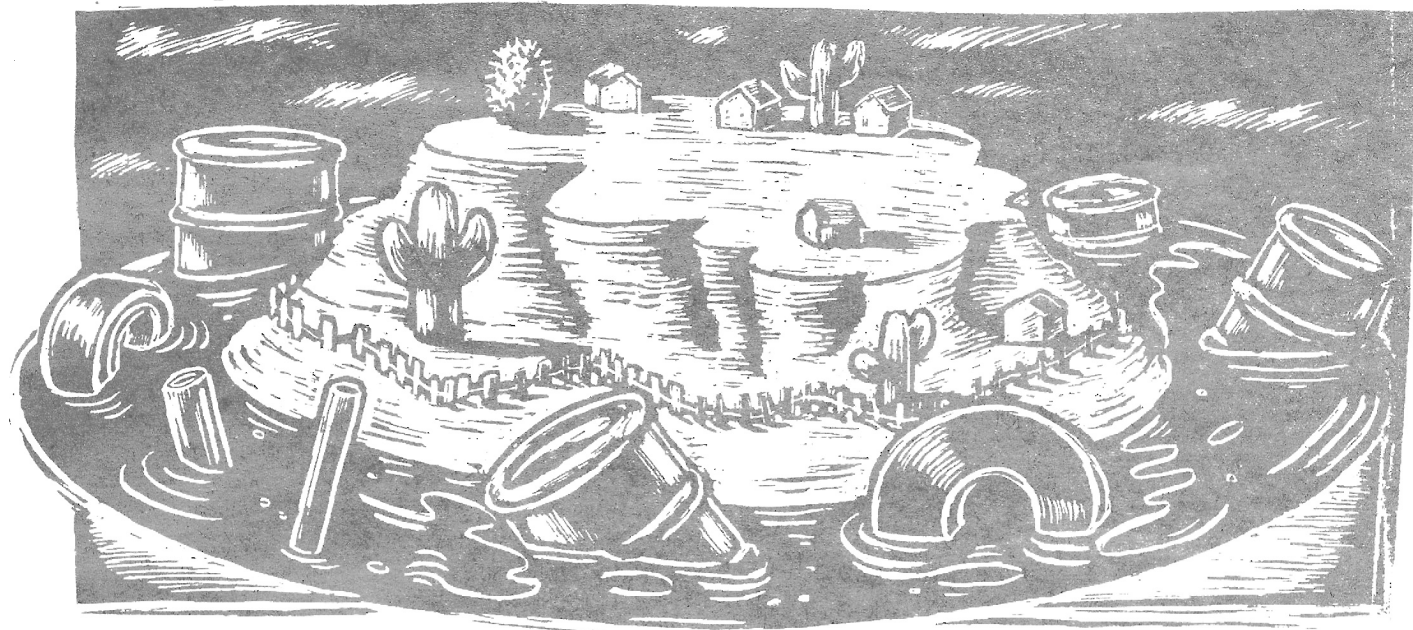
This is a comparatively stable and safe explosive but the acute or chronic poisoning of Tri Nitro toluene from inhalation of dust, skin absorption or ingestion may cause Jaundice, nausea, loss of appetite, dermatitis, cynosis etc.

Cyclo tri-methylene tri-nitramine (R.D.X.) a white crystalline powder is one of the most powerful high explosives in use today; and has more shattering power than Tri nitro toluene. This is the main active ingredient in plastic explosives and plastic sheet explosives.

However, it is extremely important to note that the readers should never experiment with explosives or pyrotechnics as there will be no excuse for mistakes. It may also lead to serious explosions and severe uncontrollable fires.



Consequences of a Bomb Blast



ENVIRONMENTAL POLLUTION

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(This article won the first prize in the Young Writers Competition - 1993.)

The term environment denotes all living and non living entities within the human habitat. There are two aspects to the environment as natural and cultural. Land, water, soil, plants and animals belong to the first category, while what is called the cultural environment is the environment constructed by man to fulfil human requirements. Religions, artistic creations, customs, behavioural qualities, roadways, buildings and social organi-

zations are features of this aspect. Man from ancient times up to the construction of the present has necessarily brought about changes in the natural environment in fashioning his civilization and in advancing it.

Accordingly, material and energy are constantly added to the environment through certain activities of man. Thereby the environment undergoes physical and chemical changes. If such

changes cause some damage to the quality of life in the area, it is environmental pollution. The main cause of modern environmental pollution has been the adverse effect of the industrial revolution of the 18th century. When we consider an environment we see an interrelationship which has developed between its plants, animals and the ecology. The sustainability of an ecological system depends on ecological balance. Herein we should pay greater

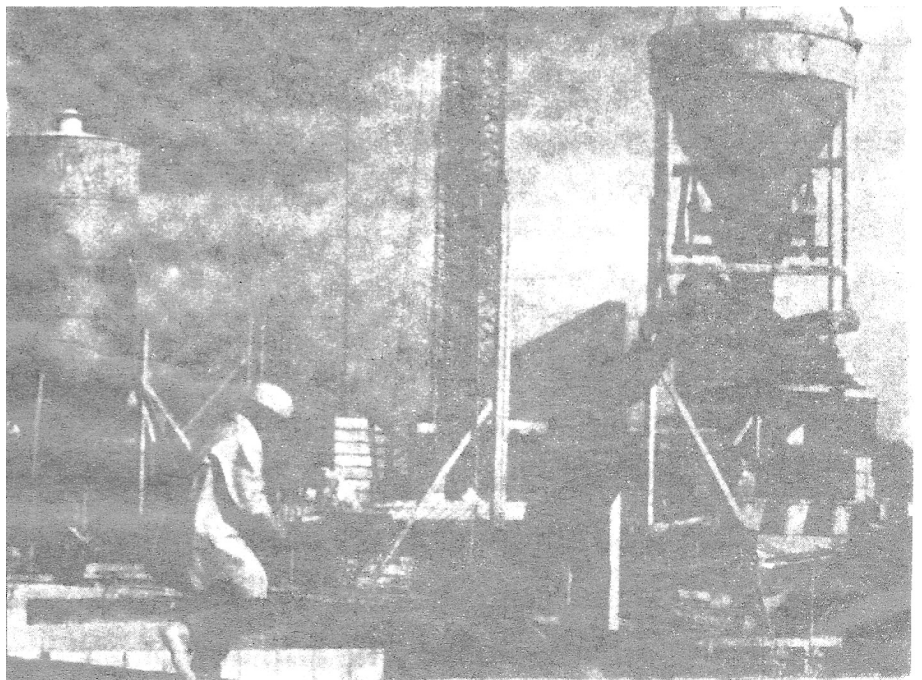
attention to air, water and soil which belong to the biosphere and in addition, to food and physical appearance etc.. Substances such as gaseous materials, solids and particles which exist in the air and energies such as heat, light, sound and radio active rays, could be identified as substances that are added to the environment through human activities. Living organisms could tolerate such sources of energy only up to a certain limit. It is due to this reason that the effluent from the boiler in a factory, when released into waterways makes it difficult for water plants, algae, fish etc. to survive. It shows that in this instance, heat has played the dominant role. Also the sound emanating from industrial areas due to industrialization and from trains, aeroplanes etc. also cause great stress. Human beings could tolerate only up to 50 decibels of this sound. Sounds exceeding this limit can impair hearing and cause deafness and also affect the nervous system. The indicates that there is a limit to the volume of sound that could be tolerated by living beings.

When we consider living organisms existing in a polluted environment, we could see a number of basic changes. The extinction of certain species which originally existed in the environment, extensive invasion of the environment by species which did not exist at the beginning, reduction in the total number of species, shortening of food chains, simplification of grids, are some such changes. Man, for his survival, should maintain the required ecological balance. However due to the changing nature of the environment, its balance is constantly disrupted. Such disruptions in ecological balance is the main cause of environmental pollution. Ecological balance is lost due to diverse human activities such as deforestation, construction of irrigation works, factories and cities, reclamation of marsh lands and through natural phenomena such as floods, cyclones, landslides, sand storms and volcanoes. Air, water, and land pollution takes place as indirect effects of these factors.

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As the countries in the world progress in science and technology, pollution has become a common place occurrence. Pollution of the environment through gases such as those emitted from factories, vehicles etc. and through compounds such as perfumes, insecticides and aerosols etc. is prevalent at present.

due to this, the ozone layer is damaged causing rays to fall directly on to earth leading to skin ailments and dangerous diseases such as cancer. In addition to this, due to the pollution which is caused by nuclear technology, from material such as nuclear fall out and ultra radiation, sicknesses such as cancers in the



Environmental Pollution by Industry

thyroid gland, lungs, breasts, the liver and kidneys etc. and cataract, hair dropping, damages to bone marrow, loss of immunity, genetic mutations in reproductory cells, brain damage, destruction of sections of the digestive system takes place. Increased temperature of the atmosphere, green house effect, destruction of ancient monuments are observed effects of the fumes mentioned above.

Water pollution caused by short sighted and indiscriminate acts of man is rampant today. People today are trying to achieve their ends at a minimum cost even through it may be at the expense of the environment. It is with this intention that people today are bent on setting up factories close to reservoirs. The addition of large quantities of effluent from garment, leather tanning, and chemical factories in turn create human hazards.

The disease called 'minimata' which affects man is a good example for this. The draining of chemical fertilizers into reservoirs and their concentration and subsequent is another consequence of water pollution. Other than this the water is also contaminated through such means as the washing of oil barges, and the addition of animal excreta and other waste materials to water.

Furthermore water, land and air are all polluted today by radiation. Soil is contaminated by the collection of garbage, introduction of chemical substances into the soil, loosening of the soil during agricultural activities, dumping of non-degradable material such as polythene, plastics and rubber onto the soil thereby reducing the space available for useful organisms, destruction of benevolent organisms and soil degradation. These affect the growth and harvests of crops.

Accordingly the natural environment could be protected through measures such as spreading the conservation concept through students, including the environmental conservation factor in the curricula from the lowest to the highest grade in school, creating public awareness through mass media, finding ways of turning contaminated by-products into useful products, taking steps to convert combustion fumes into harmless compounds, using substitute aerosol compounds, the use of compost manure produced out of waste materials in place of chemical fertilizers, introduction of recycling methods such as the production of biogas from accumulated animal waste, breeding of nitrogen fixing bacteria in the soil and thereby reducing the application of inorganic fertilizers, use of biological control in place of pesticides, using prescribed concentrations of spraying materials, measures to re-

duce the use of non biodegradable materials, adoption of soil conservation methods, improvement of drainage, conservation of the natural flora wherever possible, prevention of the ill effects from bare lands etc., establishing standardization sectors, adoption of proper hygienic practices, for the purpose of controlling the existing and probable ill effects of environmental pollution.

We have so far considered the areas which mainly affect ecological pollution. However, the degradation in the cultural environment too deserves attention since this too is taking place on a large scale today. Its degradation leads to changes in the social environment. Cultural values and moral qualities are thereby degenerated. Urbanization and tourism can be cited as the main factor contributing to this. This environment is also polluted due to the warped behaviour patterns resulting from addiction to drugs such as Marijuana and LSD. It is our duty to formulate laws to prevent these distortions and implement them in order to safe guard human ethics and cultural values and bring about attitudinal changes and thereby protect the cultural environment and protect the natural environment and thereafter turn this earth into a suitable haven for human civilization.

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Setting up a Nuclear Plant;

will it be Beneficial or Harmful

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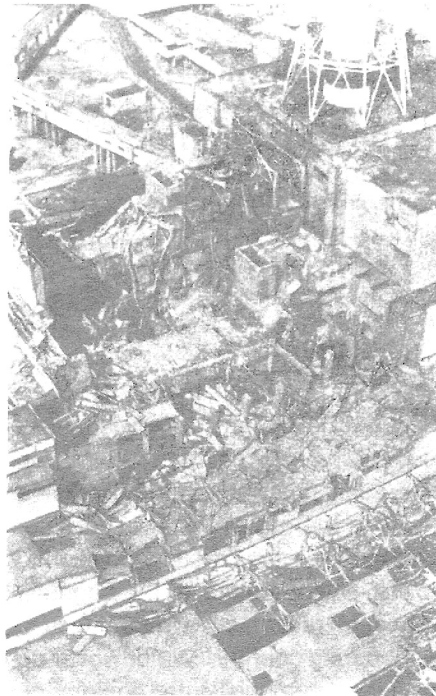
(This article was received for Young Writer's Competition -1993)

It is no secret that science and technology has reached its zenith in the 21st century. This being such an age, the use of advanced technology for the construction of a nuclear plant can be considered a common occurrence. Do we have in our countries, such technology and such a high level of industrial discipline.

All the nuclear plants found in the world today have been established according to the process known as "nuclear fission". The two nuclear bombs which were dropped on the areas of Hiroshima and Nagasaki in 1945 were also built on the same principle. However the nuclear missiles which exist today have been built using the process called nuclear fission. It provides more energy than the nuclear fission system. However, upto now it has not been possible to use the nuclear fission process for nuclear power plants. It is therefore clear that the system in operation all over the world still is a low efficiency high risk process. During the fission process, a sudden and powerful explosion takes place inside a bomb. However inside a power plant there is provision to control the energy released in this way. Yet it should be reiterated that there is a high risk of massive accidents taking place inside power plants which rely on the fission process. The by products of this process are highly radio active. Any sudden leakage from such a power plant will result in large quanti-

ties of radio active material entering the atmosphere outside the power plant. Several such unexpected events have ended up in vast disasters.

If we take a look at the great tragedy which took place at Chernobille, the explosion at the Chernobille power plant released a large amount of radio active chemicals into the atmosphere. Those who were affected most were the peo-



Chernobyl Nuclear Plant

ple of Chernobille. To be exact, everyone within a 30 k.m. radius from Chernobille had to be evacuated immediately. However every thing did not end with that. Through out Europe levels of radioactivity were raised. Various problems cropped up.

Further, some radio active materials which escaped during the Chernobille explosion were found in Japan and in the United states of America. Isn't this an indication of the scale of the destruction caused? What caused this disaster which took place at Chernobille in the Soviet Union to have an effect on such distant countries. This was caused mainly by the wind. The radio active material which entered the atmosphere at Chernobille was blown by the wind, not only into countries such as Norway and England but even to states which were further away.

It needs no mention that if such an accident were to take place in Tamil Nadu which is a mere 20 miles away from Sri Lanka, and radio active material is released from a power plant in Tamil Nadu, we in Sri Lanka would be severely affected. On that day, Sri Lankans will suffer a tragic fate. The Winsco power plant in England met with such a fate. The power plant located in the Three Mile Island in Pennysylvania in the U.S.A. too suffered a radio active leakage causing harm to a large number of lives. More

than all these, it is the Chernobile tragedy that has left the strongest impression in our minds.

According to nuclear scientists, in the event of such a sudden leakage, people living within a minimum range of a 90 mile radius from the plant should be evacuated immediately. However, this can only lower the risk. It is no secret that due to the accident at Chernobile, radio activity affected agricultural products, and livestock, not only in Russia but even in Northern Europe. It is also no secret that for a considerable period of time thereafter, not only in Russia but even in Sri Lanka food items (powdered milk, jams etc.) had to be referred to laboratories. The direct result of nuclear radio active leakages affect a minimum of 100 miles and it could spread further according to the nature of the blowing.

Further, when a nuclear plant is in operation diverse waste products are generated. These are radio active materials. Therefore such wastes cannot be dumped haphazardly. Because of these, European Countries are facing a serious problem even today. This waste material is normally stored in barrels made of concrete. Thereafter the barrels are sunk to the bottom of the sea. Yet who can think that the problem will end with that? Is it not possible for this radio active material to escape from the barrels some day? In these circumstances how will such nuclear waste from the power plant in Tamil Nadu be stored? Will it be in the Indian ocean which surrounds us? We should know about it. Why? Because this waste material is dangerous. Furthermore, many countries generally attempt to hush up accidents causing radio active releases without anyone's knowledge. We come to know only about accidents which cannot be kept secret like the Chernobile disaster.

Generally, European countries are constantly on the alert regarding this type of

If we take a look at the great tragedy which took place at Chernobile, the explosion at the Chernobile power plant released a large amount of radio active chemicals into the atmosphere. Those who were affected most were the people of Chernobile. To be exact, everyone within a 30 k.m. radius from Chernobile had to be evacuated immediately. However every thing did not end with that.

accident. They have highly sophisticated equipment which can record even a very slight change in the level of radio activity in the atmosphere. Therefore European countries are in a position to know it, even if there is the slightest release of radio active material in a neighbouring country. We however do not have such sophisticated equipment. Nor do we make an effort to identify the constant changes in the level of radio activity.

Therefore even if such an accident were to take place in India, we have no way of knowing it. Even at a moment when the whole of Sri Lanka is in danger, we could still be unaware of it. Our fate may be sealed without even knowing it. Isn't that an extremely dangerous proposition?

Today the storage of nuclear waste has become a problem even to European countries. They use a splendid strategy to solve this problem. They despatch this waste to third world countries on the sly. These are stored in third world countries with the knowledge of some of the citizens of those countries. The developed countries are prepared to pay in millions to those who help them to do this. Marshall Islands provides a good example for this. Nuclear waste from various countries have already been deposited there. This remains a secret.

It is in this context that the voice of our scientists is raised against the establishment of a nuclear power plant in Sri Lanka. It is a myth to think that we too should go in for nuclear power plants simply because developed countries are using it. Even Sweden which is at the forefront of high-tech has decided to get rid of nuclear power plants before the end of this century. Although Australia is naturally endowed with large amounts of Uranium required for nuclear power plants it has no nuclear plants. The amount of money received by islanders per year is a hundred million dollars. That is for helping to store nuclear waste on their mother land. Who could predict whether the day when Sri Lankans too will be interested in such short cuts to making money, will not dawn? It becomes easier, because the waste material could be obtained from Tamil Nadu. It has to be transported only over a distance of 20 miles. What would we do when this day arrives?

New Frontiers in *Biotechnology*

Samanthi Geethika Rabbadigala

Year 13 E

Mahamaya Balika Vidyalyaya

Kandy

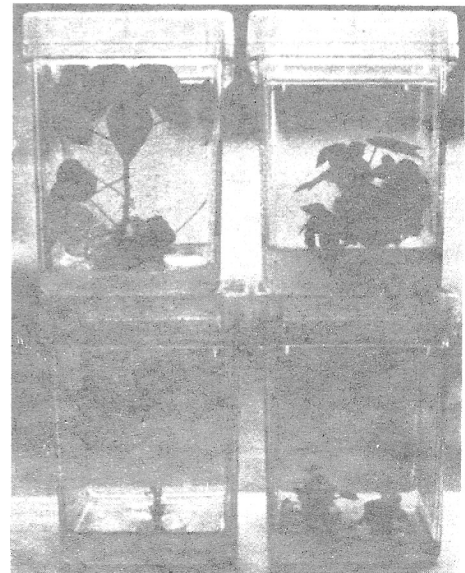
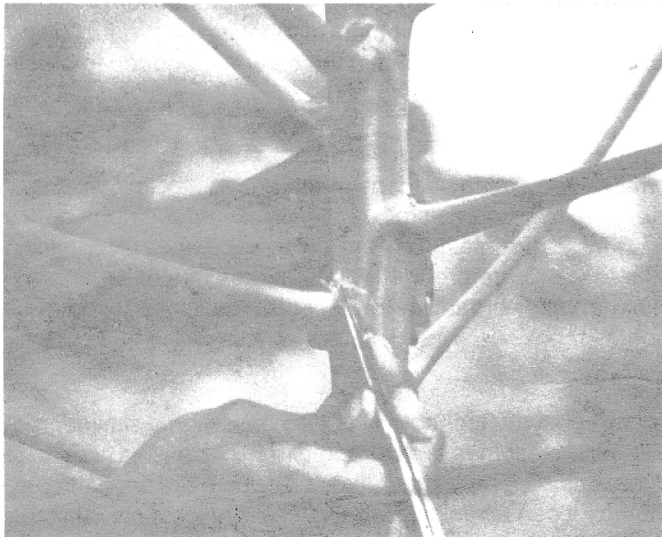
(This article was received for Young Writer's Competition -1993)

It is clear that in an age such as the present, in which science and technology, at the highest rung of the ladder of development, is paving new avenues for the benefit of the world, we as the inheritors of tomorrow's world, should remain vigilant.

We who are at the threshold of the 21st century will be the owners of that century. Even a little knowledge of biotechnology, which is a subject receiving much attention in the field of modern science today, will be helpful to us in the serious task of taking over the responsibilities of future.

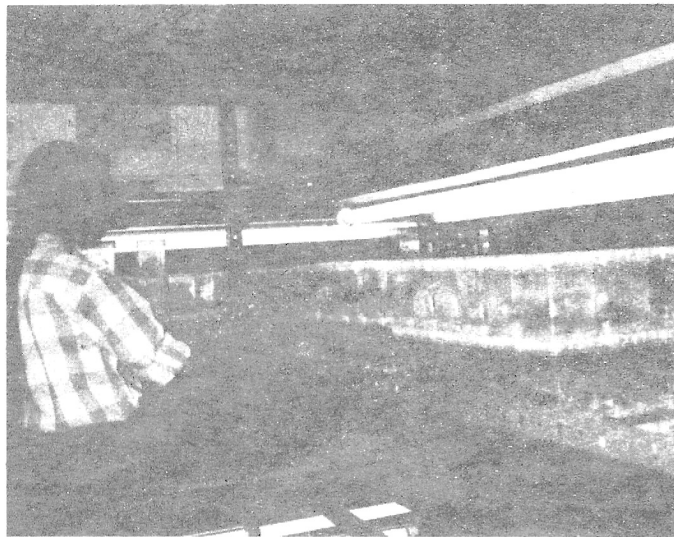
Biotechnology is the practical use of an organism or a subcellular organism to assist some production or production process and for managing the environment. This definition of biotechnology was adopted by the SPINK Committee on Modern Biotechnology which met in London in 1980.

Although Bio Technology has made considerable practical progress in modern times, its history goes as far back as around 6000 B.C.. The ancient Sumarians and the Babylonians knew about wine manufacture and Egyptians from around

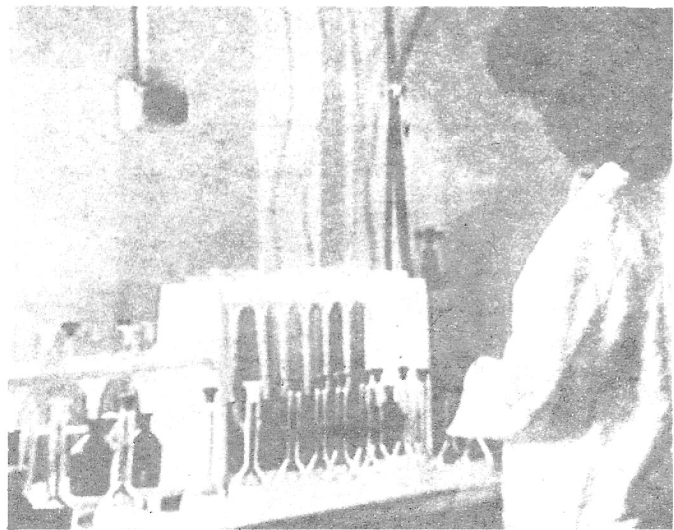


Tissue culture of papaw

4000 B.C. knew about yeast which is important for fermentation and about making bread. If we take a look at the history of Sri Lanka, there is evidence to show that our ancestors knew how to produce toddy.



Production of resistant plant varieties



Genetic Engineering - fast developing area

What is known as modern biotechnology is a process carried out under sterile conditions. In biotechnological processes carried out to obtain economic advantages the objective is to

change the genetic pattern of the organisms used in order to make the process concerned more effective. In genetic engineering which can be called a fast developing area today, the genetic structure of an organism is reconstituted in a manner which is economically important to us. Recombination or mutations are used for this purpose. The transmission of the bacteria known as *Escherichia coli* which is the insulin producing gene in the human body, was the first step in genetic engineering. Today there are wonderful inventions such as tobacco plants which shine like fire flies, super quality pigs with high meat content and low fat content.

Further, as a result of genetic engineering, a paddy plant which is totally free of leaves has been developed by a group of scientists in the John's Inn Institute at Norwich. This discovery has made it possible to grow paddy in areas which have strong winds. The paddy seeds of this strain also have a shorter maturing period. Harvesting is easy and there is sufficient photosynthesis through the stems and panicles of this variety.

Protoplast fusion and Tissue Culture could be cited as two frequently used principles of genetic engineering. In Tissue culture, plants can be reproduced in acidic cellular solutions.

Enzyme technology can be considered an area which is developing as quickly as the science of genetic engineering. The purpose of this technology is to make optimum use of the different enzymes in the leaf.

A particular product could be obtained from a series of biochemical reactions in a cell because the cell does not contain the enzyme which is required to break down that product. For instance, if we consider the production of alcohol from a yeast cell we can obtain alcohol as the product only if the yeast cells do not contain the enzyme required to break down the alcohol.

Further, the termite cannot digest cellulose because the termite's body does not contain the enzyme cellulase. However the microorganism known as *Trochonympha* which exists inside the intestine of the termite is capable of producing cellulase. Therefore the termite makes use of an enzyme within another organism to digest the cellulose found in its food.

Modern enzyme technology is also based on a similar process. First, enzymes are extracted from organisms or parts of organisms. Thereafter such enzymes are immobilized. Thereby it can be linked to the necessary location. Immobilization of enzymes can be done in several ways. Enzymes can be immobilized into a total enzyme. Or else it is done to part of the cell or to an organism. Then the enzymic activity could be carried out and the required economic purpose

achieved. An example of such an activity is the production of high fructose syrup. This syrup has a very high percentage of fructose.

These are important for the manufacture of cordials. Their production is carried out by using the enzyme called glucose isomerase found in bacteria.

In biotechnological reactions, conditions under which the reaction is carried out invariably affect the speed of the reaction. Therefore bioreactors or fermenters are important for the provision of such conditions during biochemical engineering activities. Bioreactors have been designed in such a way as to enable the use of computers to control factors such as the temperature and pH value of the site where the biochemical production is being carried out. By this method the quantum produced is increased and a higher percentage of the product could thereby be obtained.

Successful results could be obtained by using mechanisms like biosensors for processes for which modern devices cannot be fabricated. Biotechnology can be used for medical treatment in addition to its use for the production of medicine. Further, it also helps to cure the side effects arising from treatment with drugs.

Biotechnology makes it possible to produce plant varieties which are resistant to natural hazards such as droughts, and damage by insect pests. Agriculture in the modern world faces a serious problem with regard to nitrogenous fertilizer, because of the high price of petroleum products or due to their scarcity. Genetic Engineering has provided an answer to this problem. Rhizobium genes capable of fixing gaseous nitrogen in leguminous root nodules can be used for this purpose. Different plants can be drafted using the genetic system called Nifsystem consisting of around 17 genes which has the ability to fixate gaseous nitrogen.

Biotechnology is a process which should be monitored systematically and closely. There should be a standard policy so that countries may be prevented from acting arbitrarily in this regard.

In a biochemical production the production process is called an upstream process and the process for the separation of the products is called the downstream process. Bio reactors and fermenters are widely used in the production of wine and beer and antibiotics. This technical process, constructs units by combining biological molecules, such as enzymes and antibiotics through processes such as protein technology and cell immobilization. These units are known as biosensors. Mechanisms can be arranged by combining these biosensors. For instance, if we need to isolate foreign matter or to remove some chemical from an alcoholic solution which is being prepared, the solution should be passed through a biological sensor. Thereby the undesirable chemicals in the solution can be removed.

There is a bad side as well as a good side to every thing. This universal characteristic doubtless applies to biotechnology as well. Just as a large amount of money spent on machinery could be saved through the use of biotechnology, it also reduces energy consumption. Organisms used in biotechnology sustain themselves and essential products are obtained, using as raw materials, inexpensive substances which are freely available in the environment. Furthermore,

Further, biotechnology can also pose threats to humanity. Large numbers of lives can be destroyed by destructive weapons such as microorganic weapons. *Clostridium botulinum* is such a destructive microorganic weapon. The dangerous organisms which could be produced by drafting the gene called Bangaratoxin produced by the reptile *Bangarus circulus* to other animals, can pose a real threat to human beings.

Biotechnology is a process which should be monitored systematically and closely. There should be a standard policy so that countries may be prevented from acting arbitrarily in this regard. Further, it is common place nowadays for developed countries to pilfer genetic resources from underdeveloped countries. This is taking place on a large scale. Steps should also be taken to prevent this.

However it is true that biotechnology is extremely beneficial to man. Yet if such developments are used for the detriment of man it will bring us to harm like the proverbial razor in the monkey's hand. Not only biotechnology for that matter, any scientific discipline should progress with a human approach and not with the intention of destroying the world.

Toxins in Food : *Aluminium*

Manohari Sandanayake

*Assistant Director
NARESA*



In the 1970s, however, doctors noticed some distressing side effects in certain people with chronic kidney disease. Some of these unfortunate people first became anaemic and eventually suffered from dementia. They also developed soft or brittle bones. These patients had been exposed to higher concentrations of aluminium than normal from the large volumes of water used in dialysis. They had also taken large doses of antacids containing "active" aluminium hydroxide.

New Scientist 21 January 1989

Aluminium, a metal which was in use in various countries in the world since the latter part of the nineteenth century, was considered a non-toxic metal. Due to the same reason, vessels turned out of this metal were used in the preparation of food.

However, at the end of the twentieth century, it has become necessary to pay attention to the ill effects of aluminum on the human system.

Aluminium was introduced to the industrial world by Henri Saint Claire Deville. It was described by him around 100 years ago as a bluish white, lustrous, light weight, resonant metal.

Further, it was presented by him as a heat resistant metal which is harmless to humans and suitable for household use. Later, aluminum came to be considered as the most suitable metal for vessels for food preparation. Accordingly metals such as copper and tin which were currently in use, went into disuse.

However, according to recent discoveries, a certain amount of aluminum infiltrates the food in certain situations. Vessels made out of aluminium reacts with oxygen in the atmosphere and forms aluminium oxide. Aluminium vessels kept exposed to the atmosphere gradually lose their shine due to this process.

Although the layer of aluminium oxide serves as a protective coating, it starts to dissolve in acidic and alkaline media.

Further, due to scrubbing with alkaline materials such as soda in cleaning aluminium receptacles, the layer of aluminium oxide is damaged, exposing the metal. It can be presumed that a certain amount of aluminium enters the food which is cooked in such vessels.

Cooking acidic foods such as tomatoes, fish with gamboge, meat with vinegar etc. in aluminium vessels, storing fruit juices in aluminium vessels, baking foods such as cakes and biscuits in aluminium trays can be hazardous to health. These can lead to a higher intake of aluminium by the human body.

Earlier, machine parts and receptacles made of aluminium were used in the distillery industry and in milk powder manufacture.

The sad situation in this regard was that babies imbibed a considerable amount of aluminum through milk powder. Scientists have found that a child fed on such milk powder has absorbed 173 - 2285 micro grams of aluminium per day in comparison to the 2 - 10 micrograms absorbed by a child fed purely on mother's milk. Due to the revelation of these facts the use of aluminium in food manufacture as well as in the manufacture of milk powder has now been restricted.

In countries which experience acid rain, it has been reported that pipe borne water often contains aluminium. In such circumstances these countries make a constant effort

The blood plasma of a healthy human being normally contains 10 micro grams of aluminium. 75% - 95% of the 4 - 8 milligrams of aluminium taken in by us along with our daily intake of food is excreted from the system in the form of non-soluble salts in waste matter. Any quantity in excess of this amount of aluminium imbibed by the system could be harmful to the system in several ways.

to maintain the correct pH value of water.

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The excess compounds of aluminium enters the blood circulation system through the intestinal walls and along with the blood flow reaches the brain where it gets deposited. Scientists have shown that this can cause diseases in the brain.

Aluminium also gets deposited around the body tissues. This happens mostly in blood corpuscles, bones and lungs. With time this will lead to diseases of the blood plasma (anemia) bone diseases (swelling of joints) and lung diseases.

Aluminium which enters the urinary system is deposited in the kidneys and with time the kidneys may stop functioning.

Aluminium ingested with food may cause ulcers in the intestines.

It has to be emphasized that we should as far as possible, rid our lives of the metal aluminium to free ourselves from all these hazards and live a healthy life.

The Planet in Peril: Depletion of the Ozonosphere

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While direct conflict and turmoil reign over the inhabited regions of our earth, as never before in History, Nature itself appears to have intervened, mainly due to human activities, leading to further disasters not only for human beings but for all life forms upon the earth. Principal among these effects are (1) the so called **Greenhouse Effect** leading to global warming; (2) the depletion of the Ozone Layer, surrounding the earth, resulting in the possible elimination of certain life forms and further disasters for human life; (3) the periodic phenomenon known as the El Nino, which radically changes our weather patterns and which we in Sri Lanka experienced during the unprecedented drought early in 1992. Of these phenomena (1) and (2) appear to be caused by human activity partly through ignorance and partly due to the greed for profits. It is significant that these effects were first identified by artificial satellites.

It is ironical that over the centuries science and technology, developed by man, have advanced civilization to a degree, undreamed of in the past. However, while benefitting mankind, it is now turning into its opposite, threatening the very existence of the human race upon this planet.

The earth's atmosphere, through many aeons of evolution, is today highly complex. Up to about 70 km above the earth's surface we have the troposphere, consisting largely of the gases nitrogen and oxygen. They are finely balanced to permit the evolution and existence of living beings upon the earth. The temperature of the troposphere decreases in an upward direction. Above this is the stratosphere a rarefied region where the temperature begins to rise as we proceed

upwards. Between heights of 150-300 km there are a series of spherical electrified layers, known as the ionosphere. It is the reflection and re-reflection of radio waves between the ionosphere and the earth that enable us to "pick up", for example, BBC from Sri Lanka.

What interests us here is a spherical layer of gas (OZONE) which exists at a height of 70-100 km above the earth. This is known as the ozonosphere. What is ozone? What is its composition? and what function does the ozonosphere fulfil? Contrary to the view of certain philosophers, Nature generally has a purpose or purposes in its activities. Without delving into the realm of the sub-atomic, matter is known to consist of atoms. Each element in Nature has its own atomic structure and is described chemically by diverse symbols: e.g. oxygen - O, hydrogen - H, nitrogen - N, Fluorine - F etc. These atoms in reality exist singly or bonded together to form molecules - e.g. oxygen O_2 (two atoms of oxygen), nitrogen - N_2 hydrogen - H_2 , chlorine - Cl, etc. For instance in our troposphere, nitrogen exists as N_2 , oxygen as O_2 etc. More atoms are also bonded together in many instances to form complex molecules, with properties that differ from their component atoms - e.g. carbon dioxide CO_2 , common salt - NaCl etc.

Our Sun - like other stars and unlike the nine planets revolving around it - produces its own radiation - heat, light and a variety of other radiations ranging from the smallest wavelengths to the longest (radio waves). Only a small fraction of the light emitted by the sun is visible to the human eye. Among these invisible radiations is the ultra-violet, ranging in wavelength from 200 nm to 400 nm (nm: nano metre; where 1 nm = 10^{-9}

metre = 1/9 zeros). After plant life evolved upon the earth, oxygen (O₂) was released which formed a viable constituent of our atmosphere.

Reactions between O₂ and ultra-violet light from the sun resulted in the conversion of O₂ (oxygen) into ozone (O₃) at a height where the oxygen density was appropriate for these reactions. The spherical layer, known as the ozonosphere was created. Opposite processes generally tend to co-exist in Nature. Even as the ozonosphere was created by the sun's radiations, it developed the property of absorbing excessive ultraviolet light from the sun. An excess of ultra-violet radiation could have a deleterious effect on living organisms, including human life.

A fine balance was created between the ultra-violet emissions from the sun and the ozonosphere, which permitted only a minimal amount of ultra-violet light to reach the earth. This amount in certain circumstances could be of a health giving nature to humans and other living organisms. Such fine balances are common to Nature - both physically and chemically. In fact, the ozonosphere acts as an effective umbrella against excessive ultra-violet emissions from the sun.

Ultra-violet light from the sun can be roughly divided into three categories, depending on their wavelengths. They differ in their degrees of absorption by the ozonosphere:

Category	Wavelength	Absorption by the Ozonosphere
UV - C	200 - 290 nm	Fully absorbed
UV - B	290 - 320 nm	Partially absorbed
UV - A	320 - 400 nm	Not absorbed

Thus, UV - C, at present poses no threat to life on the earth. Such was the natural situation of our earth for a few billion years.

With the speedy development of technology and industrialisation new chemicals came into usage in the form of foams, solvents, sprays (insecticides, weedicides etc.), refrigeration and air-conditioning, leading to the slow release of a variety of chlorine-based compounds into the atmosphere. These rose over the years to stratospheric levels causing disastrous effects in the ozonosphere. known as CFC's

Parts per Trillion (1 Trillion = 10¹² or a million)

Year pre Industrial	CCl ₄	CH ₂ CCl ₃	CCl ₃ F (CFC 11)	CCl ₂ F ₂ (CFC 12)	CHCl F ₂ (CFC 22)	C ₂ Cl ₃ F ₃ (CFC 113)	Total Gaseous Chlorine
	0	0	0	0	0	0	0
1959	315.8	x	x	x	x	x	x
1960	316.8	x	x	x	x	x	x
1961	317.5	x	x	x	x	x	x
1962	318.3	x	x	x	x	x	x
1963	318.8	x	x	x	x	x	x
1964	x	x	x	x	x	x	x
1965	319.9	x	x	x	x	x	x
1966	321.2	x	x	x	x	x	x
1967	322.0	x	x	x	x	x	x
1968	322.8	x	x	x	x	x	x
1969	323.9	x	x	x	x	x	x
1970	325.3	x	x	x	x	x	x
1971	326.2	x	x	x	x	x	x
1972	327.3	x	x	x	x	x	x
1973	329.5	x	x	x	x	x	x
1974	330.1	x	x	x	x	x	x
1975	331.0	104	120	200	x	x	1,202
1976	332.0	106	133	217	x	x	1,290
1977	333.7	115	148	239	x	x	1,416
1978	335.3	123	159	266	x	x	1,544
1979	336.7	116	167	283	46	x	1,621
1980	338.5	121	179	307	52	x	1,755
1981	398.8	122	185	315	59	x	1,797
1982	341.0	121	193	330	64	x	1,863
1983	342.6	126	205	350	71	24	1,983
1984	344.3	130	213	366	76	27	2,072
1985	345.7	130	223	384	85	31	2,163
1986	347.0	127	232	404	98	35	x
1987	348.7	133	247	421	105	41	x
1988	351.3	133	263	439	x	52	x

(x - Not available)

(chlorofluoro-carbons) their growth is indicated below ("World Resources" 1990-1991, published by the World Resources Institute in collaboration with UNEP and UNDP):

The Process of Ozone Depletion by UV Radiations Acting on CFC's

C: Carbon atom
Cl: Chlorine atom
F: Fluorine atom

CFC molecules are transported to the stratosphere. In the stratosphere, UV radiation from the sun is strong enough to split the chlorine atoms off the CFC molecule. The free chlorine atom attacks an ozone molecule. An oxygen atom splits off, binds to the chlorine and forms chlorine monoxide. The rest of the ozone molecule is left as an ordinary oxygen molecule. The chlorine monoxide is not stable, however. A free oxygen atom can steal its oxygen, leaving the chlorine atom ready to go after another ozone molecule. Each chlorine atom can destroy up to 100,000 ozone molecules. (From a UNEP feature, reproduced in "The Island" science page of May 14, 1992)

Observations made by artificial satellites have considerably improved our knowledge of trends in the ozonosphere. A few years ago studies revealed that a "hole" (actually a considerable thinning) had occurred in the ozonosphere over Antarctica over an area of 26 million Km² which is roughly the area of South America. Recently, another "hole" has been discovered in the ozonosphere over the Arctic. The decline in the ozone layer occurs at high and mid-latitudes in both hemispheres both during the winter and spring/ summer. NASA investigations show that the ozone over the northern hemisphere fell significantly between 1969 and 1986. Similar changes may have occurred in the southern hemisphere but the available data is insufficient for any reliable analysis.

NASA figures for the northern hemisphere are as follows:

Decline in the Ozone Layer (1969-1986)

Latitude	Winter change	Summer change
53°-64°	-6.2%	+0.4%
40°-52°	-4.7%	-2.1%
30°-39°	-2.3%	-1.9%

Professor G.O.P. Obasi, Secretary General of the WMO (World Meteorological Organisation), shows that "in four of the past five years the ozone hole over the Antarctic was deeper and larger than any ever observed.

"The latest findings show higher chlorine concentrations in Arctic air over Eastern Canada and Northern New England than any previously observed in the Arctic or the Antarctic."

A Scientific Assessment Report, co-ordinated by WMO and UNEP, prepared by more than 100 scientists from 28 countries, stated that the ozone layer is being depleted at an even faster rate than predicted.

"Depletion now covers North America, a large part of South America and Asia, nearly the whole of Europe, Australia and New Zealand. The tropics are the only areas which are not affected" (for the present of course!)

What are the ill-effects of excessive ultra-violet radiation upon life forms that exist on the earth? The principal agent, as we have shown earlier is UV-B. The worst effects on human beings are skin cancers, both benignant and malignant. For every 1% decrease in ozone, it has been estimated that benign skin cancers will increase by 3%. Protracted exposure to sunlight of those with light skins would more readily acquire benign skin cancers. Unfortunately, white-skinned tourists visiting tropical resorts frequently sun-bathe and expose themselves readily to UV radiation, particularly to acquire a tan.

Current estimates predict a 5% to 10% ozone depletion of mid-attitudes in summer by the year 2000 AD, compared to the mid-1970's. Dr. Mostafa K Tolba, UNEP's Executive Director, writes: "If there were a sustained 10% loss of ozone, one could expect a 26% increase in the incidence of non melanoma skin cancer. The full consequences of our past folly will be painful."

The US has had a somewhat varying malignant skin cancer rate of about 7,800 per year, resulting in death. Over the past 35 years this death rate has increased by 200%.

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Scientists have other worries. The rate of development of cataracts in human eyes have shown a pronounced increase by excessive exposure to ultraviolet radiation.

They also worry about the possible effect of increased UV-B radiation on aquatic organisms. According to the microbiologist head of UNEP: "This could reduce phytoplankton bio-mass and change the composition and diversity of species. In turn, this may reduce marine food production at the bottom of the food chain and consequently, the food supply to fish and mammals higher on the food chain."

Halting or substantially reducing the depletion of the ozone layer by the elimination or substituting of CFC's by other chemicals requires a global effort, the co-operation of countries largely responsible for their generation in industry. The 1987 Montreal Protocol and the 1990 London Amendment to this Protocol is certainly a step in the correct direction. Dr. Mostafa K. Tolba writes thus: "A 1996 total phase-out of CFC's halons and other chemicals controlled by the 1990 London Amendment of the Montreal Protocol will speed up the recovery of the ozone layer by 10 to 15 years."

"In terms of human health this could mean a total of about a million fewer cases of skin cancer and about 350,000, fewer cases of cataract-induced blindness per year".

However, despite the "best laid plans of mice and men" (Steinbeck), politics and economics play an ever increasing role in human affairs, including their efforts to harness and control Nature, to make the World a better place to live in. The severe conflicts now ravaging our planet-from north to south, from east to west -and the unprecedented "recession" developing in intensity tend to influence the efforts of scientists to "control" Nature and protect the future of the human race.

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A few cases of hope do exist, strangely in the developing world: Laws have been passed, though half-heartedly, to ban the use of CFC's. China has embarked on a limited programme, banning the use of CFC's and the development of refrigeration alternatives. Mexico has announced that, with adequate financing (!) it will follow the same phase-out schedule as certain developed countries. Singapore has reported a 60% reduction in CFC use since 1986, the highest reduction of any country in the world. (From the science page of "The Island" - May 14, 1992).

However, the situation remains grim. The Executive Heads of WMO and UNEP concur that "faced with the expanded threat of ozone depletion, the original provisions of the 1987 Montreal Protocol and the 1990 London Amendment and Adjustments are quite clearly insufficient.

"A total phase-out by 2000 AD seems far too leisurely an approach. As we now know, time is not on our side."

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