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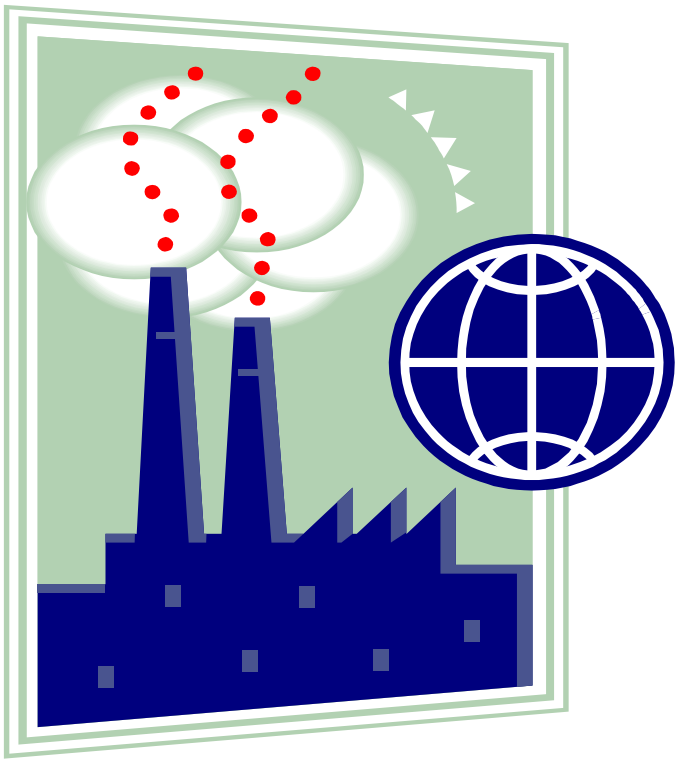
MODERN ECOLOGICAL PROBLEMS



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СОВРЕМЕННЫЕ ЭКОЛОГИЧЕСКИЕ ПРОБЛЕМЫ

Сборник текстов на английском языке
для студентов неязыковых вузов

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ПРОБЛЕМЫ**

Сборник текстов на английском языке

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ECOLOGY

Ecology is the study of the relationship of plants and animals with their physical and biological environment. The physical environment includes light and heat or solar radiation, moisture, wind, oxygen, carbon dioxide, nutrients in soil, water, and atmosphere. The biological environment includes organisms of the same kind as well as other plants and animals.

Because of the diverse approaches required to study organisms in their environment, ecology draws upon such fields as climatology, hydrology, oceanography, physics, chemistry, geology, and soil analysis. To study the relationships between organisms, ecology also involves such disparate sciences as animal behavior, taxonomy, physiology, and mathematics.

An increased public awareness of environmental problems has made ecology a common but often misused word. It is confused with environmental programs and environmental science. Although the field is a distinct scientific discipline, ecology does indeed contribute to the study and understanding of environmental problems.

The term "ecology" was introduced by the German biologist Ernst Heinrich Haeckel in 1866; it is derived from the Greek "oikos" ("household"), sharing the same root word as "economics". Thus, the term implies the study of the economy of nature. Modern ecology, in part, began with Charles Darwin. In developing his theory of evolution, Darwin stressed the adaptation of organisms to their environment through natural selection. Also making important contributions were plant geographers, such as Alexander von Humboldt, who were deeply interested in the "how" and "why" of vegetation distribution around the world.

The thin mantle of life that covers the earth is called the biosphere. Several approaches are used to classify its regions.

BIOMES

The broad units of vegetation are called "plant formations" by European ecologists and "biomes" by North American ecologists. The major difference between the two terms is that "biomes" include associated animal life. Major biomes, however, go by the name of the dominant forms of plant life.

Influenced by latitude, elevation, and associated moisture and temperature regimes, terrestrial biomes vary geographically from the tropics through the arctic and include various types of forest, grassland, shrub land, and desert. These biomes also include their associated freshwater communities: streams, lakes, ponds, and wetlands. Marine environments, also considered biomes by some ecologists, comprise the open ocean, littoral (shallow water) regions, benthic (bottom) regions, rocky shores, sandy shores, estuaries, and associated tidal marshes.

ECOSYSTEMS

A more useful way of looking at the terrestrial and aquatic landscapes is to view them as ecosystems, a word coined in 1935 by the British plant ecologist Sir Arthur George Tansley to stress the concept of each locale or habitat as an integrated whole. A system is a collection of interdependent parts that function as a unit and involve inputs and outputs. The major parts of an ecosystem are the producers (green plants), the consumers (herbivores and carnivores), the decomposers (fungi and bacteria), and the nonliving, or abiotic, components, consisting of dead organic matter and nutrients in the soil and water. Inputs into the ecosystem are solar energy, water, oxygen, carbon dioxide, nitrogen, and other elements and compounds. Outputs from the ecosystem include water, oxygen, carbon dioxide, nutrient losses, and the heat released in cellular respiration, or heat of respiration. The major driving force is solar energy.

ENERGY AND NUTRIENTS

Ecosystems function with energy flowing in one direction from the sun, and through nutrients, which are continuously recycled. Light energy is used by plants, which, by the process of photosynthesis, convert it to chemical energy in the form of carbohydrates and other carbon compounds. This energy is then transferred through the ecosystem by a series of steps that involve eating and being eaten, or what is called a food web. Each step in the transfer of energy involves several trophic, or feeding, levels: plants, herbivores (plant eaters), two or three levels of carnivores (meat eaters), and decomposers. Only a fraction of the energy fixed by plants follows this pathway, known as the grazing food web. Plant and animal matter not used in the grazing food chain, such as fallen leaves, twigs, roots, tree trunks, and the dead bodies of animals, support the decomposer food web. Bacteria, fungi, and animals that feed on dead material become the energy source for higher trophic

levels that tie into the grazing food web. In this way, nature makes maximum use of energy originally fixed by plants.

The number of trophic levels is limited in both types of food webs, because at each transfer a great deal of energy is lost (such as heat of respiration) and is no longer usable or transferable to the next trophic level. Thus, each trophic level contains less energy than the trophic level supporting it. For this reason, as an example, deer or caribou (herbivores) are more abundant than wolves (carnivores).

Energy flow fuels the biogeochemical, or nutrient, cycles. The cycling of nutrients begins with their release from organic matter by weathering and decomposition in a form that can be picked up by plants. Plants incorporate nutrients available in soil and water and store them in their tissues. The nutrients are transferred from one trophic level to another through the food web. Because most plants and animals go uneaten, nutrients contained in their tissues, after passing through the decomposer food web, are ultimately released by bacterial and fungal decomposition, a process that reduces complex organic compounds into simple inorganic compounds available for reuse by plants.

IMBALANCES

Within an ecosystem, nutrients are cycled internally. But there are leakages or outputs, and these must be balanced by inputs, or the ecosystem will fail to function. Nutrient inputs to the system come from weathering of rocks, from windblown dust, and from precipitation, which can carry material great distances. Varying quantities of nutrients are carried from terrestrial ecosystems by the movement of water and deposited in aquatic ecosystems and associated lowlands. Erosion and the harvesting of timber and crops remove considerable quantities of nutrients that must be replaced. The failure to do so results in an impoverishment of the ecosystem. This is why agricultural lands must be fertilized.

If inputs of any nutrient greatly exceed outputs, the nutrient cycle in the ecosystem becomes stressed or overloaded, resulting in pollution. Pollution can be considered an input of nutrients exceeding the capability of the ecosystem to process them. Nutrients eroded and leached from agricultural lands, along with sewage and industrial wastes accumulated from urban areas, all drain into streams, rivers, lakes, and estuaries. These pollutants destroy plants and animals that cannot tolerate their presence or the changed environmental conditions caused by them; at the same time, they favor a few organisms more tolerant to changed conditions. Thus, precipitation filled with sulfur dioxide and oxides of nitrogen from industrial areas converts to weak sulfuric and nitric acids, known as acid rain, and falls on large areas of terrestrial and aquatic ecosystems. This upsets acid-base relations in some ecosystems, killing fish and aquatic invertebrates, and increasing soil acidity, which reduces forest growth in northern and other ecosystems that lack limestone to neutralize the acid.

POPULATIONS AND COMMUNITIES

The functional units of an ecosystem are the populations of organisms through which energy and nutrients move. A population is a group of interbreeding organisms of the same kind living in the same place at the same time. Groups of populations within an ecosystem interact in various ways. These interdependent populations of plants and animals make up the community, which encompasses the biotic portion of the ecosystem.

DIVERSITY

The community has certain attributes, among them dominance and species diversity. Dominance results when one or several species control the environmental conditions that influence associated species. In a forest, for example, the dominant species may be one or more species of trees, such as oak or spruce; in a marine community, the dominant organisms frequently are animals such as mussels or oysters. Dominance can influence diversity of species in a community because diversity involves not only the number of species in a community, but also how numbers of individual species are apportioned.

The physical nature of a community is evidenced by layering, or stratification. In terrestrial communities, stratification is influenced by the growth form of the plants. Simple communities such as grasslands, with little vertical stratification, usually consist of two layers, the ground layer and the herbaceous layer. A forest has up to six layers: ground, herbaceous, low shrub, low tree and high shrub, lower canopy, and upper canopy. These strata influence the physical environment and diversity of habitats for wildlife. Vertical stratification of life in

aquatic communities, by contrast, is influenced mostly by physical conditions: depth, light, temperature, pressure, salinity, oxygen, and carbon dioxide.

HABITAT AND NICHE

The community provides the habitat – the place where particular plants or animals live. Within the habitat, organisms occupy different niches.
A niche is the functional role of a species in a community – that is, its occupation, or how it earns its living. For example, the scarlet tanager lives in a deciduous forest habitat. Its niche, in part, is gleaning insects from the canopy foliage. The more a community is stratified, the more finely the habitat is divided into additional niches.

ENVIRONMENT

Environment comprises all of the external factors affecting an organism. These factors may be other living organisms (biotic factors) or nonliving variables (abiotic factors), such as temperature, rainfall, day length, wind, and ocean currents. The interactions of organisms with biotic and abiotic factors form an ecosystem. Even minute changes in any one factor in an ecosystem can influence whether or not a particular plant or animal species will be successful in its environment.

Organisms and their environment constantly interact, and both are changed by this interaction. Like all other living creatures, humans have clearly changed their environment, but they have done so generally on a grander scale than have all other species. Some of these human-induced changes – such as the destruction of the world's tropical rain forests to create farms or grazing land for cattle – have led to altered climate patterns. In turn, altered climate patterns have changed the way animals and plants are distributed in different ecosystems.

Scientists study the long-term consequences of human actions on the environment, while environmentalists-professionals in various fields, as well as concerned citizens-advocate ways to lessen the impact of human activity on the natural world.

UNDERSTANDING THE ENVIRONMENT

The science of ecology attempts to explain why plants and animals live where they do and why their populations are the sizes they are. Understanding the distribution and population size of organisms helps scientists evaluate the health of the environment.

In 1840 German chemist, Justus von Liebig first proposed that populations could not grow indefinitely, a basic principle now known as the Law of the Minimum. Biotic and abiotic factors, singly or in combination, ultimately limit the size that any population may attain. This size limit, known as a population's carrying capacity, occurs when needed resources, such as food, breeding sites, and water, are in short supply. For example, the amount of nutrients in soil influences the amount of wheat that grows on a farm. If just one soil nutrient, such as nitrogen, is missing or below optimal levels, fewer healthy wheat plants will grow.

Either population size or distribution may also be affected, directly or indirectly, by the way species in an ecosystem interact with one another. In an experiment performed in the late 1960s in the rocky tidal zone along the Pacific Coast of the United States, American ecologist Robert Paine studied an area that contained 15 species of invertebrates, including starfish, mussels, limpets, barnacles, and chitons. Paine found that in this ecosystem one species of starfish preyed heavily on a species of mussel, preventing that mussel population from multiplying and monopolizing space in the tidal zone. When Paine removed the starfish from the area, he found that the mussel population quickly increased in size, crowding out most other organisms from rock surfaces. The number of invertebrate species in the ecosystem soon dropped to eight species. Paine concluded that the loss of just one species, the starfish, indirectly led to the loss of an additional six species and a transformation of the ecosystem.

Typically, the species that coexist in ecosystems have evolved together for many generations. These populations have established balanced interactions with each other that enable all populations in the area to remain relatively stable. Occasionally, however, natural or human-made disruptions occur that have unforeseen consequences to populations in an ecosystem. For example, 17th-century sailors routinely introduced goats to

isolated oceanic islands, intending for the goats to roam freely and serve as a source of meat when the sailors returned to the islands during future voyages. As non-native species free from all natural predators, the goats thrived and, in the process, overgrazed many of the islands. With a change in plant composition, many of the native animal species on the islands were driven to extinction. A simple action, the introduction of goats to an island, yielded many changes in the island ecosystem, demonstrating that all members of a community are closely interconnected.

To better understand the impact of natural and human disruptions on the Earth, in 1991, the National Aeronautics and Space Administration (NASA) began to use artificial satellites to study global change. NASA's undertaking, called Earth Science Enterprise, and is a part of an international effort linking numerous satellites into a single Earth Observing System (EOS). EOS collects information about the interactions occurring in the atmosphere, on land, and in the oceans, and these data help scientists and lawmakers make sound environmental policy decisions.

FACTORS THREATENING THE ENVIRONMENT

The problems facing the environment are vast and diverse. Global warming, the depletion of the ozone layer in the atmosphere, and destruction of the world's rain forests are just some of the problems that many scientists believe will reach critical proportions in the coming decades. All of these problems will be directly affected by the size of the human population.

POPULATION GROWTH

Human population growth is at the root of virtually all of the world's environmental problems. Although the growth rate of the world's population has slowed slightly since the 1990s, the world's population increases by about 77 million human beings each year. As the number of people increases, crowding generates pollution, destroys more habitats, and uses up additional natural resources.

The Population Division of the United Nations (UN) predicts that the world's population will increase from 6.23 billion people in 2000 to 9.3 billion people in 2050. The UN estimates that the population will stabilize at more than 11 billion in 2200. Other experts predict that numbers will continue to rise into the foreseeable future, to as many as 19 billion people by the year 2200.

Although rates of population increase are now much slower in the developed world than in the developing world, it would be a mistake to assume that population growth is primarily a problem of developing countries. In fact, because larger amounts of resources per person are used in developed nations, each individual from the developed world has a much greater environmental impact than does a person from a developing country. Conservation strategies that would not significantly alter lifestyles but that would greatly lessen environmental impact are essential in the developed world.

In the developing world, meanwhile, the most important factors necessary to lower population growth rates are democracy and social justice. Studies show that population growth rates have fallen in developing areas where several social conditions exist. In these areas, literacy rates have increased and women receive economic status equal to that of men, enabling women to hold jobs and own property. In addition, birth control information in these areas is more widely available, and women are free to make their own reproductive decisions.

GLOBAL WARMING

Like the glass panes in a greenhouse, certain gases in the Earth's atmosphere permit the Sun's radiation to heat Earth. At the same time, these gases retard the escape into space of the infrared energy radiated back out by Earth. This process is referred to as the greenhouse effect. These gases, primarily carbon dioxide, methane, nitrous oxide, and water vapor, insulate Earth's surface, helping to maintain warm temperatures. Without these gases, Earth would be a frozen planet with an average temperature of about –18 °C (about 0 °F) instead of a

comfortable 15 °C (59 °F). If the concentration of these gases rises, they trap more heat within the atmosphere, causing worldwide temperatures to rise.

Within the last century, the amount of carbon dioxide in the atmosphere has increased dramatically, largely because people burn vast amounts of fossil fuels – coal and petroleum and its derivatives. Average global temperature also has increased – by about 0.6 Celsius degrees (1 Fahrenheit degree) within the past century. Atmospheric scientists have found that at least half of that temperature increase can be attributed to human activity. They predict that unless dramatic action is taken, global temperature will continue to rise by 1.4 to 5.8 Celsius degrees (2.5 to 10.4 Fahrenheit degrees) over the next century. Although such an increase may not seem like a great difference, during the last ice age the global temperature was only 2.2 Celsius degrees (4 Fahrenheit degrees) cooler than it is presently.

The consequences of such a modest increase in temperature may be devastating. Already scientists have detected a 40 percent reduction in the average thickness of Arctic ice. Other problems that may develop include a rise in sea levels that will completely inundate a number of low-lying island nations and flood many coastal cities, such as New York and Miami. Many plant and animal species will probably be driven into extinction, agriculture will be severely disrupted in many regions, and the frequency of severe hurricanes and droughts will likely increase.

DEPLETION OF THE OZONE LAYER

The ozone layer, a thin band in the stratosphere (layer of the upper atmosphere), serves to shield Earth from the Sun's harmful ultraviolet rays. In the 1970s, scientists discovered that chlorofluorocarbons (CFCs)-chemicals used in refrigeration, air-conditioning systems, cleaning solvents, and aerosol sprays-destroy the ozone layer. CFCs release chlorine into the atmosphere; chlorine, in turn, breaks down ozone molecules. Because chlorine is not affected by its interaction with ozone, each chlorine molecule has the ability to destroy a large amount of ozone for an extended period of time.

The consequences of continued depletion of the ozone layer would be dramatic. Increased ultraviolet radiation would lead to a growing number of skin cancers and cataracts and also reduce the ability of immune systems to respond to infection. Additionally, growth of the world's oceanic plankton, the base of most marine food chains, would decline. Plankton contains photosynthetic organisms that break down carbon dioxide. If plankton populations decline, it may lead to increased carbon dioxide levels in the atmosphere and thus to global warming. Recent studies suggest that global warming, in turn, may increase the amount of ozone destroyed. Even if the manufacture of CFCs is immediately banned, the chlorine already released into the atmosphere will continue to destroy the ozone layer for many decades.

In 1987, an international pact called the Montreal Protocol on Substances that Deplete the Ozone Layer set specific targets for all nations to achieve in order to reduce emissions of chemicals responsible for the destruction of the ozone layer. Many people had hoped that this treaty would cause ozone loss to peak and begin to decline by the year 2000. In fact, in the fall of 2000, the hole in the ozone layer over Antarctica was the largest ever recorded. The hole the following year was slightly smaller, leading some to believe that the depletion of ozone had stabilized. Even if the most stringent prohibitions against CFCs are implemented, however, scientists expect that it will take at least 50 more years for the hole over Antarctica to close completely.

HABITAT DESTRUCTION AND SPECIES EXTINCTION

Plant and animal species are dying out at an unprecedented rate. Estimates range that from 4,000 to as many as 50,000 species per year become extinct. The leading cause of extinction is habitat destruction, particularly of the world's richest ecosystems-tropical rain forests and coral reefs. If the world's rain forests continue to be cut down at the current rate, they may completely disappear by the year 2030. In addition, if the world's population continues to grow at its present rate and puts even more pressure on these habitats, they might well be destroyed sooner.

AIR POLLUTION

A significant portion of industry and transportation burns fossil fuels, such as gasoline. When these fuels burn, chemicals and particulate matter are released into the atmosphere. Although a vast number of substances contribute to air pollution, the most common air pollutants contain carbon, sulfur, and nitrogen. These chemicals interact with one another and with ultraviolet radiation in sunlight in dangerous ways. Smog, usually found in urban areas with large numbers of automobiles, forms when nitrogen oxides react with hydrocarbons in the air to produce aldehydes and ketones. Smog can cause serious health problems.

Acid rain forms when sulfur dioxide and nitrous oxide transform into sulfuric acid and nitric acid in the atmosphere and come back to Earth in precipitation. Acid rain has made numerous lakes so acidic that they no longer support fish populations. Acid rain is also responsible for the decline of many forest ecosystems worldwide, including Germany's Black Forest and forests throughout the eastern United States.

WATER POLLUTION

Estimates suggest that nearly 1.5 billion people worldwide lack safe drinking water and that at least 5 million deaths per year can be attributed to waterborne diseases. Water pollution may come from point sources or nonpoint sources. Point sources discharge pollutants from specific locations, such as factories, sewage treatment plants, and oil tankers. The technology exists to monitor and regulate point sources of pollution, although in some areas this occurs only sporadically. Pollution from nonpoint sources occurs when rainfall or snowmelt moves over and through the ground. As the runoff moves, it picks up and carries away pollutants, such as pesticides and fertilizers, depositing the pollutants into lakes, rivers, wetlands, coastal waters, and even underground sources of drinking water. Pollution arising from nonpoint sources accounts for a majority of the contaminants in streams and lakes.

With almost 80 percent of the planet covered by oceans, people have long acted as if those bodies of water could serve as a limitless dumping ground for wastes. However, raw sewage, garbage, and oil spills have begun to overwhelm the diluting capabilities of the oceans, and most coastal waters are now polluted, threatening marine wildlife. Beaches around the world close regularly, often because the surrounding waters contain high levels of bacteria from sewage disposal.

HOW ECOSYSTEMS WORK. ECOSYSTEM MANAGEMENT

Ecosystem comprises organisms living in a particular environment, such as a forest or a coral reef, and the physical parts of the environment that affect them. The term ecosystem was coined in 1935 by the British ecologist Sir Arthur George Tansley, who described natural systems in "constant interchange" among their living and nonliving parts.

The ecosystem concept fits into an ordered view of nature that was developed by scientists to simplify the study of the relationships between organisms and their physical environment, a field known as ecology. At the top of the hierarchy is the planet's entire living environment, known as the biosphere. Within this biosphere are several large categories of living communities known as biomes that are usually characterized by their dominant vegetation, such as grasslands, tropical forests, or deserts. The biomes are in turn made up of ecosystems. The living, or biotic, parts of an ecosystem, such as the plants, animals, and bacteria found in soil, are known as a community. The physical surroundings, or abiotic components, such as the minerals found in the soil, are known as the environment or habitat.

Any given place may have several different ecosystems that vary in size and complexity. A tropical island, for example, may have a rain forest ecosystem that covers hundreds of square miles, a mangrove swamp ecosystem along the coast, and an underwater coral reef ecosystem. No matter how the size or complexity of an ecosystem is characterized, all ecosystems exhibit a constant exchange of matter and energy between the biotic and abiotic community. Ecosystem components are so interconnected that a change in any one component of an ecosystem will cause subsequent changes throughout the system.

The living portion of an ecosystem is best described in terms of feeding levels known as trophic levels. Green plants make up the first trophic level and are known as primary producers. Plants are able to convert energy from the sun into food in a process known as photosynthesis. In the second trophic level, the primary consumers – known as herbivores – are animals and insects that obtain their energy solely by eating the green plants. The third trophic level is composed of the secondary consumers, flesh-eating or carnivorous animals that

feed on herbivores. At the fourth level are the tertiary consumers, carnivores that feed on other carnivores. Finally, the fifth trophic level consists of the decomposers, organisms such as fungi and bacteria that break down dead or dying matter into nutrients that can be used again.

Some or all of these trophic levels combine to form what is known as a food web, the ecosystem's mechanism for circulating and recycling energy and materials. For example, in an aquatic ecosystem algae and other aquatic plants use sunlight to produce energy in the form of carbohydrates. Primary consumers such as insects and small fish may feed on some of this plant matter, and are in turn eaten by secondary consumers, such as salmon. A brown bear may play the role of the tertiary consumer by catching and eating salmon. Bacteria and fungi may then feed upon and decompose the salmon carcass left behind by the bear, enabling the valuable nonliving components of the ecosystem, such as chemical nutrients, to leach back into the soil and water, where they can be absorbed by the roots of plants. In this way, nutrients and the energy that green plants derive from sunlight are efficiently transferred and recycled throughout the ecosystem.

In addition to the exchange of energy, ecosystems are characterized by several other cycles. Elements such as carbon and nitrogen travel throughout the biotic and abiotic components of an ecosystem in processes known as nutrient cycles. For example, nitrogen traveling in the air may be snatched by tree-dwelling, or epiphytic, lichen that converts it to a form useful to plants. When rain drips through the lichen and falls to the ground, or the lichen itself falls to the forest floor, the nitrogen from the raindrops or the lichen is leached into the soil to be used by plants and trees. Another process important to ecosystems is the water cycle, the movement of water from ocean to atmosphere, to land and eventually back to the ocean. An ecosystem such as a forest or wetland plays a significant role in this cycle by storing, releasing, or filtering the water as it passes through the system.

Every ecosystem is also characterized by a disturbance cycle, a regular cycle of events such as fires, storms, floods, and landslides that keeps the ecosystem in a constant state of change and adaptation. Some species even depend on the disturbance cycle for survival or reproduction. For example, longleaf pine forests depend on frequent low-intensity fires for reproduction. The cones of the trees, which contain the reproductive structures, are sealed shut with a resin that melts away to release the seeds only under high heat.

ECOSYSTEM MANAGEMENT

Humans benefit from these smooth-functioning ecosystems in many ways. Healthy forests, streams, and wetlands contribute to clean air and clean water by trapping fast-moving air and water, enabling impurities to settle out or be converted to harmless compounds by plants or soil. The diversity of organisms, or biodiversity, in an ecosystem provides essential foods, medicines, and other materials. But as human populations increase and their encroachment on natural habitats expand, humans are having detrimental effects on the very ecosystems on which they depend. The survival of natural ecosystems around the world is threatened by many human activities: bulldozing wetlands and clear-cutting forests – the systematic cutting of all trees in a specific area – to make room for new housing and agricultural land; damming rivers to harness the energy for electricity and water for irrigation; and polluting the air, soil, and water.

Many organizations and government agencies have adopted a new approach to managing natural resources – naturally occurring materials that have economic or cultural value, such as commercial fisheries, timber, and water, in order to prevent their catastrophic depletion. This strategy, known as ecosystem management, treats resources as interdependent ecosystems rather than simply commodities to be extracted. Using advances in the study of ecology to protect the biodiversity of an ecosystem, ecosystem management encourages practices that enable humans to obtain necessary resources using methods that protect the whole ecosystem. Because regional economic prosperity may be linked to ecosystem health, the needs of the human community are also considered.

Ecosystem management often requires special measures to protect threatened or endangered species that play key roles in the ecosystem. In the commercial shrimp trawling industry, for example, ecosystem management techniques protect loggerhead sea turtles. In the last thirty years, populations of loggerhead turtles on the southeastern coasts of the United States have been declining at alarming rates due to beach development and the ensuing erosion, bright lights, and traffic, which make it nearly impossible for female turtles to build nests on beaches. At sea, loggerheads are threatened by oil spills and plastic debris, offshore dredging, injury from boat propellers, and being caught in fishing nets and equipment. In 1970, the species was listed as threatened under the Endangered Species Act.

When scientists learned that commercial shrimp trawling nets were trapping and killing between 5000 and 50,000 loggerhead sea turtles a year, they developed a large metal grid called a Turtle Excluder Device (TED) that fits into the trawl net, preventing 97 percent of trawl-related loggerhead turtle deaths while only minimally

reducing the commercial shrimp harvest. In 1992, the National Marine Fisheries Service (NMFS) implemented regulations requiring commercial shrimp trawlers to use TEDs, effectively balancing the commercial demand for shrimp with the health and vitality of the loggerhead sea turtle population.

ECOLOGY & ENVIRONMENT

The three elements namely earth, water and space constitute the whole cosmos therefore it re-affirms to work with people towards creating awareness and as a movement for perseverance, sustenance of flora and fauna and cosmic elements and to usher ecology and environment of this earth where integrity of creation will be a cherished value.

AIR

- Air pollution has now become a major killer with three million people dying of it every year.
- Carbon emissions doubled in three decades. Global warming is now a serious threat.
- US Carbon emissions are 16 % above 1990 levels making it a major polluter.

WATER

- Forty percent of world population now faces chronic shortage of fresh water for daily needs.
- Half the world's wetlands have been lost and one-fifth of the 10,000 freshwater species is extinct.
- Contaminated water kills around 2.2 million people every year.

LAND

- Since 1990, 2,4 % of the world's forests have been destroyed. The rate of loss is now 90,000 sq. km. every year.
- Now two-thirds of the world's farmlands suffer from soil degradation.
- Half the world's grasslands are overgrazed. India is 25 % short of its fodder needs.

WILDLIFE

- 800 species have become extinct and 11,000 more are threatened.
- Almost 75 % of the world's marine captures is over fished or fully utilized. In North America, 10 fish species went extinct in the 1990s.
- Of the 9,946 known bird species, 70 % has declined in numbers.

PEOPLE

- The world added 800 million people since 1990. In 2000, global population was 6 billion, up from 2.5 billion in 1950.
- In 10 years, the world will have to feed and house another billion

CARING FOR THE NATURE

"Nature has everything for man's need but not his greed", – said once Mahatma Gandhiji. A large-scale de-forestation that is taking place around the globe is causing tremendous ecological and environmental imbal-ances throughout the world. The resultant fury of the nature is witnessed all around through drastic change in the climate, flash, floods, failure of rain and many more, causing damage to thousands of lives and livestocks throughout the world.

THE ENVIRONMENT IN THE NEW MILLENNIUM:

THE WAY OF THE WORLD

"The Economist", the famous magazine of the United Kingdom, has analyzed the trend of the world in the twentieth century. The environment of the past 100 years has not been as bad as the people have thought. On the contrary, the environment of the world has been good and will be so until the next century. Although the population of the world has been increasing quickly during the last century, it has not caused any serious problems as world production has also been highly increased. The environment of the world has not been a disaster (like the prophecy of many others) because of the changes of many factors. There is the change of resource prices and society. The development of democracy and the planning of environment are to meet the pressure from the people.

It is seen that when there are more people, more consuming, more production, the use of natural is increasing. The price goes up when there is the need. There is then the force of being economical in use, the need to find new resource sites, new kinds of resources, new technology, and new ways for humanity. The mechanism of prices has been quite efficient in solving the problems of natural resource.

However, we need to accept that marketing mechanisms have not been quite satisfactory in solving environmental problems, particularly, where there is something in nature, which does not belong to any one. Therefore, there is the tendency that resources will be used inconsiderately. There is no one to care for conservation. There is the example that resources in the sea and the ocean will continue being in hazard in the next century.

Moreover, in some cases, the hazard in the environment has not been reflected in the way we can see like "price". There is the case that pollution is setting into air and water. The pollution occurs to the ecology and community. However, the price does not reflect any of these damages. It is because private business wants to decrease the capital amount and want to continue getting the highest profit. They let the disasters happen. Communities, society and nature meet danger from the environment as we see in the developing countries all over the world

"The Economist" points out that in a country with advanced industry, pollution is not a big problem because they have developed democracy, which then has the checking, there is always the pressure from the people. The democratic government has answered the people's needs with the awareness that something needs to be done and some things have already been done. We can see that air pollution in industrial society, which had been increasing for 300 years, is solved satisfactorily. This will be continued for a long time. In a developing country, this problem may continue to the next century.

THE CRISIS OF ECOLOGY IN THE DEVELOPING WORLD

In the analysis, "The Economist" may be too positive in assessing the environmental problem and regarding only one aspect like pollution in industry. There is the conclusion that the incidence of pollution in the air has been decreasing. Nothing is said about the pollution of toxic waste, which has been left, and keeps piling up in the environment for so long in the world of industry. This tendency will continue until the next century as the government in industrial countries like America, Japan and Germany have not been successful in solving the problems of toxic waste, which has been accumulating for so long. It is because the main environmental policy emphasizes only the problems, which are visible and can be felt. The emphasis is on short-term pollution, which has an immediate effect to on people's health. The accumulating pollution cannot be seen easily, it is then neglected.

Besides, the analysis of the population of the world overlooks one main fact – although the growth rate is not as high as before the population of the world in this turn of the century will increase by approximately 80 million a year. (The amount is equal to the number of people in Germany.) It means that this amount of population among the impoverished and the deterioration of rural environment will heighten the environment crisis, which will have an effect on the production system and the ways of living of the people in developing countries. The very high increase of the population has affected the development in city and the living in urban areas. At present, there are 2.6 billion people living in cities. 1.7 billion of that amount live in the cities of developing countries. There is the prediction that the ratio will accelerate until the year 2015. Three quarters of the world population is in developing countries, which are very crowded, and the health problems are serious.

When we adopt the well-known "environmental formula" of Anne and Paul Ehrlich as the base on considering problems, we get the conclusion that the environment crisis has the tendency to become very critical. This formula says:

"Environment crisis (I) is settled by the amount of the population (P), the economic growth (A) and Production Technology (T), that is $I = P \times A \times T$".

Economic growth is also another main variable. The more development, there is the more the increase in production. It heightens the ecology system. Moreover, the production of one unit may cause a large quantity of pollution because of the use of unclean (unhealthy) technology, which endangers the environment. It is worrying that the trading, the production and the consuming will enhance the squandering of resources and the environment will be seriously destroyed.

DEMOCRACY AND ENVIRONMENT

We can give the main conclusions for the future of the developing world as follows.

1. The worst pollution may occur among the poor countries. It reflects some basic problems. These countries hardly have democratic development, their people have no rights, no vote, they do not get information on the environment, and they are unable to force their government to be against the businesses threatening environmental conditions. The lack of democracy is then the main factor causing environmental crisis.

2. The seriousness of pollution has not occurred because of the over development of the economy. It is because the first part of the development by government and private business emphasizes only the economic enlargement (to increase population income and the export). After a certain period, people in various fields started to develop their conscience of "Green" and there is a large cry for the awareness of "Sustainable Development". During this time, the government has to respond to the starting of environmental planning with the aims of economic development along with environmental protection. However, there needs to be "Democracy of the environment" as the main base.

3. Regarding the long 100 years of experience of the West, we may look further ahead that in the 21st century the developing countries may be trying to solve environmental crises by themselves. However, there are many other factors for their success, particularly, the following:

– there needs to be information which is quite complete for the comparison of capital for the controlling of environment and the benefits from which society will gain;

– there are efficient criteria, which is the mixture of the standards of marketing and the price, and the criteria in setting up the environmental standards.

Finally, the solving of the crisis of the environment is not only the economic problems (e.g. the promulgation of Green Tax) but also the political problem. If there are too strict standards, it may not be accepted politically. The people may criticize. The business world may be against it and react (by decreasing the investment in employee's wages or increasing the price so high that it causes people to be in trouble.) In a democracy, the politicians who plan the policy on environment do not usually like strict standards. There is no one being concerned about how much the standard and the policy on environment will be affected.

It is predicted that in the twenty-first century the green power group in developing countries will increase. The movement will be in a wider scope and there will be the call for solving the problems down to the root. This is because the environment problem is becoming serious while the reaction from the government is quite slow. It is because the government has the tendency not to have strict standard that they may have to be concerned with private business and the national economy.

ENVIRONMENTAL INNOVATION

Among the rich countries, it is assumed that it is not so hard to solve environmental problems of the 21st century. These countries will compete with each other in improving the quality of their products. There is always the search for innovation, environmental innovation, in particular, is an important instrument in encouraging the progress of the industrial world. At present, the rich countries have already had the high potentiality of developing new technology for the production process with the regard for environmental quality.

The innovative analyst regards that the ability of industry in responding to the environmental problems is the main indicator if that kind of industry can compete at the world level. Those who want to succeed must integrate the main idea with the production system. It means the protection of the environment, solving the problem of pollution, increasing the efficiency in using natural resources and power. The strict standard of the environment will enhance the thinking of production method, which will benefit the environment.

At present, the governments of the industrial world, like Sweden, agree with "Environment Innovation Ways". There is a conclusion in the latest report of the national environment that "The policy on environment of the Swedish government is very important in enhancing the modernity in industrial business sectors. The im-

provement of the environment has turned out to be the main factor in accelerating the competition in this industry."

This is the entire new western concept, which emphasizes "How to bring about Ecological Modernization." It is the new concept on new environmental technology and every step is used for the industrial production process. However, there needs to be adaptation of the whole production structure, which needs systematic «environmental planning», and the adapting of world vision and the conscience of the environment of the people in every field. The concept of "Ecological Innovation" does not emphasize only the technology but also regards the importance of "Environmental management" which needs to be done in both the governmental and private sectors. This can be seen in countries like Sweden, Denmark, Holland and Germany, which are regarded as the leaders in "Environmental Innovation".

ENVIRONMENTALISM AND TECHNOLOGY

Wait a minute, you might say, it is environmentalism against technology, for isn't technology a fundamental source of environmental problems?

This has been the position of deep greens. In fact, some trace all environmental problems to the beginning of agriculture, arguing that it was the shift from hunter-gatherer to farming that created what they consider the human cancer consuming the globe. Even moderate greens can be anti-tech, reflecting both skepticism about capitalism and the counter cultural ideology that characterizes most environmental discourse.

Consider, for example, something as mainstream, as the precautionary principle, which holds that no new technology be introduced until it can be demonstrated to have no harmful environmental impacts. Taken at face value, this embeds within it a strong preference for "privileging the present" – that is, attempting to ban or limit technological evolution – for the potential implications of all but the most trivial technological innovations cannot be known in advance.

Positioning environmentalism against technology, however, has its problems. For one, it misunderstands the nature of complex cultural systems. These inevitably evolve, generally towards greater complexity; consider, for example, how much more complex international governance, information networks, or financial structures are now than just a few years ago.

And technologies are evolving rapidly as well, particularly in the three areas that promise to impact environmental systems the most: biotechnology, nanotechnology, and information technology. The first will, over time, give us design capabilities over life; the second will let us manipulate matter at the molecular level; the third will change how we perceive and understand the world within which the first two are accomplished.

Moreover, developing such capabilities will give the cultures that do so significant competitive advantages over those that opt for stability rather than technological evolution. There are historical examples of this process – for example, China, from roughly the 11th to the 14th centuries. At that time, China was the most technically advanced society, but for a number of reasons its elite chose stability over the social and cultural confusion that development and diffusion of technologies (such as gunpowder and firearms) might have caused. Northern Europe, however, followed a more chaotic path, including the Enlightenment and the Industrial Revolution, which favored technological evolution. The result: Eurocentric, not Chinese, culture forms the basis of today's globalization.

Applying this lesson to current conditions raises the question of whether deep-green opposition to certain technological advances, especially genetically modified organisms, could halt technological advance. Some societies – Europe, in particular – may choose stasis over evolution. But biotech is such a powerful advance in human capabilities that other societies – especially developing countries with immediate needs that biotech can address – are not likely to forego its benefits. And to the extent, their cultures become more competitive by doing so, they may come to dominate global culture.

So is the answer then to simply give up and let technology evolve, as it will? Not at all. In fact, the essential problem with an ideological opposition to technology is that it prevents precisely the kind of dialog between

the environmentalist and technological discourses required to create a rational and ethical anthropogenic earth. For technologies are not unproblematic, and their evolutionary paths are not preordained; rather, they are products of complex and little-known social, cultural, economic, and systems dynamics, it is important that they be questioned and understood.

The challenge is thus not unthinking opposition, or maintenance of ideological purity, or even meaningless repetition of ambiguous phrases such as "precautionary principle." It is far more demanding. It is to learn to perceive and understand technology as a human practice and experience, and to help guide that experience in ways that are environmentally appropriate.

BUT I WANT TO WORK ON ENVIRONMENTAL STUFF!

One of the horrible existential challenges of being a student is that, in most cases, one must at some point leave school and begin work, presumably in an area for which one has been training these many years. For those reading this column, the area of interest is likely environmental, usually expanded these days to include sustainability. Put bluntly, the relevant questions are likely to be "How do I do well and what is the job market like?" Recognizing that planning your career on the basis of a 750-word column is probably not a great idea, here are some thoughts while you hit the books.

First, the good news. There are plenty of opportunities to do great things: to help your employer (be it a private firm, government, or NGO), help the world, and feed yourself. Now, the bad news. Most of these opportunities are disguised, most have nothing to do with environment as currently taught and thought about at most schools, many of the opportunities have yet to be invented, and almost any worthwhile job will require that you develop it yourself, from inside.

To begin with, traditional environmental jobs that is, those based on current regulatory and policy structures, primarily cleanup and end-of-pipe emissions control will be with us for a long time, especially in developing countries. They are necessary. But this field is not growing, offers few intellectual challenges, and will have little to do with solving the larger problems of the anthropogenic world albeit improving health significantly in developing countries. So if you really want to help the environment in the broader sense – perturbed climatic and oceanic systems; anthropogenic carbon, nitrogen, sulfur, and hydrologic system changes; biosphere disruptions – this is not the place for you.

The next step up is a position in the "sustainability industry." Superficially, at least, such jobs, which are frequently with niche consulting firms, are broader in scope and offer more intellectual opportunities. But caution is in order. The term "sustainability" has now grown to be so politically correct, and at the same time flown so far beyond mere ambiguity, that there is no substantive content to much of this work. In too many cases, it now amounts to a somewhat patronizing, highly ingrown dialog within a small circle of friends that tend to regard themselves as the great and the good, and spend a lot of time reinforcing one another's mental models.

The result is a nouveau utopianism that has tenuous connections with the real world, except for the few that are already True Believers. Thus, for example, I recently participated in a sustainability workshop where one conclusion was that firms should exist not for profit, but only to redistribute income (and that, by the way, money should be banned). Those with any historical background will recognize that this proposed policy closely tracks that of the early Leninist/Marxist Soviet Union. They did ban money – and the economy collapsed. Moreover, you can imagine how the typical executive would greet such a proposal as a model for how his/her firm could be "sustainable."

So, be careful if you want to work in this area. Before you jump in, you may want to work inside a firm first to get an idea of what companies really are like. It will help you maintain perspective. There are a few real opportunities – but caveat emptor.

So what to do? Back to first principles. The challenge of environmental (and related social) issues is precisely that they have become so all encompassing. They are not separable from the messy, multidisciplinary worlds of commerce, of ordinary life, of birth and death, of long natural cycles. So the kinds of things that contribute most to social and environmental progress – employee telework options, efficient network routing algorithms for air and ground transport systems, low-energy and reduced-water manufacturing technologies – come not from the environmental staff, but from the core operating competencies – engineers, business planners, product designers, and others. So, by all means remain committed to sustainability, but get expertise in international business, chemical engineering, or finance. Then, when you get your non-environmental, line position, you can start to change the world.

WORKING FOR THE ENVIRONMENT – INDUSTRIAL COMPLEX

A while ago, I was reading an article on pollution prevention written by an ex-EPA consultant, and was both amused and somewhat surprised to see "industrial ecology" identified as industry green wash.

My first response, of course, was dismissive: didn't the author realize that meaningful environmental progress could be achieved only through such systematic approaches as industrial ecology, and its implementation through (for example) Design for Environment and Life Cycle Assessment methodologies?

Indeed, pollution prevention as usually interpreted by environmental regulators is a singularly limited concept, a relatively insignificant extension of end-of-pipe approaches, and it requires something like industrial ecology to energize it.

But my initial reaction was both unfair and superficial. The author was not really reacting to industrial ecology as laid out in existing texts or as being implemented in some firms today. Rather, the article implicitly made an important point about the nature of "environment" itself: the very concept (and closely related concepts such as "wilderness" and "nature") is constructed from underlying mental models, which may differ significantly and carry very different policy and governance implications.

Thus, "industrial ecology" does not enter the environmental discourse as an objective concept (although industrial ecology studies strive for objectivity and good science). Rather, an environmentalist will see it as a response to growing political pressure by powerful administrative and bureaucratic systems, with a belief system based on scientific and technical rationality – as, in short, a defensive thrust based on a state/corporatist managerialism mental model.

Seen in this light, the concept carries several implications which to an environmentalist may be problematic: a powerful (and polluting) elite co-opting "real" environmentalism; establishment of a playing field (high technology and industrial systems) which implicitly degrades the knowledge base and operational characteristics of traditional environmental NGOs; and, more subtle but all the more powerful for that, a vision of a future "sustainable" world based on a high technology, urbanized society as opposed to an agrarian, localized world with large portions of limits to people.

It was important, therefore, not to take that article as just a naive rejection of industrial ecology and its promise, but to understand it as a reflection of deeply conflicting worldviews which were all the more critical for being implicit and, to a large extent, even unconscious.

And, of course, these two mental models – call them the managerialistic and the edenistic – are not the only common ones. Others which might be identified include the "authoritarian" (environmental crises require centralized authoritarian institutions); "communal" (with the caution that some communities can be extraordinarily violent towards minorities and outsiders); "ecosocialist" (capitalistic exploitation of workers and commoditization of the world are the source of environmental degradation); "ecofeminist" (male exploitation of nature and women derive from the same power drive, and must be addressed concomitantly) and "pluralistic liberalism" (open collaboration involving diverse interests is the proper process to achieve environmental progress).

All of these raise some very difficult questions. For example, ecosocialism is somewhat tarnished by the abysmal environmental record of Eastern European communist governments.

The obvious question for the manager blessed with the opportunity to manage among these minefields is which one of these mental models is "right"? The unfortunate truth is that we as a society are not ready to answer that question yet.

This is not just because most people – environmental professionals, environmentalists, regulators, industry leaders – are naive positivists, and therefore unwilling or unable for the most part to recognize their own mental models, much less to respect other parties' mental models.

It also reflects a disturbing and almost complete ignorance about the implications of each model for the real world. What levels of human population, of biodiversity, of economic activity, would each mental model imply? What kind of governance structure? Who would win and who would lose (more precisely, what would the distributional effects of each model be)?

The important point, I think, is not the correctness of any particular model. Rather, it is the need to understand that differences among stakeholders in environmental disputes may arise not just from factual or economic disagreements, but from differences in fundamental worldviews – and that, at present, our current knowledge cannot anoint any particular one as "privileged."

A little sensitivity to how one's position and practices are understood by others can go a long way towards facilitating collaborations, which are both necessary and plenty difficult as it is. Before one too readily criticizes others, one should recall the Socratic admonition and know thyself – and thy mental models.

PRE-CAMBRIAN PERIOD

The Earth formed under so much heat and pressure that it formed as a molten planet. For nearly the first billion years of its formation – called the Hadean Period (or "hellish" period) – Earth was bombarded continuously by the remnants of the dust and debris – like asteroids, meteors and comets – until it formed into a solid sphere, fell into an orbit around the sun, and began to cool down.

As Earth began to take solid form, it had no free oxygen in its atmosphere. It was so hot that the water droplets in its atmosphere could not settle to form surface water or ice. Its atmosphere was also so poisonous that nothing would have been able to survive.

Earth's early atmosphere most likely resembled that of Jupiter's atmosphere, which contains hydrogen, helium, methane and ammonia, and is poisonous to humans.

Earth's atmosphere was formed mostly from the outgassing of such volatile compounds as water vapor, carbon monoxide, methane, ammonia, nitrogen, carbon dioxide, nitrogen, hydrochloric acid and sulfur produced by the constant volcanic eruptions that besieged the Earth. It had no free oxygen.

About 4.1 billion years ago, the Earth's surface – or crust – began to cool and stabilize, creating the solid surface with its rocky terrain. Clouds formed as the Earth began to cool, producing enormous volumes of rainwater that formed the oceans. For the next 1.3 billion years (3.8 to 2.5 billion years ago), called the Archean Period, first life began to appear (at least as far as our fossil records tell us... there may have been life before this!) and the world's landmasses began to form. Earth's initial life forms were bacteria, which could survive in the highly toxic atmosphere that existed during this time. In fact, all life was bacteria during the Archean Period.

Toward the end of the Archean Period and at the beginning of the Proterozoic Period, about 2.5 billion years ago, oxygen-forming photosynthesis began to occur. The first fossils, in fact, were a type of blue-green algae that could photosynthesize.

Some of the most exciting events in Earth's history and life occurred during this time, which spanned about two billion years until about 550 million years ago. The continents began to form and stabilize, creating the super continent Rodinia about 1.1 billion years ago. (Rodinia is widely accepted as the first super continent, but there were probably others before it.) Although Rodinia is composed of some of the same land fragments as the more popular super continent, Pangea, they are two different super continents. Pangea formed some 225 million years ago and would evolve into the seven continents we know today.

Earth's atmosphere was first supplied by the gasses expelled from the massive volcanic eruptions of the Hadean Era. These gases were so poisonous, and the world was so hot, that nothing could survive. As the planet began to cool, its surface solidified as a rocky terrain, much like Mar's surface and the oceans began to form as the water vapor condensed into rain. First life came from the oceans. Free oxygen began to build up around the middle of the Proterozoic Period around 1.8 billion years ago – and made way for the emergence of life, as we know it today. This event, of course, created conditions that would not allow most of the existing life to survive and thus made way for the more oxygen dependent life forms.

By the end of the Proterozoic Period, Earth was well along in its evolutionary processes leading to our current period, the Holocene Period, also known as the Age of Man. Thus, about 550 million years ago, the Cambrian Period began. During this period, life "exploded" developing almost all of the major groups of plants and animals in a relatively short time. It ended with the massive extinction of most of the existing species about 500 million years ago, making room for the future appearance and evolution of new plant and animal species.

And then, about 498 million years later – 2.2 million years ago – the first modern human species emerged.

EARTH'S TRUE VITAL SIGNS REVEALED FROM SPACE

Circling the Earth 16 times a day 438 miles above the surface, new satellite technology is revolutionizing earth science and now scientists are able to understand the health of the planet and distinguish between human impact and natural phenomenon. On February 4, scientists began collecting images of the earth's vital signs from its bus-sized Terra satellite, the flagship of NASA's 15-year Earth Observing System (EOS). EOS is an international collaboration designed to help scientists develop those answers about Earth's climate and environmental changes that have not been available before.

Though the earth is approximately 4.5 billion years old, the earliest ancestors of the human race only appeared between three and four million years ago, according to most scientists. This is only one-tenth of one percent of Earth's time span, a relatively insignificant period. Even the first known civilization did not appear until about 6,000 BC. But since the dawn of humankind, the earth supplied all of their wants and needs, which led to settled life in groups or villages. Yet during the entire lifespan of the earth, natural geologic forces have constantly been changing and rearranging the planet's features, climate and environment. And now, there is "compelling evidence that human activities have attained the magnitude of geological force and are speeding up the rates of global change," according to Dr. Yoram Kaufman, Terra Project Scientist.

According to Dr. Kaufman, these changes have occurred without much knowledge at all about their impact on earth's life systems. "Scientists don't understand the cause-and-effect relationships among Earth's lands, oceans, and atmosphere well enough to predict what, if any, impacts these rapid changes will have on future climate conditions," he said.

This image from Terra shows chlorophyll concentrations and phytoplankton health in the Arabian Sea via its MODIS instrument.

"There are some basic questions about the Earth system that need to be answered in order to understand our world's climate system well enough to predict future changes, and how those changes may impact our quality of life," – said Dr. Kaufman during a recent NASA news briefing in Washington, DC. "Terra data, along with other measurements, will feed earth science models so we can predict climate variations and climate change, and prepare for the future. We anticipate that Terra data will revolutionize our understanding of the Earth's climate system and help show the human impact," – he continued. "Terra is measuring a wide array of vital signs, many of them for the first time, to help us understand our planet, to distinguish between natural and man-made climate change, and to show us how the Earth's climate affects the quality of our lives."

Dr. Kaufman describes that this revolution in earth science is necessary to help in the understanding of our world's climate systems enough to accurately predict changes and how those changes will impact quality of life. Questions, which need to be answered, include "How are the soils and vegetation types changing around the world?"

"What are the changes in the extent of snow and ice, and why are 2 – 3 of the world's glaciers disappearing each week?"

"What are the variations in the phytoplankton in the ocean and how are these plants affected by windblown Saharan dust?"

"What is the concentration of atmospheric airborne particles and gaseous pollutants, and how do they affect the ability of the atmosphere to cleanse itself?"

"What fraction originates from natural or man-made sources?"

"How do the availability of water vapor and the presence of pollutants affect cloud formation, properties and precipitation?"

"Is the Earth system taking in more radiant energy than it reflects and emits back into space, or is the radiation budget in balance (global warming)?"

"Is there a change in the frequency of wild fires, floods & volcanic eruptions?"

"Is the frequency related to climate change?"

The Terra observatory uses five instruments to thoroughly study and track Earth's vital systems: Land, Ocean, Atmosphere, and the life, exchange of nutrients, carbon, heat, moisture and pollution among them. The

first instrument is called the Moderate-resolution Imaging SpectroRadiometer (MODIS). MODIS provides frequent global views of changes occurring within the Earth system, including the study of snow and ice cover, cloud cover and cloud type, vegetation cover and other land covers, the temperature of the oceans, and the study of plant life on land and in the oceans.

This thermal infrared image shows the urban heat island effect in the San Francisco Bay area through Terra's ASTER instrument.

The second instrument is the Multi-angle Imaging SpectroRadiometer (MISR) that physically characterizes the Earth's surface, atmosphere, and clouds, and how they interact with sunlight, the primary energy source for Earth's climate system. The third instrument, the Advanced Space borne Thermal Emission and Reflection radiometer (ASTER) is a joint US-Japan project provided by Japan's Ministry of International Trade and Industry. It is the zoom lens of the Terra satellite. The primary goals of ASTER are to characterize the Earth's surface and to monitor dynamic events and processes that influence habitability at human scales. The Measurements of Pollution in the Troposphere (MOPITT) is a fourth instrument that helps scientists to determine the amount of carbon monoxide and methane at different altitudes in the atmosphere. MOPITT is a joint effort of the US and Canada.

The final instrument is called Clouds and the Earth's Radiant Energy System (CERES), which measures reflective sunlight. Measuring the energy emitted by the surface and atmosphere of the Earth, CERES monitors the balance of the "radiation budget" which indicates whether the earth is warming or cooling. If the radiation budget if perfectly balanced, the earth should neither be warming nor cooling.

THE OZONE LAYER

Although ozone (O_3) is present in small concentrations throughout the atmosphere, most ozone (about 90 %) exists in the stratosphere, in a layer between 10 and 50 km above the surface of the earth. This ozone layer performs the essential task of filtering out most of the sun's biologically harmful ultraviolet (UV-B) radiation. Concentrations of ozone in the atmosphere vary naturally according to temperature, weather, latitude and altitude. Furthermore, aerosols and other particles ejected by natural events such as volcanic eruptions can have measurable impacts on ozone levels.

THE OZONE HOLE

In 1985, scientists identified a thinning of the ozone layer over the Antarctic during the spring months, which became known as the "ozone hole". The scientific evidence shows that human-made chemicals are responsible for the creation of the Antarctic ozone hole and are also likely to play a role in global ozone losses. Ozone Depleting Substances (ODS) have been used in many products which take advantage of their physical properties (e.g. chlorofluorocarbons (CFCs) have been used as aerosol propellants and refrigerants).

CFCs are broken down by sunlight in the stratosphere, producing halogen (e.g. chlorine) atoms, which subsequently destroy ozone through a complex catalytic cycle. Ozone destruction is greatest at the South Pole where very low stratospheric temperatures in winter create polar stratospheric clouds (PSCs). Ice crystals formed in PSCs provide a large surface area for chemical reactions, accelerating catalytic cycles. The destruction of ozone also involves sunlight, so the process intensifies during springtime, when the levels of solar radiation at the pole are highest, and PSCs are continually present.

Although ozone levels vary seasonally, stratospheric ozone levels have been observed to be decreasing annually since the 1970s. Mid-latitudes have experienced greater losses than equatorial regions. In 1997, the Antarctic ozone hole covered 24 million km^2 in October, with an average of 40 % ozone depletion and ozone levels in Scandinavia, Greenland and Siberia reached an unprecedented 45 % depletion in 1996.

ENVIRONMENTAL AND HEALTH EFFECTS

The amount of UV reaching the earth's surface has been shown to correlate with the extent of ozone depletion. In 1997, UV-B levels continued to rise at a rate of 2 % per annum. Increased UV levels at the earth's surface are damaging to human health, air quality, biological life, and certain materials such as plastics. Human health effects include increases in the incidence of certain types of skin cancers, cataracts and immune deficiency disorders. Increased penetration of UV results in additional production of ground level ozone, which causes respiratory illnesses. Biologically, UV affects terrestrial and aquatic ecosystems, altering growth, food chains and biochemical cycles. In particular, aquatic life occurring just below the surface of the water, where

plant species forming the basis of the food chain are most abundant, are adversely affected by elevated levels of UV radiation. The tensile properties of certain plastics can be affected by exposure to UV radiation. Depletion of stratospheric ozone also alters the temperature distribution in the atmosphere, resulting in indeterminate environmental and climatic impacts.

FUTURE PERSPECTIVE

Despite existing regulation of ODS, there continues to be severe ozone depletion and maximum stratospheric levels of chlorine and bromine are predicted to occur only during the next decade. Without further measures, the ozone hole will continue to exist beyond 2050. However, the success of the Montreal Protocol has already been observed in terms of changes in the concentrations of man-made chlorine-containing chemicals in the troposphere (i.e. the rates of release of ODS to the atmosphere have been reduced). Additional measures are currently being proposed by the European Commission to accelerate the phase out of various ODS and thereby to provide much-needed additional protection for the ozone layer.

WHAT YOU CAN DO TO PROTECT THE OZONE LAYER

You have already taken the first steps to help protect the ozone layer by informing yourself of the problem and its causes. Try to find out as much as you can about the problem from publications, schools or public libraries. The only way to mend the ozone hole is to stop the release of CFCs and other ozone depleting substances (ODS) into the atmosphere. European legislation aims to achieve this by phasing out ODS as soon as viable alternatives become available, and where no such alternatives are available, restricting the use of these substances as far as possible. However, there are a number of practical initiatives, which can be taken at the individual level to help protect the ozone layer: try to use products, which are labeled "ozone-friendly".

Ensure technicians repairing your refrigerator or air conditioner recover and recycle the old CFCs so they are not released into the atmosphere.

Vehicle air conditioning units should regularly be checked for leaks.

Ask about converting your car to a substitute refrigerant if the a/c system needs major repair.

Remove the refrigerant from refrigerators, air conditioners, and dehumidifiers before disposing of them.

Help start a refrigerant recovery and recycling program in your area if none already exists.

Suggest school activities to increase awareness of the problem and to initiate local action.

PROTECTING YOURSELF FROM UV RADIATION

There is a direct link between increased exposure to UV radiation and elevated risk of contracting certain types of skin cancers. Risk factors include skin type, sunburn during childhood, and exposure to intense sunlight. Recent changes in lifestyle, with more people going on holiday and deliberately increasing their exposure to strong sunlight, are partly responsible for an increase in malignant skin cancers. In order to minimize the risk of contracting skin cancer, cover exposed skin with clothing or with a suitable sunscreen, wear a hat, and wear UV-certified sunglasses to protect the eyes.

CARBON MONOXIDE IN THE ATMOSPHERE

Human activities cause nearly half of the world’s carbon monoxide pollution. It is produced by the deficient or incomplete combustion of gasoline and other fossil fuels such as used in automobiles, furnaces and industry, as well as by the burning of natural organic matter such as wood and grasses (from fireplaces to forest fires). Not only is carbon monoxide dangerous by itself, but it also produces ozone, a greenhouse gas that forms naturally in the upper atmosphere but is dangerous to humans.

According to NASA, Terra has allowed scientists to observe carbon monoxide in the atmosphere from two to three miles above the Earth’s surface where it forms ozone through interaction with other gases. Once the pollutant moves higher in the atmosphere, high winds can blow it rapidly across great distances. By tracking this movement, scientists can also track the movement of other pollutants that are also produced by combustion but are not easily detected from space.

Using the Data Such technology not only gives scientists details on the state of the Earth’s current condition, but the information it produces will help scientists, engineers, researchers, consumers and industry plan a course of action to correct the problems. People have known for years that the burning of fossil fuels and or-

ganic matter creates pollution, but technology such as the Terra satellite provides specific detail on what happens to that pollution. Contrary to many theories and common beliefs that air pollution simply dissipates in the atmosphere or is remedied by Earth's natural processes, we have learned that these pollutants not only can remain in the atmosphere for very long periods of time, but they can reach anywhere in the world. The Antarctic is a very good example. This pristine, ice-covered continent is untouched by industry and dense human populations that are strong sources of pollution. Yet, traces of these pollutants can be found in Antarctica's ice shelves and the seawaters that surround it.

Methane hydrates, found in large deposits underneath ocean floors, could meet the world's energy needs for centuries, but mining them and their environmental impact are still questionable.

Armed with this information, scientists and engineers – supported by industry – are racing to develop alternative energy to the point where it can effectively and affordably replace the need for fossil fuels, and to find ways to burn fossil fuels more efficiently. Already, hybrid combustion cars – which operate primarily from an electric engine and is supported by a separate combustion engine when needed – have entered the mass marketplace and are expected to develop firm roots among consumer over the next ten years. The hybrid automobile is seen as a bridge between today's all-combustion engines and the non-combustion engines of the future. Solar energy is slowly becoming utilized as a feasible alternative form of energy, but has not yet been able to meet the extraordinary energy demands of industry. Water and wind have been tapped as energy sources throughout history, and they will continue to serve as important sources for part of the world's energy needs.

The key challenges may not be pollution so much as the dwindling fossil fuel reserves that remain. With fossil fuels being consumed faster than they form, we can expect to deplete them before the end of this century. Methane hydrates could solve the planet's energy needs for centuries to come, but the impact they could have on the environment is poorly understood.

THE PROJECT: REDUCE POLLUTION

What are SO_2, NO_x, and CO_2? How do they contribute to pollution?

CO_2. Carbon dioxide is the principle "greenhouse gas" implicated in global warming. CO_2 is released into the atmosphere as a result of burning fossil fuels such as coal, oil and natural gas. Coal is particularly dirty, producing about twice as much CO_2 for the same amount of power as natural gas. CO_2 is also generated in smaller amounts by forest clearing and cement production.

NO_x. Nitrogen oxides cause smog, irritate the lungs and lower resistance to respiratory infections such as influenza. Smog is formed when nitrogen oxides, which are emitted by burning fossil fuels at electric power plants and in automobiles, mix with other chemicals in the air, sunlight, and heat. The two largest sources of smog-forming pollution are motor vehicles (30 %) and power plants (26 %).

The effects of short-term exposure to nitrogen oxides are still unclear, but continued or frequent exposure to concentrations higher than normal may cause increased incidence of acute respiratory disease in children. Nitrogen oxides are an important precursor to both ozone and acidic acid rain and can affect both land and water ecosystems.

SO_2. Sulfur dioxide comes from the combustion of fuel containing sulfur, mostly coal and oil. It is also produced during metal smelting and other industrial processes. The major health concerns associated with exposure to high concentrations of SO_2 include effects on breathing, respiratory illness, alterations in the lung's defenses, and aggravation of existing cardiovascular disease. While everybody is adversely impacted by SO_2 to some degree, people that are particularly at risk include asthmatics and individuals with cardiovascular disease or chronic lung disease, as well as children and the elderly.

WHAT IS GLOBAL WARMING AND WHY ARE GREENHOUSE GAS EMISSIONS RAISING THE EARTH'S TEMPERATURE?

Increases in concentrations of carbon dioxide and other pollutants contribute to global warming, which is predicted to raise average temperatures, alter precipitation patterns, and raise sea levels. These changes may negatively impact our quality of life, including increases in infectious diseases, respiratory illness, and weather-related deaths. Global warming may also decrease crop yields, water quality, and regional forest health and

productivity. Atmospheric concentrations of CO_2 have been increasing at a rate of about 0.5 % per year and are now about 30 % above pre-industrial levels.

HOW DOES SO_2 CREATE ACID RAIN?

Scientists have confirmed that sulfur dioxide (SO_2) and nitrogen oxides (NO_x) are the primary causes of acid rain. Acid rain occurs when these gases react in the atmosphere with water, oxygen, and other chemicals to form various acidic compounds. Sunlight increases the rate of most of these reactions. The result is a mild solution of sulfuric acid and nitric acid.

WHAT IS THE ELPC?

The Environmental Law and Policy Center (ELPC) is the Midwest's leading public interest environmental legal advocacy and eco-business innovation organization. We develop and lead successful strategic environmental advocacy campaigns to protect our natural resources and improve environmental quality. We are public interest environmental entrepreneurs who engage in creative business deal making with diverse interests to put into practice our belief that environmental progress and economic development can be achieved together. ELPC's multidisciplinary staff of experienced public interests attorneys, environmental business specialists, and policy advocates and communications specialists brings a strong and effective combination of skills to solve environmental problems. ELPC promotes development of clean energy efficiency and renewable energy resources to reduce pollution from coal and nuclear plants, advocates high-speed rail and smart growth planning solutions to combat sprawl, and implements sound environmental management practices to preserve natural resources and improve the quality of life in our communities. Our vision embraces both smart, persuasive advocacy and sustainable development principles to win the most important environmental cases and issues in the Midwest.

AS THE EARTH WARMS:
THE THINNING OF THE ARCTIC ICE CAP

The geographic North Pole was last covered with water about 50 million years ago, during the early part of the present Cenozoic Era. Known as the age of Mammalso and the recent Life Era, this modern age, which saw the dawn of human beings began 65 million years ago.

This global view of the Arctic Ocean, captured using advanced radar that sees through all weather conditions, is enabling researchers to determine how global warming may be affecting the Polar Ice Cap. The Arctic sea ice is providing clues to the Earth's overall climatic condition.

During the Cenozoic Era, the continents that formed Pangea, the super continent, had begun to move into their present positions. As these continents drifted northward, they formed the shoreline of the Arctic Ocean, which lies directly over and around the geographic North Pole.

About 15 million years into the Cenozoic Era (about 50 million years ago), the Arctic Ice Cap formed over the Arctic Ocean, virtually covering the entire sea with a sheet of ice. As the continents continued to move, climatic changes brought about by shifts in water and air currents caused the Earth to gradually cool down. This created the glaciers that mostly dominated the land masses through the end of the Great Ice Age in the Pleistocene Epoch, about 10,000 to 1.8 million years ago, and that still exist today on Greenland.

The same climatic conditions that created the glaciers, which are essentially great ice sheets formed on land, also formed the Arctic Ice Cap. Yet the ice sheet covering the Arctic Ocean rests directly on top of the ocean instead of land, and it has remained relatively stable and frozen since it was formed...

The Arctic Ice Cap is shrinking dramatically. Roughly the size of the United States, it has lost an area roughly the combined size of Massachusetts and Connecticut each year since the late 1970s. Since the 1950s, when data was first collected on the Arctic, the ice cap has lost nearly 22 % of its volume. It is projected that in another 50 years, nearly half of the Arctic Ice Cap will be gone.

So what is going on? We know that the Arctic Ice Cap, frozen for 50 million years, is melting. We also know that above normal Arctic temperatures from the ocean water to the air currents account for the melting. Global warming is real, and the melting of the Arctic Ice Cap is one of its symptoms.

Scientists have determined that the Earth's surface temperature has increased an average of 1 °F since the beginning of the 20th century, which is enough to trigger significant global climatic changes. According to the United States Environmental Protection Agency (EPA), the 20th century was the warmest century of the last

millennium, and the 1990s was the warmest decade. Increased average temperatures have been recorded in both the southern and northern hemispheres, although some regions have recorded cooler temperatures.

Using the best available data, many scientists believe this warming trend will cause an additional 5 – 10 °F increase in the average global temperature in the next century. Still, there are many scientists who believe the global warming trend may reverse itself within the next century. The fact is, there is not enough known about WHY the climate is changing the way it is for scientists to determine what really is going on or what will happen in the future.

But there is enough information to tell us several things.

1. Human activity, such as the burning of fossil fuels, is releasing enormous volumes of carbon dioxide and other greenhouse gases that are contributing to the Earth's natural greenhouse effect, the Earth's natural process of trapping the sun's warmth. About 5 – 6 billion tons of carbon dioxide are emitted each year due to human activity. This increase results in additional heat being trapped within the Earth's atmosphere.

2. The Polar Ice Cap itself reflects sunlight energy (heat) back into space, rather than the heat being absorbed by the Earth. This is called albedo, the amount of sunlight reflected by an object. As the Ice Cap melts however, the albedo is reduced and the Earth absorbs the energy that is not reflected. Thus, more heat is retained in the Arctic.

3. The Earth's natural carbon cycling process the amount of carbon dioxide that enters and leaves the atmosphere as a result of the natural cycle of water exchange from and back into the sea and plants account for about 95 % of the carbon dioxide in the atmosphere which contributes to the greenhouse effect.

4. Ocean waters constantly move along a giant oceanic conveyer belt, which travels, from the North Atlantic to the Atlantic, Pacific and Indian Oceans. This circulation distributes warm tropical waters northward, which are then chilled and returned to the warmer southern oceans. This heat exchange also has a significant impact on global weather patterns.

Ocean waters are constantly on the move, carrying warmer waters north toward the Arctic and cooler waters south to the temperate and tropical zones. This ocean circulation is referred to as the great oceanic conveyer belt, which is a single continuous current that carries chilled water from the North Atlantic into the Atlantic, Indian and Pacific basins. The conveyer belt returns water warmed in the tropics back to the North Atlantic.

Ocean currents also affect global heat exchange by redistributing heat, especially in coastal regions. In fact, the oceans have the greatest impact on the Earth's climate.

PUTTING IT ALL TOGETHER

The point is that while all of these things are taking place at the same time none of them exists in a vacuum. They are all interrelated and can have a reciprocating effect on each other. To what extent, scientists do not know at this point.

The climatic changes that are taking place can have profound impacts on the Earth's ecosystems, human health, plant and animal species. Scientists fear that continued melting of sea ice could weaken the North Atlantic Current, the northward continuation of the Gulf Stream. The Gulf Stream transports 25 times more water than all the Earth's rivers, and a diversion could result in extremely cold winters in the North Atlantic regions, especially in northern Europe.

There are many-fold scenarios; however, human-induced global warming is one that we should pay close attention to because we can control it. If we can reduce carbon-dioxide emissions, it could have a penetrating effect on the natural climatic occurrences that have been affected by human activity. Scientists project that the amount of carbon dioxide released into the atmosphere in the next 30 years will double or triple. The number of cars in operation around the world will double by the year 2030.

ARCTIC ICE DELUGE

One concern that most people have with regard to the melting of the Arctic Ice Cap is the eventual flooding of the landmasses. What is commonly misunderstood is that the Arctic Ice Cap is relatively thin, about 10 feet thick on average.

And about 90 % of that is already displacing the water (taking up space that would otherwise be occupied by water). Thus, even a complete melting of the Arctic Ice Cap would only result in a small increase in sea water level.

Antarctica is a continental landmass 98 % covered by thick ice sheets. It contains 70 % of Earth's fresh water and 90 % of Earth's ice. The average ice thickness is 1.5 miles, reaching 3 miles deep in some regions.

The major concern, however, would be the increase of fresh, cold water into the marine environment. This would alter ecosystems and the food chain dependent on the saline waters would funnel more cold water into the oceanic conveyer belt. As a result, you would see a global climate change due to the introduction of the additional cold water into the southern oceans, and you would see a displacement of plant and animals species dependent on the more saline ecosystems. Some animal species will, of course, retreat to the land-based ecosystems.

TRACKING AIR POLLUTION FROM SPACE

NASA's Terra spacecraft is providing scientists the most complete view of global pollution. Terra sees C in the atmosphere from 2 – 3 miles above the surface, where it interacts with other gases and forms ozone. NASA's Terra Spacecraft has assembled the first ever-complete view of the world's air pollution as it treks around the globe. Terra's new global air pollution monitor, contributed by the Canadian Space Agency, allows scientists to identify the major sources of air pollution and see what happens to it anywhere on the planet.

Terra is one of the United State's major Earth-observing satellite systems (EOS), designed for the accumulation of data needed to predict future changes in the global environment.

It takes pictures with digital cameras, about 435 miles (700 km) above the Earth, basically to catch reflected sunlight and released heat on or from the Earth, rather than scanning the global surface by microwaves. Unlike other satellites, Terra travels in a North-South polar orbit.

Through Terra, which launched in December 1999, air pollution is clearly identified as a global problem, with pollution from sources in one region having a dramatic impact on others. Among the greatest impacts observed so far there is the transcontinental drift of an immense carbon monoxide plume from a source in Southeast Asia across the Pacific to North America. The pollution reaches North America in fairly high concentrations. In the winter, a major source of pollution captured by Terra is the burning of fossil fuels for mass transportation and business and residential heating in the northern regions of the planet, which is observed traversing a majority of the hemisphere.

A NEW LOOK AT HUMAN EXTINCTION

The very powerful technologies of the new Millennium – from robotics, genetic engineering and nanotechnologies – "are threatening to make humans an endangered species," according to the April 2000 issue of "Wired Magazine" ("Why the Future Doesn't Need Us") in an article by Billy Joy, co-founder and chief scientist of Sun Microsystems. As man's dependence on technology continues to substantially increase, so does his progress in developing intelligent machines that can and will do all things better than humans can do themselves. In a way, it is the technological version of Charles Darwin's "survival of the fitted." If technological evolution reaches the point where sophisticated systems of machines can function on a cognitive level, and make decisions and perform tasks without the need for any human intervention whatsoever, then, as Mr. Joy points out, the human race would be at the mercy of machines.

So, why doesn't the future need us? Mr. Joy covers this possibility in extraordinary thought which considers a simple theme in our efforts to improve the quality of our lives, we – humans – strive to make things that can do things better than we can ourselves. In so doing, we create things that replace what humans once did exclusively. Just consider such simple creations as the calculator, remote control devices, personal computers and microwave ovens.

Yet, the 21st century will provide such compelling technologies as genetic engineering and nanotechnologies (work at the atomic, as opposed to the molecular level) that have the potential to threaten any human involvement whatsoever – far more than the simpler technologies of yore. According to Joy, "Specifically, robots, engineered organisms, and nanobots (robots on the atomic level) share a dangerous amplifying factor: they can self-replicate. A bomb is blown up only once – but one can become many, and quickly get out of control." And the risk of this would be substantial damage to the physical world, the environment on which humans and all of Earth's other organic co-inhabitants depend.

The promises of these new technologies are equally powerful: virtual immortality, providing treatments and cures for almost every disease, and solutions and advances that could expand the human life span indefinitely and improve the quality of our lives – particularly the environment. All the while, Joy says, "with each of these technologies, a sequence of small, individually sensible advances leads to an accumulation of great power, and, concomitantly [coupled with], real danger."

Simply getting rid of machines would be suicide, Joy points out. So perhaps an equally viable option is that human progress be tempered with the care of ensuring that human involvement remains essential to that progress, thereby ensuring that human needs are maintained and the quality of life improved. While it's true that

machines and other products of our technologies have no consciousness, it does not mean that they will not some day have the cognitive qualities to perform tasks as humans do. Today, that is called science fiction.

But as we have learned from our science fiction literature of the past, such things are based on real possibilities, many of which we have already witnessed in our lifetime, such as space travel, visiting other planets, the creation of the atomic bomb, nuclear power and machines that will talk to you. Perhaps English author H.G. Wells, considered by many to be the father of modern science fiction, could foresee such human decline "at a time when civilization passes it zenith," when he authored his first literary work, "The Time Machine" in 1895. In speaking of the result of human progress witnessed far into the future by the Time Traveler, he wrote: "The great triumph of Humanity I had dreamed of took a different shape in my mind. It had been no such triumph of moral education and general co-operation as I had imagined. Instead, I saw a real aristocracy, armed with a perfected science and working to a logical conclusion the industrial system of today. Its triumph had not been simply a truth over Nature, but a triumph over Nature and the fellow man."

HOW CAN I BECOME INVOLVED AND MAKE A DIFFERENCE?

First, think about what you might be able to change about your lifestyle that would help you consume less energy. Many of the simple things you've heard before really will help: walk or ride a bike instead of driving, turn off the lights, recycle and use products that have less packaging – it takes much more energy to produce new products than to reuse what we already have.

Then, encourage others in your family and community to do the same. Ask community leaders and decision makers in your state and Congress to provide incentives for conservation and energy efficiency, instead of consumption. Become involved with organizations that are speaking out about global warming, renewable energy and energy efficiency. Use e-mail to let friends and colleagues know about the global warming and energy problems and what they can do to help reduce greenhouse gases and use energy more efficiently.

WHAT KIND OF ENERGY EFFICIENT PRODUCTS/APPLIANCES CAN I BUY?

The typical American household could reduce its electricity consumption by 40 % simply by replacing existing lighting and appliances with efficient Energy Star models. Such enormous efficiency gains can go a long way toward helping the US reduce global warming gases. The most important appliances to consider are those that use the most energy: lights, refrigerators, washing machines and dryers, air conditioners, and dishwashers.

LIGHTING

Lighting alone represents 10 % of US electricity consumption, and offers the largest potential savings. Compact fluorescent light bulbs (CFLs) generate the same amount of light as incandescent but use only 25 % of the electricity. CFLs cost more than incandescent, but because they last 10 times as long and use so much less electricity they have a lifetime cost that is much lower than the competition. Two companies producing CFLs are based in the Midwest and are members of the Midwest Global Warming Leadership Council: "GE Lighting", headquartered in Cleveland, Ohio, is the largest lamp manufacturer in North America. "GE Lighting" offers a full line of "Energy Star Labeled" energy efficient compact fluorescent products.

"Technical Consumer Products (TCP)" in Aurora, Ohio manufactures spring lamps that use 75 % less energy when compared to an equivalent incandescent bulb. Spring lamp's 10,000 hour average life equals 10 standard incandescent bulbs and it will fit anywhere a standard bulb will fit.

JAPANESE WHALING: ALL IN THE NAME OF SCIENCE

Despite widespread international criticism, Japan continues to defy the international moratorium on commercial whaling.

Each year Japan takes a total of more than 500 whales from the North Pacific and from the Southern Ocean Whale Sanctuary. This sanctuary was established by the IWC in 1994 as an international "safe haven" for whales.

In May 2000, Japan expanded its "scientific" whaling program in the North Pacific to include an annual take of ten sperm and 50 Bryde's whales. Each Bryde's whale yields significantly much meat, thus the inclusion of the new species makes Japan's hunt much more profitable.

The move to take Bryde's whales was described by the United Kingdom's then-Fisheries Minister, Elliot Morley, as "a blatant act of defiance of international opinion", deserving "widespread international condemnation."

On 27 February 2002, Japan announced plans to further expand its scientific whaling program in the North Pacific by including a quota of 50 individuals of yet another species – the sei whale. The sei whale is considered "Protected Stock" by the IWC because it was depleted by commercial whaling only a few decades ago. This species is also listed as endangered by the IUCN (World Conservation Union).

Moreover, Japan intends to increase the number of whales it kills by allowing its coastal whaling companies to hunt 50 of them annually. For many years Japan has been arguing for this interim quota for relief to "distressed local communities," but has so far failed to convince the IWC. Now they have decided to take the whales anyway for the purposes of "science".

On 6 March 2002, the Japanese government announced that it intends to import Norwegian whale meat beginning as soon as April 2002. This commercial trade in whale products would be the first in more than a decade. It is in defiance of an international ban on trade in whale products under the Convention on International Trade in Endangered Species.

The Australian Federal Minister for the Environment and Heritage, Dr David Kemp, said in a statement condemning this latest move by the whaling countries, "This is the second alarming announcement within a week to indicate that whaling nations are aggressively charting a course to resume hunting whales on a commercial basis, despite international opinion."

The Japanese whaling fleet departs twice a year; in November to the "Southern Ocean Sanctuary" to take 400-plus whales, and around May to the northwest Pacific to take 100 Bryde's and sperm whales. Commencing this year, they will also hunt sei whales.

On 24 September 2002, Japan's whaling fleet returned to port having killed a total of 94 whales (according to Fisheries Agency official Kiichiro Mitsumori) from a planned catch of 210. The six whaling boats caught 50 Bryde's, 39 sei and five sperm whales in the northwest Pacific Ocean.

ICELAND: WHALING VERSUS WHALE WATCHING

In 2002, Iceland was allowed to rejoin the *International Whaling Commission* (IWC) with a "reservation" on the commercial whaling moratorium. In other words, it is once again a member of the IWC but does not wish to comply with the current ban on whaling.

Iceland withdrew from the IWC in 1992 and has abided by the IWC's moratorium on commercial whaling since 1990. However, at the 2001 and 2002 IWC meetings, Iceland stated that it wanted to rejoin the commission – this time with a reservation on the moratorium.

Iceland's request was twice rejected by the IWC members. But, at an intercessional meeting on 14 October 2002, Iceland was finally voted in. Many countries were upset at this outcome. Sweden, Germany, Brazil, France, Italy, Netherlands, the United Kingdom and Mexico have either lodged a formal objection to this decision or are in the process of doing so.

Iceland's successful effort to rejoin the IWC has seriously disrupted business at two of the IWC's annual meetings. More importantly, it raises the question of whether *any* IWC decision will remain binding.

In the future, other nations may simply leave the IWC and rejoin with a reservation to any existing decision they cannot abide. This risks subverting the intention of an international agreement that was designed to regulate the activities of each its members for the greater good.

These attempts to sabotage the international system of protection for whales bring no material benefits to Iceland, but they could result in Iceland acquiring the image of an anti-conservation nation, thereby damaging its tourism and export industries.

The behavior of the Icelandic delegation to the IWC and CITES has been quite out of line with the normally serious and responsible position of Iceland in other international affairs. Though Iceland has rejoined the

IWC with a reservation, in other international forums it argues against countries taking reservations to key decisions.

Now that Iceland has completed one season of "scientific" whaling – after having been readmitted to the IWC on a promise of not hunting whales before 2006, it has shown a serious breach of faith.

Iceland should now abide by the IWC's rules. Although legal, Iceland is likely to suffer negative consequences for choosing to use the "scientific" whaling provision of the IWC.

LOBSTERS ARE DISAPPEARING

Lobsters are disappearing from the once bountiful. Long Island Sound that runs between Long Island, NY, and the mainland coast of Connecticut and New York, causing a great fear among fisherman and consumers alike that the future bodes ill for this popular delicacy. Nobody knows why they are disappearing although a combination of warming waters and environmental stresses are suspected. This is already having a huge impact on the New York – Connecticut lobster industry, particularly the fishermen whose businesses are off as much as 70 percent because of the weak lobster crop. Disaster relief requests from New York and Connecticut are already being considered by the US Commerce Department.

Restaurants need not worry, however. Canada, Maine and Massachusetts are the major suppliers and they continue to produce millions of pounds of lobster annually. In 1998 alone, Massachusetts and Maine provided nearly 60 million pounds of lobster for human consumption.

CAPTIVE CHIMPANZEES FIND SANCTUARY

It took a great collective effort to rescue a group of chimpanzees from the laboratories of the Coulston Foundation. These chimpanzees, which were part of the US space program, were awarded to Coulston in August 1998 by the US Air Force and the Department of Defense as a result of a Congressional decree. And so, on October 28, 1999, after a yearlong lawsuit against the US Air Force, the Center for Captive Chimpanzee Care (CCCC) was awarded 21 of the chimpanzees that will be retired to a 150-acre sanctuary in South Florida. The chimpanzees are expected to move to their new homes sometime this spring or summer, as soon as the compound can be prepared to accommodate them. Even though it was the will of many people to retire the "Space Chimps", including such well-known supporters as Dr. Jane Goodall and Dr. Roger Fouts, it was the efforts of CCCC founder and director Dr. Carol Noon that made it happen. "This has been an agonizing year, but today makes it all worthwhile," Dr. Noon said after the agreement was announced.

The agreement follows a yearlong lawsuit brought against the U.S. Air Force by the Center. The Center filed its case after the Air Force awarded 111 of its 141 chimpanzees to The Coulston Foundation in August 1998. The chimps were the subjects of a controversial. The Center, which has world-renowned primatologist Jane Goodall on its board of directors, submitted a proposal to the Air Force to retire the chimps to a sanctuary, but the bid was rejected. The remaining 30 chimps were sent to Primarily Primates in San Antonio, TX, which is a sanctuary for chimpanzees and other "domesticated" wildlife unable to be returned to the wild.

Chimpanzees have been used as human surrogates in biomedical experiments for most of the 20th century. The reason was that chimpanzees are most similar to humans of all other animal species; they share about 98.5 percent of humans' DNA; and it was "logically" felt that the very dangerous and often lethal tests for the advancement of human medicine would be best served by using chimpanzees. This gave rise to the development of a large number of biomedical research laboratories, such as the Coulston Foundation, which have heavily relied upon such research on chimpanzees and the billions of dollars they have received in funding for such research.

The chimpanzees awarded to the Center for Captive Chimpanzee Care are direct descendants of those who paved the way for human space travel. The most famous of these descendants is Ham, the first chimp in space, who preceded Alan Shepard's inaugural manned space slight. CCCC's chimpanzees range in age from 6 to 40 years old. The oldest is Hanzie who was born in Africa right around the time Jane Goodall began her study of chimpanzees. The youngest is Lil' Mini whose mother died last year. Minnie was used in the original Project Mercury tests including zero gravity testing. Mercury "couch" training – the chair Ham and Enos (the second chimpanzee in space) were strapped into during their space flights. Enos' flight was a full dress rehearsal for the space flight that would carry it into orbit.

Did you know...?

Chimpanzees do not smile. When they appear to be smiling, such as Ham appeared to be doing when he returned to Earth from his space flight on January 21, 1961, they are most likely frightened. In a recent Ecology

interview with Dr. Jane Goodall, she said, "In all of my years of observing chimpanzees in the wild, I have never seen one of them "smile". When they grin the way Ham was grinning as he sat in his space capsule, they are truly frightened." The Air Force interpreted Ham's smile as an extreme state of happiness and thus labeled the test flight a total success. It was reported that Ham was so frightened by the space flight, he refused to go back into the Mercury capsule that took him into space during a press conference following the historic event.

NEW TECHNOLOGY IN SPACE

Technology is now taking us even further into our understanding of how all the elements of our environment work together.

Dedicated to increasing our understanding of the Earth, NASA launched Triana on January 1, a satellite mission to the point in space between the Earth and the Sun where there is no force of gravity. From a distance of 1.5 million kilometers (about 932,000 miles), Triana will provide a constant view of the sun-lit part of the Earth, 24 hours a day, to help scientists better understand the total Earth system and the effects of natural and human-induced changes on global ecology.

Triana will attempt to answer many questions scientists still have about how our planet works together as a single system. In one area, for example, Triana will help scientists learn more about how much of the Sun's energy the Earth absorbs, releases and reflects back into space, which are vital links in our planet's climate and general health.

Other areas in which Triana will have a great impact include how clouds form in respect to the size and shapes of their particles and interactions with the Sun's energy; how both natural and human-caused pollution affects the Earth and the evolution of the ozone; how Earth's vegetation is evolving; how much ultraviolet radiation actually reaches the ground and the effect that is having; how solar wind and the Earth's magnetic field effect earth's climate and ultimately vital ecosystems.

Did you know...?

Triana is named for Rodrigo de Triana, the first sailor to spot the "New World" from Columbus' ship.

RESTORING THE EARTH

Every year, tens of millions of acres of once fertile land around the world are becoming deserts due to uncontrolled land use and over cultivation by man. By the middle of the 21st century, many scientists are predicting that those areas, which receive an average of 10-to-20 inches of rainfall each year (semi-arid regions) will also become deserts due to global warming.

The desert covers 65 % of Israel, largely as a result of years of neglect and by other human and natural causes. At the turn of the 20th century, this ancient Holy Land, which had once been a lush vista of green forests, was a desolate wasteland barren with rocky hills and little or no vegetation. Since the establishment of the independent State of Israel in 1948, halting desertification (the process of turning land into desert) has been a top national priority.

Today, through the efforts of the Jerusalem-based Keren Kayemeth LeIsrael (KKL) organization, neglected countryside has been revitalized with the planting of over 200 million trees throughout the arid region. What sets the efforts of the KKL apart from other similar tree-planting efforts worldwide is that the trees planted were done so by individuals from all over the world in honor of loved ones or others close to them. As the KKL states, "Our forests are living legacies populated by millions of trees dedicated to millions of friends throughout the world." Not only are the trees planted by people devoted to the Holy Land, but they are planted by people devoted to the environment, heads of state, artists, religious leaders and tourists from all walks of life, religions, cultures and ethnic heritage.

These efforts, which began with the launch of KKL in 1901, have not only restored the beautiful vistas of the Israeli countryside, but they have significantly improved the air and land quality within environment.

Did you know...?

Planting trees does not require more water for your landscape. Rather, the opposite is true. Trees not only help retain water in the soil, but they can also help keep the soil intact and healthy. This results in the retention of even more water so less watering is required. Trees also act as air filters to provide better air quality for both humans and wildlife.

Those areas, which receive an average of 10-to-20 inches of rainfall each year (semi-arid regions) will also become deserts due to global warming.

EARTH'S ULTIMATE FATE

It happens all around us in the universe. Stars, many like our own sun, are shrinking, exploding and eventually dying. Everything dependent on these stars suffers a related fate. It's the laws of physics and natural evolution of our universe.

The American Association on the Advancement of Science says Earth will ultimately either "dry up, burn up or freeze" based on continuing scientific research on the Earth's ultimate fate. This is because the Earth's sun is becoming brighter and hotter, on its way to becoming a white dwarf ... billions of years from now. But even before then, the Earth's temperature will rise to the point where the planet will begin to lose its water.

In an interview with MSNBC, Pennsylvania State University Professor of Geosciences, James F. Kasting, said that astronomers have long known that the sun would meet this fate – and Earth along with it, and that it could happen in five billion years. However, a more pessimistic scientific model indicates the oceans could evaporate in about 1.2 billion years.

Dr. Kasting explains that the warmer temperatures will cause vital carbon dioxide gases – essential for plant life – to be absorbed by the oceans. Plant life will eventually die off as will all life dependent on plants for survival.

In yet another scenario, according to the MSNBC report, the sun may expand into a giant ball of burning hydrogen as it exhausts its fuel, incinerating the inner planets of Mercury, Venus, Earth and Mars. Before that, in about 3.5 billion years, the sun will be hot enough to burn up all life forms on Earth, with the exception of some bacteria. And yet, according to University of Michigan Physics Professor Fred Adams, Earth could be jettisoned out of its orbit into deep space due to the disruption of the sun's gravity and the gravity of a passing star. In this case, the Earth would freeze as it spins through space without its sun.

This is a simple description of the natural evolution of our planet and solar system, like all others in the universe. While this fate will eventually meet all stars and planets, new solar systems are being born that will go through the same cycles. And a billion years can allow for some remarkable and fascinating developments that will ensure the perpetuation of Earth's life forms within our vast universe. As NASA's Hubble Telescope has confirmed, the expansion of the universe, which has been known since the 1920s, is likely to continue forever.

IVORY WARS UPDATE: IVORY TRADE PROPOSALS RESCINDED FOR NOW

The four southern African nations, which asked for approval from the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) to resume selling their ivory stockpiles on the global market have withdrawn their proposals.

Tusks of bull African elephant are very rare since most elephants do not survive beyond the age of 30.

South Africa, Zimbabwe, Namibia and Botswana – four countries with healthy elephant populations – had asked CITES that they be allowed to resume their trade in ivory, guaranteeing that money from the sales will be used to ensure continued elephant conservation efforts in their countries. The proposals were to be considered by the 150 member nations at the eleventh meeting of the Conference of the Parties to CITES April 10 – 20 in Nairobi, Kenya. The countries encountered strong resistance from environmental and science groups around the world, as well as nations with endangered elephant populations, who feared that there would be a resurgence of elephant poaching. Kenya and India, in particular, united to form the strongest resistance and lobbying effort against the proposals.

According to Dr. Steve Osofsky, senior program officer for species conservation of the World Wildlife Fund – US, agreements were made that gave both the Kenyan and southern African parties a little bit of what they each wanted. While neither South Africa, Namibia, Botswana nor Zimbabwe can trade in ivory, they may conduct trade in other parts including hides, as well as hunting trophies for non-commercial purposes, and trade in live animals to appropriate and acceptable destinations. This is a result of the African elephant being "down listed" from Appendix I to Appendix II of the CITES treaty in the four southern African countries only. An Appendix II listing means that a species is deemed biologically secure enough that some trade involving those species may take place under CITES-specified conditions. The African elephant retains its Appendix I listing in all other countries (populations). CITES does not allow any trade involving Appendix I (endangered) species except with rare exceptions.

When asked if South Africa, Botswana, Namibia and Zimbabwe would again try to gain approval to resume their trade in ivory, Dr. Osofsky firmly replied: "You can bet on it." In fact, in withdrawing their proposals, the four nations reaffirmed their commitment to the concept of "wise use of their natural resources," and said they will seek permission to resume their trade in ivory when the CITES parties meet again in two years.

The key to resuming legal trade in ivory involving healthy elephant herds is being able to ensure that other elephant populations can be sustained at a healthy level. But, according to Dr. Osofsky, that would be an impossible task without the existence of effective monitoring and enforcement systems. "The conservation community may be in for a rude awakening," – he says. "How much better the monitoring systems will be in two years is hard to answer, but there will be a lot of hard work to do between now and then" when CITES will once again consider the southern African proposals.

This herd is located in Botswana's Chobe National Park where tourism thrives as a result of the country's healthy elephant populations. Botswana wants to sell their ivory stockpiles, guaranteeing that elephant conservation will remain a top priority "This is a tensely political situation," – Dr. Osofsky said. – "The southern African nations have been patient for a long time, and effective real-world monitoring systems are still potentially a long way off in much of Africa and Asia."

A global ban on ivory was passed in 1989 by CITES, which appears to have helped reverse elephants, spiral toward extinction in Asia and Africa, particularly in Africa. Five hundred years ago, perhaps 10 million elephants lived and roamed throughout Africa. Today, it is estimated that about six percent of that number exists, or roughly 600,000, on the African continent.

Some estimates put the number closer to 300,000, an indication of today's inefficiencies in monitoring elephant populations worldwide. The Asian elephant population is estimated at between 35,000 and 50,000 in the wild.

The only way ivory can be collected is through the death of an elephant, whose tusks are the source of the raw material. The historical demand for ivory, called "white gold" by many traders, had led to rampant poaching of elephants in both Asia and Africa, decimating most populations and threatening both species with extinction. Both male and female African elephants bear tusks while only the male Asian elephant has them.

South Africa, Botswana, Namibia and Zimbabwe had argued that their ivory only comes from elephants, which have died naturally or were culled (legally killed for management purposes) in overcrowded areas. Entering this recent conference of the parties, they had also ensured that no elephants would be killed specifically to generate ivory for trade. Opponents believe that granting their requests would have had an alarming impact on the elephants in other countries where it is unknown exactly how many elephants remain and how they are faring.

According to Dr. Osofsky, culling has not taken place in the four southern Africa countries in the past few years, but it could conceivably take place again, perhaps before but more likely after the next CITES meeting.

Did you know...? Elephant tusks are actually overgrown incisor teeth. They are not used for chewing and thus their growth continues unabated.

ICEBERG UPDATE: NEW MASSIVE ICEBERGS ARE CALVED

May 5, 2000. Two new massive icebergs have broken off from the Ross Ice Shelf as a result of the movements of a much larger adjacent iceberg that was calved in March. Three additional icebergs have also broken off from the Ross Ice Shelf as a result of the gyrations of the giant iceberg, designated as B-15 by the National Ice Center. According to the National Ice Center, additional icebergs may continue to calve in the next few weeks due to the ebb and flow of the ocean tides and the subsequent collisions of the larger icebergs with the ice shelf itself. The largest of the new bergs, designated as B-17, still is considerably smaller than B-15, which is about 4,250 square miles (11,000 square kilometers) or twice the size of Delaware. B-17 is approximately 960 square miles (2,480 square kilometers), and is already beginning to show signs of breaking up into smaller pieces. The second smaller iceberg has been designated as B-18. To the west of B-15, a separate iceberg called B-16 formed at about the same time as the giant iceberg and now appears floating out to sea. B-15 is also beginning to pull further away from the ice shelf.

This iceberg activity is not related to global warming, according to the National Science Foundation. Rather, it is "part of a normal process in which the ice sheet maintains a balance between constant growth and periodic losses."

The mammoth B-15 iceberg was "calved," or broke off, from the main ice sheet about 200 miles east of the National Science Foundation (NSF) McMurdo Station on March 20. Among the largest ever observed, it is ex-

pected to drift westward around the Antarctic for several years, eventually moving northward into the eastward-trending currents of the Southern Ocean.

Though B-15 is currently the largest iceberg known to exist, its size is eclipsed by an iceberg that was spotted in 1955 about 150 miles west of Scott Island inside the Antarctic Circle by the U.S.S. Glacier, the US Navy's most powerful icebreaker at the time. That iceberg was reported as 60 miles wide by 208 miles long, or about 12,000 square miles (31,000 square kilometers).

COAL AS FUEL OF THE FUTURE

Imagine traveling over nine times the speed of sound in a hypersonic aircraft powered by... coal.

It is true that hypersonic flight is being ushered into our future with such aeronautic innovations as NASA's unpiloted X-43 Hypersonic flight vehicle, which will ultimately result in larger, manned aircraft with larger engines.

But the major obstacle for such high-speed flight is heat, particularly the amount of heat exposed to an aircraft's engines and the fuel that powers them.

While today's jet engines are exposed to heat of roughly 310-320 degrees Celsius (600 degrees Fahrenheit), hypersonic speeds can introduce these engines to temperatures over 480 degrees Celsius (900 degrees Fahrenheit).

Not only is coal-powered flight possible, according to scientists, but it may be available within a few years, according to The Energy Institute at Pennsylvania State University.

X-43A Hypersonic Experimental Vehicle, or "Hyper-X," was developed to fly at speeds from Mach 7 up to Mach 10 (Mach 1 represents the speed of sound). Heat associated with such flight can cause problems for conventional jet fuels and coal may hold the answer to the fuel challenge.

Funded for over nine years by the US Air Force, research at Penn State University has concluded that coal is more suited for high velocity flight because the conventional petroleum-based jet fuel cannot withstand the intense temperatures associated with supersonic flight. Petroleum-based fuels will breakdown under intense heat.

"Solid coal itself could not of course be used in these applications, but coal-derived liquid fuels most certainly could be used," said Dr. Harold Schobert, Director of the Energy Institute, in reference to the possibility that coal could become the primary fuel for hypersonic flight.

Coal-based fuels, however, have shown that they can withstand much more intense heat than petroleum fuel, and they have already been put to the test by the Penn State research team. Coal fuel has been subjected to temperatures in excess of 800 degrees Celsius (approximately 1,450 degrees Fahrenheit), and plans are to continue experimenting with higher temperatures. It is expected these fuels will be tested in actual engines by 2005, if not sooner.

COAL POWER FOR THE FUTURE

It seems logical that coal would be used as the predominant fuel of the future until other non-petroleum-based substitutes are fully developed. Coal burns cleaner, despite the false image that associates coal with the dingy, smog-choked air of the old coal-burning cities and towns, particularly during the Industrial Revolution. Furthermore, according to The World Coal Institute (WCI), "technologies have been developed to improve the environmental performance of coal-use techniques" and that the efficient burning of coal-based fuels results in the release of fewer pollutants into the atmosphere. All fossil fuels produce greenhouse gases; but greenhouse gases from coal contribute to less than 20 % of any enhanced greenhouse effect.

Currently, coal is the primary source of fuel for electricity generation worldwide, according to WCI. Over 62 % of the world's total coal production is used for about 37 % of the world's electricity.

Electricity needs are on the increase worldwide at an alarming pace for cities such as this one in India. India, which derives 75 % of its electricity from coal-based fuel, is the third largest producer of coal.

Other uses for coal are used for steel and cement production, commerce, public services, agriculture and other industries, as well as domestic use. Gas (16 %), oil (9 %), nuclear (17 %), and renewable energy sources (21 %) supply the rest of the world's electricity needs.

Total world production of hard coal is about 3,700 metric tons, with China, the United States, India, South Africa, Australia and Russia topping the list of coal producers. Coal provides the majority of the electricity needs for countries such as Poland (96 %), South Africa (90 %), China (81 %), Greece (70 %), India (75 %), USA (56 %), and Germany (51 %).

If coal-based fuels could be relied on more heavily for domestic and commercial transportation, such as airlines and automobiles, all countries around the world can be confident that their coal-based energy resources would be secured, and dependency on the more centralized petroleum-based production industry would be significantly reduced. According to WCI, this would mean that our energy needs can be assured and prices would remain stable and competitive with other fuels.

Scientists have confirmed that there are over 200 years of coal resource availability worldwide, far exceeding current known and available petroleum reserves.

"In terms of BTUs [British thermal unit – unit of measurement used to express the heat contained in energy resources] in the ground, there is plenty of coal," – said Dr. Schobert. – "But the "killer issue" on coal is that it produces more (carbon dioxide) emissions per BTU of energy than the other major fuels."

However, "technologies are available or under development to address (these issues)."

Still coal remains our safest, most viable and dependable energy resource to meet our enormous energy needs. When asked if there is any source of energy that could replace coal as our primary energy source within our lifetimes, Dr. Schobert replied, "There is only one: nuclear."

What is Coal?

Coal is an organic, sedimentary (produced from sediments) rock composed primarily of carbon, hydrogen and oxygen.

Over half of the world's coal reserves are of the bituminous variety, such as is being mined here in Queensland, Australia. Only anthracite coal is harder than bituminous.

Coal was formed from pre-historic vegetation that has been under the heat and pressure within the earth. After going through physical and chemical changes over millions of years, the vegetation was converted into coal. Such processes did not begin until land plants evolved some 400 million years ago.

Peat was the first stage of coal to form, which was eventually converted into lignite or brown coal. After millions of more years of heat and pressure from within the earth's surface, bituminous or hard coal evolved. Ultimately, the bituminous coal transforms into an even harder form called anthracite coal.

Anthracite has a higher carbon and energy content and a lower level of moisture than bituminous coal, and is used for domestic and industrial purposes, including smokeless fuel. Bituminous coal is primarily used for power generation, and the production of cement, iron and steel.

Did you know....?

The largest environmental threat from coal is not in its use, but in mining it. Strip mines, such as the technique that had been heavily used in West Virginia, essentially strip the top layers of earth away to expose the coal reserves underneath. This has resulted in devastation to natural habitats, natural growth and water supplies on the surface. Over time, however, coal-mining companies have worked diligently to reduce the environmental impact of strip mines by reclaiming the land with original matter and re-seeding the mined surface. This is still a highly controversial practice and strip-mining bans are placed or sought in many regions, including such Federal restrictions in the Appalachian Mountains.

Also...

The commercial airline industry should be able to use coal-based fuels to power current commercial aircraft in the not too distant future. Not only would this technological enhancement provide deeper and more stable reserves than petroleum-based fuels, but it would provide less atmospheric pollution. The aircraft would not fly faster, but they would fly cleaner.

AGRICULTURE DEVELOPS ROOTS IN SPACE

The $60 billion-plus International Space Station is allowing scientists and other researchers to explore and develop food production systems in space that will enable sustained life support systems. Termed astroculture, these studies hold clues for increasing and sustaining Earth's environmental and public health.

Crops in Space? Absolutely... especially if people are to travel for months and years to other worlds and systems. It would be impossible, for instance, to send along enough food and water for a team of space explorers on a mission to Mars.

The reality is food and water production over a full life cycle is essential for extended space exploration.

But more importantly, space offers extraordinary possibilities for increasing the yield and vitality of food production on Earth and for the generation of self-sustaining life support systems wherever people may live.

Astronauts have been trying to grow plants in space since the early days of space exploration. When the Apollo astronauts explored the Moon, scientists attempted to grow seeds in the lunar soil that was returned to

Earth. But with the establishment of the Russian space station Mir and the International Space Station completed last March, agriculture in space took on new dimensions.

Despite all of Mir's technical challenges, the space station delivered the first wheat crop ever grown and harvested in space, thanks to a special Bulgarian-built greenhouse that created the right conditions for growth. Thus, a new age of food production in space was born, and scientists began to see how space technology can positively impact many of Earth's environmental problems.

An advanced AstroCulture plant growth unit is helping scientists gain new insights about how to improve food products including crop production.

Astroculture, as trademarked by NASA, is a pioneering science that connects people directly with the elements essential to the web of life that depend on healthy, natural processes. Whereas on Earth, the processes for healthy life are naturally occurring, systems have to be put in place for these same processes to occur in space. And NASA is well along in the study of creating these bioregenerative life support systems capable of indefinitely supporting human and plant life.

The lack of gravity is essential for plants to develop strong rooting, sunlight, available nutrients, insects (for cross pollination), controlled climate and clean water are all challenges for astroculture. Bioregenerative support systems take all of these vital elements into consideration.

First of all, humans and plants are ideal companions in space and on Earth.

People breathe air and produce carbon dioxide, and plants consume the carbon dioxide to produce oxygen. Humans can also consume edible plants or plant parts for sustenance. This produces waste by-products, which can be broken down to supply nourishment for plants.

Given this unique relationship between plants and humans, all that is left for consideration is the supply of energy, regeneration of clean water and the effect of gravity to make it all work. Energy, which must be highly efficient, is provided in the form of light. And clean water comes from re-occurring and self-sustaining natural cleaning and filtration systems inherent to regenerative life support systems.

A space greenhouse creates energy from light sources, which must be as efficient as possible to reduce energy demands. Here, wheat is growing under Light Emitting Diodes (LEDs), which are generally used in today's consumer electronics.

LEDs save energy by only releasing light in frequencies that plants can use for photosynthesis.

The creation of microgravity systems, which would be developed for long-term piloted missions to Mars and other places, would provide the gravitational effects needed for healthy plant growth.

Today, industries and scientists are being allowed to explore and study plant growth and long-term plant production on board the $60 billion International Space Station, which launched last May. NASA's Astroculture Commercial project is providing myriad platforms for such study, which will also have a huge impact on Earth-based agriculture. In one instance involving microgravity, researchers will be studying and expecting to develop custom crops that withstand hostile conditions, resist diseases and require less space in which to grow. According to NASA scientists, the microgravity provides a highly efficient environment for using bacteria to transfer desirable genes such as those that increase a plant's immunity to disease and pestilence.

Simply put, if we can sustain food production in space, then we can sustain human life anywhere in the universe. Plants, like all living things, depend on nourishment and the right living conditions in order to grow. And with a burgeoning population on Earth, astroculture benefits will help us better provide food, sustenance and the required healthy ecosystems essential to promoting public health.

Did you know...?

Without gravity, water spreads all throughout the soil of plants making it harder for the water to reach the roots.

Fans are necessary to provide air movement in space, since there are no natural wind currents like on Earth. Without air movement, space plants can suffocate on the oxygen they exhale!

LIFE SUPPORT SYSTEMS: MARS ACADEMY

Over Antarctica, the Ozone hole may be shrinking. But it will take a while for the Earth's ozone layer to return to normal.

Nearly three times the size of the United States, the ozone hole over Antarctica appears to be shrinking or at least stabilizing, according to scientists. Reduction of human emissions, which destroy ozone in the atmosphere, has contributed to this reduction. But the ozone layer may take 50 years or more to return to normal.

Having reached nearly three times the size of the United States, the ozone hole over Antarctica appears to be slowing down, possibly reversing its growth rate, according to scientists at New Zealand's National Institute

of Water and Atmospheric Research (NIWAR). The hole in the ozone layer, a region of the Earth's stratosphere that contains relatively high levels of the toxic gas and is about 12 – 30 miles high, forms each year during the Antarctic spring. Last September, the ozone hole reached its maximum size of about 10 million square miles, down by about 1.6 million square miles from its peak size in September 2000.

While the ozone hole appears to be stabilizing or even shrinking, it also appears to be staying around longer, according to NIWAR. And this extends the additional risks of ultraviolet radiation to plants and animals on the Earth's surface. Even though the peak size of the ozone hole was less this year than last year's peak, it is about 3.1 million miles larger than it was this time last year. But it may be December before it breaks up again.

Ozone is simply a molecule that consists of three atoms of oxygen (O_3), and is produced when normal oxygen molecules (O_2) are bombarded by great amounts of ultraviolet radiation from the sun. As a result, the ozone layer is formed in the stratosphere because it is closer to the sun than the lower layers of the atmosphere. The ozone layer essentially forms a blanket around the earth to filter out harmful ultraviolet radiation and prevent it from reaching the surface. However, scientists estimate that holes have been occurring in this protective ozone layer since the early 1980s.

How the Ozone Hole Forms?

In Antarctica, winter begins to arrive in March. With the onset of winter, the atmosphere cools and high-altitude winds begin blowing around Antarctica to create a circular wall that prevents air from the north latitudes from mixing with the southern air. As a result, clouds form in the stratosphere that include both ozone and substances from human emissions on the surface that can destroy ozone.

As the southern spring arrives, the sun's energy begins to warm up the atmosphere. This causes the chemical reactions between the ozone-destroying matter and ozone, and the hole in the ozone layer begins to form. Essentially, the clouds serve to change chemicals derived from the human emissions into chemicals that destroy ozone.

When the Antarctic summer arrives, the high-altitude winds forming the circular pattern around Antarctica begin to break up, and the ozone rich air from the north flows back across the Antarctic region to replenish the depleted ozone layer. Thus, the hole usually disappears in November or December.

CFCs are non-toxic, non-flammable chemicals that consist of atoms of chlorine, carbon and fluorine. When radiation hits a CFC molecule, chlorine breaks off and attacks and destroys ozone.

Chlorofluorocarbons (CFCs) are the primary human emissions that cause ozone depletion. These substances are usually found in aerosols and coolants used in refrigerators, freezers and automobile radiators. In the mid-1970s, scientists discovered that CFCs were a primary cause of ozone depletion. This was confirmed a few years later by satellite. CFCs are moved by air currents where they end up in the ozone layer of the atmosphere.

Effects of the Ozone Hole on the Surface Full, unhindered ultraviolet radiation, primarily from the type of ultraviolet radiation called UV-B, can destroy animal tissue. Sunburn is the most visible and well-known results of over-exposure to ultraviolet radiation. Exposure is also closely linked to skin cancer, cataracts, and serious weakening of the immune system. Certain amphibian species can also decline due to over-exposure of UV-B. Over time, exposure to ultraviolet radiation discolors human skin and can result in severe wrinkling and liver spots.

Ultraviolet radiation from ozone depletion may be the cause of decline in amphibian populations of the Western United States, according to the US Geological Survey (USGS). The regions where these disappearances have occurred are relatively pristine and the amphibians were previously abundant.

Plants can also suffer from over exposure to ultraviolet radiation. UV-B can damage and kill plants by interfering with photosynthesis, cause mutation of important growth cells, and interfere with respiration or the plants' ability to absorb carbon dioxide and produce oxygen.

While the ozone hole is, fortunately, located over a sparsely populated region, it poses its greatest threat to New Zealanders and other adjacent temperate areas when it begins to break up in the height of the southern summer. Fragments of the ozone-depleted air will move over New Zealand and other areas during this time when the sun's energy reaches its maximum impact on the southern hemisphere.

Even with a full, healthy ozone layer, some ultraviolet radiation will make it through. In humans, ultraviolet radiation helps humans produce Vitamin D, which is essential to the growth of healthy bones, among other aids. Brief exposure to the sun can supply 100 percent of the body's vitamin D needs. Ultraviolet radiation can also aid in the treatment of chronic skin diseases, such as psoriasis and resulting hair loss.

Scientists and medical doctors also create their own form of ultraviolet radiation for positive uses in medicine and industry. UV radiation is artificially made by passing an electric current through a gas or vapor, such as mercury vapor. These rays are used for such things as killing bacteria and viruses.

While the ozone hole over Antarctica was the first to be detected, very large ozone losses have been observed in the Arctic since 1997. Scientists reported the first one, about the size of Texas, in March 1997. Some of the ozone holes detected have lasted only a few weeks and some only a few days.

Although ozone-depleting gases have ceased to grow in the atmosphere, most researchers say it could be 30 – 50 years before normal ozone levels are restored.

Since the signing of the Montreal Protocol in 1987, and with international cooperation, the worst of the ozone-depleting compounds and CFCs dropped dramatically in the 1990s. In 1977, the Environmental Protection Agency (EPA) and Food and Drug Administration (FDA) banned the use of CFCs in the production of most aerosol cans in the United States Important Ecology Tip. Ultraviolet radiation will always make it through even the healthiest ozone layer and can have severe impact on humans, animals and plants if over-exposed. Sunburn is the most common effect of exposure to UV radiation, but skin cancer, cataracts and other diseases can also result. So always ... always ... protect yourself and your animals from the sun by using protective clothing, using UV-rated sunglasses or sunscreen when outdoors. The sunscreen you use should be at least SPF (Sun Protection Factor) 30 or higher.

You can be seriously affected by UV radiation even on a cloudy day. And remember, that beautiful, golden brown tan you get today can very well turn into very rough, wrinkled and spotted skin, as you get older!

While ozone-depleting gases are no longer increasing in the atmosphere, the damage is being maintained by a feedback mechanism. According to a report filed by BBC News, the general decrease of ozone in the lower stratosphere and the global increase in greenhouse gases are contributing to the extended periods of time in which the ozone holes occur. And, there are natural occurrences that also contribute to ozone depletion, such as sulfuric acid droplets that make their way from volcanic eruptions to the ozone layer.

But the good news is, there has been worldwide cooperation in reducing emissions that contribute to ozone loss and the outlook in the long-term is good.

Did you know...?

The ozone hole is not really a complete hole in the ozone layer, but rather a thinning of the ozone in the stratosphere.

The Antarctic ozone hole has reached as far as the Falkland Islands and the tip of South America, where people were warned to protect themselves against the sun; however, in Antarctica, mainly researchers are affected because the continent is relatively uninhabited by people.

Comparatively, there is not much ozone in the atmosphere. Ozone makes up only 0.0001 percent of all atmospheric gases.

DESPITE THEIR MAN-MADE REPUTATION, BATS ARE AMONG HUMANS' BEST FRIENDS

Vampire bats really do exist! However, there are only three species of vampire bats out of the roughly 950 bat species in the world, located in Central and South America. It was the vampire bat on which early Europeans based the connections between bats and vampires, indelibly etched into the public mindset and world culture in 1897 by Bram Stoker when his novel "Dracula" was published.

Where would Halloween be without those blood-sucking, winged creatures that vampires can turn into whenever necessary?

Bats have long been associated with vampires and other supernatural beings, a connection that Bram Stoker's classic novel "Dracula" forever cemented in the public psyche in the late nineteenth century. But the legends of bat's associations with vampires and ghoulish beings far preceded the famous author.

Spanish conquistadors first saw vampire bats when they came to Central and South America in the 1500s, and noticed how their feeding off the blood of other animals was similar to the vampires of their own legends. Over time, these stories became so strongly associated with the legend of vampires that the bat and the vampire became virtually synonymous with each other.

This is really a bad rap on bats! It has become very clear in modern times that bats are not those evil beasts of the dark underworld that feed off the blood of humans. Frankly, bats are quite fascinating and very gentle creatures that are among the most beneficial animal species on Earth. Believe it or not, bats play a crucial role in the health and survival of rainforests!

Bats are mammals with wings, and they are the only mammals that fly. Their scientific name, Chiroptera, means "winged hand". They are warm-blooded animals with fur, give live birth, and nurse their young. There

are about 900 to 1,000 species of bats located in almost all but the coldest climates of the world, and all of them are at risk because their value to man and the environment are not understood. Of this number, there are only three known species of vampire bats. Nearly half of the bat species native to the United States is endangered.

The world's largest bat cave is Bracken Cave in Central Texas, summer home to more than 25 million Brazilian Free-tailed bats. Bats live in most regions of the world except in extreme cold climates.

Bats are major factors in controlling insect populations, pollinating plants and distributing seeds necessary in perpetuating the circle of life in ecosystems.

In fact, there are some plants, such as the African Baobab Tree (oddly enough, known as the upside down tree) and the Australian Ironwood, that are solely dependent on bats for spreading their seeds and for pollination. Unfortunately, their love for insect delicacies has contributed to the decline of many bat species due to poisons used by farmers and ranchers to control insects. Yet, bats can help farmers by not just eating harmful insects, but worms and other bugs, which can damage crops. For instance, a colony of just 150 big brown bats can eat up to 18 million or more rootworms each summer.

Bats have lived on the planet for over 50 million years, longer than many other mammals. They generally live naturally to 30 years of age, but many are killed by natural predators and man before then. Very adaptable, bats live in caves and buildings, under bridges, in trees and many other places. And they either migrate or hibernate, depending on the species, with some bats migrating over 3,000 miles round trip!

BAT PHENOMENON IN TEXAS

The Congress Avenue Bridge in Austin, Texas, is home to the largest urban population of bats in North America, but it almost didn't happen. When the bridge was built in 1980, thousands of the area's indigenous bats began moving in under the bridge and quickly became a national phenomenon. This set off alarms with the local citizenry who moved to eradicate the animals for fear they would attack humans or spread disease. Bat Conservation International came in and eased Austin's fears by educating them about the gentle nature and benefits of bats and those bats would not bother them as long as people did not try to handle them.

Even though many bats have excellent eyesight, many bats can also see with sound, called echolocation. This helps them see their way better in the dark and help locate their meals of insects and bugs.

Today, this colony of bats numbers over 1.5 million, and creates truly one of the most alluring tourist attractions in North America as they rise up and fly out from under the bridge each day at dusk. They will eat about
20 – 30,000 pounds of insects each night, including many bugs harmful to local crops. These Mexican free-tail bats do migrate to and from Central Mexico, arriving in Austin and other parts of the southwestern US each spring.

Bats may live in caves, such as these Kansas gray bats, but many live in buildings, under bridges, in trees and other places suitable for their nocturnal lifestyle.

The positive impact bats have had on ecosystems worldwide is immeasurable, but their role in the web of life is clear. Their legend is intriguing and will remain a staple of Halloween and the folklore of the preternatural world. In fact, you really can't picture Halloween, Dracula, Nosferatu or the real world without them!

Did you know...?

Bats are not blind. They have excellent night vision and many, such as fruit bats, use their sense of smell and sight to find their meals of flowering plants and fruits. Some bats use echolocation as a means of seeing in the dark using sound and sonar, very much the same way dolphins and Beluga whales use sound to see underwater.

Bats hang upside down in their caves, trees or other dwellings because they are not good walkers. They are the only mammals that fly and thus have never made much use for standing or walking.

Bat droppings (guano) support entire ecosystems of unique organisms, including bacteria useful in detoxifying wastes, improving detergents and producing gasohol and antibiotics.

Bats range from very small to very large flying mammals. The world's smallest one is the Bumblebee Bat, with a wingspan of six inches. The largest bat is the Flying Fox, with a wingspan of up to seven feet!

ANTHRAX: DISEASE FROM NATURALLY OCCURRING BACTERIA

While far more people die each year from influenza and other diseases than anthrax, it has created worldwide concern, particularly in the United States, because the bacteria which causes the disease has been intentionally distributed to people through the mail. Anthrax is an infectious disease caused by bacteria called bacillus anthraces.

This bacteria forms spores (single cell reproductive bodies, just like pollen in plants), which can cause the anthrax disease by spreading the bacteria to humans and animals. Anthrax occurs in humans in three forms: skin anthrax, gastro-intestinal, and inhalation. It is not contagious! Humans cannot contract anthrax from an infected human. Humans can contract anthrax through exposure to large numbers of the anthrax spores.

The anthrax bacteria occur naturally, and it can live in soil and water for up to 20 years. Anthrax commonly occurs in agricultural regions in warm-blooded animals, usually wild and domestic herbivores such as cattle, sheep, camels, goats, antelopes, oxen and other vertebrates. It is rare to find animals infected with anthrax in the United States. Most cases of anthrax infections in animals occur in South and Central America, Asia, the Middle East and southern and eastern Europe.

The microscopic spores formed by the anthrax bacteria can cause the anthrax disease in humans.

When anthrax does infect humans, it usually affects people who work with the infected animals, such as cattle ranchers, or by people who come into contact with infected, dead animals. Humans can also get anthrax by eating undercooked meat of infected animals. The recent human anthrax cases in the US, however, were deliberately caused by people who manufactured, or reproduced the anthrax spores and distributed them through the mail.

People can be vaccinated against anthrax, and there are effective treatments for the disease once it has been contracted. The earlier treatment can be administered for anthrax, particularly inhalation anthrax, the better the chances will be of recovery. Inhalation anthrax is the most fatal form of anthrax in humans.

ON THE OPPOSITE END OF EARTH

Antarctica, which covers the geographic South Pole, is itself covered with thick ice sheets. The average ice thickness is about 1.5 miles with some parts reaching as deep as three miles. Antarctica's ice shelves are also melting, for the same reasons associated with the melting of the Arctic Ice Cap, but not as dramatic. The melting of the Antarctic ice shelves has resulted in the calving of some of the largest icebergs ever known to exist, such as the series of icebergs that broke off from the Ross Ice Shelf in the spring and summer of 2000. But dramatic melting of Antarctic ice would have enormous impacts on ecosystems, climate and sea levels.

Icebergs result from a melting of the Antarctic ice shelves and the Arctic Ice Cap. While the Arctic icebergs are normally taller, the Antarctic icebergs are much larger and more massive.

Did you know...?

Hot springs and active volcanoes have recently been discovered far beneath the Arctic Ice Cap in the Arctic Ocean. While the enormous heat and energy from this activity are insignificant contributors to the increase in ocean temperatures, they appear to be an oasis for newly discovered species of plants and animals.

Antarctica is colder than the Arctic even though during the course of the year it receives almost the same amount of sunlight. In fact, Antarctica receives a little more solar energy than the Arctic because the Earth is closest to the sun in December when Antarctica has 24 hours of sunlight.

The Arctic is the northern pathway that water travels between the Atlantic and Pacific oceans.

The greenhouse effect maintains Earth's average temperature at approximately 60 °F. Without the greenhouse effect, the temperatures on Earth would be so cold that life could not exist.

Sea ice is almost all-fresh water, with some salt trapped within it. The salt is actually not part of the ice, but just got caught up in the freezing process.

The Arctic's ice is, at most, only a few feet thick with water under it. While the water would be anything but warm if you jumped into it, it is at least around 30 °F, its salt water stays liquid at a lower temperature than fresh water.

OCEAN CURRENTS AND CLIMATE

Now let me think: our communities keep getting larger and our towns and cities keep spreading out further away from where they started. There are more people living today than there used to be (over 6.2 billion of us worldwide!), and we all have the same needs for places to do business and live our lives to the most productive and healthy extent possible. So, this "natural" outgrowth kind of makes sense. But, with all of this expansion, I

am also seeing fewer natural places, trees, wild lands, and places where farms and crops have been. So, maybe this outward growth needs further reflection....

If you are not sure what to think about all of the new growth and development in your community, you are not alone. Let's call it by its name: urban sprawl.

Urban sprawl is the term we use to describe the expansion of human development out and away from city centers. And this phenomenon is eating up valuable countryside at an alarming rate, 365 acres per hour in the US alone, according to the Natural Resources Defense Council (NRDC).

Wilmington, NC, is neatly sandwiched between the Cape Fear River to the west and the Atlantic Ocean to the east. While it is totally surrounded on the north, west and south by rural areas, its population grew over 35 percent from 1990 to 2000: from just over 56,000 to nearly 76,000 people. Although its population size may pale in comparison to major centers such as New York, Tokyo and London, its rate of growth was double the world population growth rate during the same time. The success and attractiveness of the area naturally invite new challenges via urban sprawl as the Hoggard High School students have observed.

One place that has been noticeably affected by urban sprawl is on the Atlantic coast in my home state of North Carolina. Wilmington and its surrounding coastal and farm area is smaller than New York, Tokyo, Paris, London, Los Angeles, Sydney, Beijing, Amsterdam and other urban centers, but urban sprawl is just as big an issue here. My generation has some pretty unique thoughts about urban sprawl, although they have not had the opportunity to see the way things used tube like our parents did.

The way we see it, we are preparing to inherit a world of development that has been shaped by all those who came before us. And what we think of urban sprawl, therefore, is extremely important because it will determine our approach to the future.

Recently, I had the opportunity to speak with a group of environmental science students, ages 16 – 18, at Wilmington's Hoggard High School about this issue. In listening to them, urban sprawl began to take on the manifestation of a double-edged sword. Progress is a good thing, but at what cost to other things we have appreciated and even taken for granted?

"I have lived in Wilmington all my life," – says Erin, – "and it is amazing how big the city has gotten. Driving to places like Ogden [a city suburb] took forever. Now with new roads, it's a five minute trip!"

The sense that Wilmington has sprawled dramatically in recent years was something that students repeated over and over again. "We have paved over so much unnecessary land instead of putting businesses and housing developments closer together," – said Lindsey, suggesting that perhaps businesses should share more parking lots and use smaller areas.

Alli and Jonathan both live in neighborhoods where trees were "cut down in huge groups" for housing and the local mall. Alli suggests construction companies replant the trees they cut down for housing.

Alli explained, "When my family built and moved into our house in our neighborhood, we were one of eight houses this was about nine years ago, and now there are houses on every lot on every street. Trees all over the neighborhood were cut down in huge groups."

"I used to have a huge backyard full of trees and woods," – Jonathan, who lives next to a shopping mall and its parking lots, told me. – "Now I have a small backyard that backs into a hill separating us from the parking lot."

It's the same story repeated over and over again.

"I have seen so many new neighborhoods and shopping centers go up," – said Sarah.

Caroljane sees that now, "there are less natural spaces. Everywhere you look, there's a building, pavement, planted trees that seem out of place. The few remaining natural spaces are small and filled with litter."

The "booming population" and housing needs go hand-in-hand, according to Paul.

What I found particularly interesting was a set of insightful comments made about the American Dream. "Urban sprawl is a result of America's desire for bigger and better," – Erin said, agreeing with several other students that all the rapid development they have seen can be overwhelming.

Clearly these teenage students have had their antennas up, and are highly aware of the rapid changes going on around them. Although they see it as a problem necessitated by the needs of our society, they realize they have a responsibility to seek solutions that will allow for sustainable growth.

"Everything doesn't need to be new to use it," – says Alison.

So what's the deal? These students have a good start on finding a solution by first acknowledging the challenge. Says Paul: "Urban sprawl is unfortunately not going to cease due to the need for living space for the booming population."

Several students suggested improvements in public transportation as a way to cut down on car pollution, including use of monorails – or even neighborhood electric vehicles! (Now this is a good idea!) Many also

thought that development should simply be stopped. "Our city is big enough, we don't need anything else," – said Sarah.

"The city's expansion needs to be planned out better before destruction and development," – recommended Emily. (Notice how she used "destruction" as opposed to "construction"!)

Lewis suggested that part of the new plan for development should "have commerce be as centered as possible, to get rid of all the strip malls."

"Restoration is extremely important for improving downtown life and also for tourism and for space/land conservation," – says Kate.

Alli proposed "planting trees where they have been cut down for housing," and Ian said people must make "a conscious effort to preserve the ecosystem and the organisms that flourish within it too many people view nature as a thing to be conquered and dominated."

Is it Too Late?

Is it really too late to stop the momentum of urban sprawl? It will be a challenge with the world population rate booming at its current rate, and the future could find us expanding upwards instead of outwards!

So what do you think? What other issues are important to you? What's on your mind?

THE MOST IMPORTANT ORGANISM

On a recent fossil-collecting trip a friend asked: "What do you think is the most important organism on the Earth?" She knew full well I would answer, "Humans!" since we are the masters of our domain and without rival in the animal world (are we good or what?).

She was a bit surprised, and gave me the "Are you nuts?" look, when, without hesitation, I answered, "No doubt about it... hands down the most important organism on this planet is marine algae."

"Algae?!?," – she said.

Phytoplankton is tiny microscopic plants – algae – that form the base of the marine food chain. Phytoplankton is most abundant in colder waters where there is an abundance of nutrients.

"Yes, algae," – I answered. "Do you want an explanation or are you going to take my word on this?" – I asked.

"Let me think about it and I'll get back to you on that one," – she said. As we continued our hunt for shark's teeth, whalebones, and anything else we could find, she finally broke down. "I don't get it. We can change the world in so many ways ...what has algae done? "Very simple," – I said. "Algae allow us and almost every other organism you can think of, living or dead, to be here."

Suddenly, she got that look. "Ah, oxygen, right?"

"Correct!" was my very scientific reply.

Seaweed is not plants, but is algae. Not only do algae provide much of the Earth's oxygen, they also are the bases for almost all-marine life. Green algae get its color from chlorophyll and exist on or near the surface where there is plenty of sunlight. Green algae are not as common in the ocean as brown and red seaweed. It is also more closely related to land plants than any other type of algae.

It is estimated that between 70 % and 80 % of the oxygen in the atmosphere is produced by marine plants. Nearly all marine plants are single celled, photosynthetic algae. That's right. Even marine seaweed is many times colonial algae. They are a bunch of single cells trying to look like a big plant, but they are really individuals.

We need marine algae a whole lot more than they need us. Think about it. About 75 % of all the oxygen we breathe comes from algae! Without them we would really be sucking wind, but not for long! At this point you may be saying, "Yo! What about the trees and other land plants?" Well, trees and other land plants are very important, no doubt about it. But for pure survival, we couldn't make it without algae.

Why does so much of our oxygen come from algae? Well, first of all, remember that the oceans cover about 71 % of this planet and land is only about 29 %. If we assume that every square mile of the ocean produces as much oxygen as every square mile of land, then this makes sense. The oceans would produce about 71 % and the land 29 % of the oxygen we breathe. Looks like we are in the ballpark, don't you think?

Marine algae exist in different concentrations throughout the world's oceans, depending on the amount of nutrients that are available. The colder the surface waters, the more these essential nutrients – like iron – can flourish and support phytoplankton, which are microscopic algae.

Now the question is, "Are the oceans, indeed, as productive as the land?" At first you might not think so, after all when you look at the land there are trees and bushes and grass and all kinds of plants growing. They must crank out oxygen to beat the band! They do, but also remember that there are many places on land that

don't have much in the way of plants. How about Antarctica or the Sahara Desert along with many others? These are pretty good-sized chunks of real estate where plants are few and far between. How much oxygen is being pumped out in these areas? I would venture to say there's not enough to keep a pack of wild hamsters (ever seen wild hamsters?) going for very long. So, some areas on land have an abundance of plants and produce a large quantity of oxygen while others have very few plants and produce very little.

The same can be said for the oceans. There are some areas that have an abundance of algae living in the waters and other areas that don't. In the ocean there are areas of upwelling where cold, nutrient rich bottom water moves toward the surface. These upwelling waters mix with the surface water and produce an area that is like liquid fertilizer for plants. They go ballistic and there are billions of the little critters in the water just pumping out oxygen left and right. Other areas of the oceans don't have much in the way of nutrients in the water and they are like the deserts on land with very few plants.

Not All Are Green: Count Your Algae!

There are three types of algae: red, green and brown. Some algae in the ocean are very small and drift in the ocean water. Those algae are phytoplankton. The most abundant type of algae is brown algae, with over 5,000 species (not all are totally brown). Red algae have over 2,000 species, and live where light is dim, in deeper waters, mostly in temperate and tropical waters. Green algae are more common on land and in fresh water systems, but are the least common in the ocean where about 800 are known to exist.

Overall, the production of oxygen in the oceans is at least equal to the production on land if not a bit more. Plants on land are easy to spot. Plants in the ocean are a bit more difficult to see since they are single cells floating in the water. Even though you may not see them, they are there. Remember, these little cells go down to over 300 feet below the surface so they have lots of room to spread out.

Rainforests are the oldest living ecosystems on the planet. They cover 2 % of the Earth's surface or 6 % of land, and are an important source of oxygen. They also are home to many of the Earth's plant and animal species, but they also play a vital role in sustaining life beyond their ecosystems as they help regulate global climate and water cycle.

Plants on land and in the ocean are extremely important to us and we wouldn't be here without them. Land plants provide us (and other critters) with food, raw materials like wood, and fiber to make cloth and paper. They protect the land from erosion with their roots, provide beauty and shade on a hot day, and produce oxygen as an extra-added bonus although we could probably survive without the oxygen.

Marine plants are also used as food, but we tend to forget about them because they are so small and difficult to see. But remember, the next time you wake up in the morning, stretch and open wide with that big morning yawn, that breath of fresh air you are getting is due for the most part to our friend, the algae. If we kill them by polluting the oceans, we are also killing our vital lifeline.

A Dr. Jack fact: there are more than 7,000 different species of algae. Most live in the oceans, but they also live in fresh water and even on land. ... Also, algae produce about 330 billion tons of oxygen each year.

Earth is the only planet we know that can support life. This is an amazing fact considering that it is made out of the same matter as other planets in our solar system, was formed at the same time and through the same processes as every other planet, and gets its energy from the sun.

To a universal traveler, Earth may seem to be a harmless little planet in the far reaches of one of billions of spiral galaxies in the universe. It has an average size star of average brightness and is joined by eight other planets, which support no known life forms – in its solar system. While this may be fitting for a passage from the "Hitchhikers Guide to the Galaxy", by Douglas Adams, in the grand scheme of the universe, it would be a fairly accurate description.

However, Earth is a planet teeming with vitality and is home to billions of plants and animals that share a common evolutionary track. How and why did we get here? What processes had to take place for this to happen? And where do we go from here? The fact is, no one has been able to come close to knowing exactly what led to the origins of life, and we may never know. After 4.5 billion years of Earth's formation and evolution, the evidence may have been lost. But scientists have made significant progress in understanding what chemical processes may have led to the origins of life.

There are many theories, but most have the same general perspective of how things came to be the way they are. Following is an account of life's beginnings based on some of the leading research and theories related to the subject, and of course, fossil records dating back as far as 3.5 billion years ago.

The solar system was created from gas clouds and dust that remained from the Sun's formation some 6 – 7 billion years ago. This material contained only about 2 % of the solar system's mass with the Sun holding the rest.

Earth began to form over 4.5 billion years ago from the same cloud of gas (mostly hydrogen and helium) and interstellar dust that formed our sun, the rest of the solar system and even our galaxy. In fact, Earth is still

forming and cooling from the galactic implosion that created the other stars and planetary systems in our galaxy, a process that began about 16 billion years ago as the Milky Way began to form.

As our solar system began to come together some 6 – 7 billion years ago, the sun formed within a cloud of dust and gas that continued to shrink upon it by its own gravitational forces. This caused it to undergo the fusion process and give off light, heat and other radiation. During this process, the remaining clouds of gas and dust that surrounded the sun began to form into smaller lumps called planetesimals, which eventually formed into the planets we know today.

500 YEARS PLAN

The goal of work at Earth Sanctuary is to combine ecological science, landscape design, and environmental art. The design process is called the "500 Years Plan" to acknowledge that the ecological communities of the Earth Sanctuary will take hundreds of years to recover from past land use practices and develop into their fullest expression as a diverse and mature ecosystem. Also, the "500 Years Plan" acknowledges the human commitment necessary to preserve, protect, and restore the Earth Sanctuary landscape over the long term. This commitment is being accomplished through the development of land conservation covenants and the design and implementation of a phased landscape and restoration plan.

The details of the "500 Years Plan" are described in an extensive report. This 100-page document presents the Earth Sanctuary's ecological design process in four sections:

- the Earth Sanctuary landscape and land use history;
- the process of delineating and mapping the environmental regulatory landscape, including wetlands, streams, and ponds;
- an overview of the vegetation, wildlife, and fish surveys we have conducted – the scientific basis for the ecological design;
- the landscape and restoration design projects.

In addition, the plan includes extensive appendices detailing high tech survey techniques, wetland, wildlife, and fish studies, and plant lists. The "500 Years Plan" was prepared by wetland and river ecologist Kevin Fetherston. It incorporates contributions on wetlands and vegetation by Scott D. Miller, on wildlife by Kathryn Kelsey, and on fish by Ann Garrett.

It is hoped that the "500 Years Plan" can serve as an inspiration and model for future developers and ecologists. It is a real-life project that holistically integrates the best in ecological study with landscape design, environmental art, and traditional earth energy studies.

INTERNATIONAL FUND FOR ANIVAL WELFARE (IFAW)

The mission of the International Fund for Animal Welfare (IFAW) is to improve the welfare of wild and domestic animals throughout the world by reducing commercial exploitation of animals, protecting wildlife habitats, and assisting animals in distress. They seek to motivate the public to prevent cruelty to animals and to promote animal welfare and conservation policies that advance the well being of both animals and people. IFAW was founded in 1969 to confront the cruel commercial slaughter of harp and hooded seals. Having successfully rallied worldwide condemnation of the hunt, they have grown to become one of the largest international animal welfare organizations in the world. Today IFAW has offices in 12 countries and a staff of more than 200 experienced campaigners, legal and political experts, and internationally acclaimed scientists. They are a pragmatic and dedicated family of professionals who believe that animals suffer far too much from commercial exploitation, habitat destruction, and needless cruelty. And they are joined in that belief by more than 1.8 million supporters.

Much of Africa's habitat and its wildlife are threatened by overpopulation and unsustainable use of natural resources by poor people. Raptors are no exception, over 100 species either breed in Africa or migrate there each winter from Europe and Asia. Conservation of far ranging species like raptors and other migratory birds presents special problems to biologists. How do we protect animals that range so far and need widely dispersed habitats in which to survive? The Peregrine Fund's Pan Africa Program aims to establish projects throughout Africa that train local people to do the studies needed to achieve conservation of birds, of prey and other species. The programme will bring biologists from diverse countries and cultures together in a common effort to protect Africa's natural resources.

BREEDING BIRD SURVEY

Many thanks to Yvonne Palka and Frances Wood who conducted a breeding bird survey for Earth Sanctuary using criteria established by the Audubon Society. Over 50 breeding birds were identified from May to July, including my favorites: Great Horned Owl, Barred Owl and Rufous Hummingbird.

The ponds, particularly the Central pond, are extremely rich habitat for breeding ducks. 10 broods of ducks were observed: Mallard, Hooded Merganser, Wood Duck, Green-winged Teal, and Cinnamon Teal. Yvonne reports: "At the high point of baby ducks in mid to late June there were approximately 35 baby ducks feeding and swimming on the central and west ponds. It looked and felt like a big playground for ducklings with attentive mamas swimming close by!"

BIRD NESTING IMPROVEMENT PROGRAM

Since early 2002, we have steadily been installing a multitude of bird nesting boxes, which are commonly known as birdhouses. We have had a successful breeding season which saw over one third of our nesting boxes put to use by various types of birds.

In January 2004, a Barred Owl nesting box was placed in a large mixed stand of Douglas fir and Western Red Cedar located approximately 150 feet from water. The Barred Owl is a medium-sized gray-brown Owl streaked with white horizontal barring on the chest and vertical barring on the belly. The Barred Owl is a highly vocal Owl giving a loud and resounding set of hoots that is often phrased as "Who, cooks, for you?"

Courtship between the sexes begins in February with breeding occurring between March and August, and breeding pairs mate for life. Eggs typically number between 2 and 4, and are almost perfectly round, with a rough texture similar to sand paper. When the young leave the nest, at about 4 weeks, they are not able to fly, but still manage to crawl out of the nest using their beak and talons to sit on branches. These Owls are called branchers. Rest assured, the folks who placed the nest box had the fledglings in mind, so rest assured there is ample branching area for them to view the world safely.

BIRDS AND WILDLIFE

Within the boundaries of Earth Sanctuary lies a rich and unique habitat that provides refuge for a diverse community of animals. The Earth Sanctuary's three ponds, known locally as the "Newman Ponds," occupy 25 % of the Sanctuary's land. They've been recognized for their importance as waterfowl habitat and designated as a "Habitat of Local Importance" by the Whidbey Audubon Society and the Island County Critical Areas Program.

Earth Sanctuary's "500 Years Plan" assesses the status of the Sanctuary's wildlife communities, offers recommendations for enhancing those communities, and provides data to guide the Sanctuary's restoration and landscape design. The Plan also incorporates detailed species lists of birds and other wildlife.

BIRDS

On any given spring morning at Earth Sanctuary you may see the local pair of nesting osprey and their new fledglings, adolescent and mature bald eagle, a great horned owl, wood ducks, killdeer, tree and violet-green swallows, cinnamon teal and great blue heron, among others. The forested areas of the Earth Sanctuary provide habitat resources for as many as 90 species of birds. Those most likely to be seen are species dependent on freshwater and forest. The aquatic environment of the ponds provides a significant feeding ground for birds. And the pond's protected shorelines, the bog island, as well as the many tree snags (dead and dying trees) provide wonderful nesting locations for birds.

Most of these species are perching birds (known for their singing), woodpeckers, hummingbirds, owls, and hawks. Near the ponds marsh, ground and tree cavity nesting waterfowl can be found

WETLAND ECOLOGY

The Earth Sanctuary property is characterized primarily by pond, mixed conifer forest, and alder forest. Its 72 acres are unique in the south Whidbey Island landscape for their complexity and abundance of aquatic, wet-

land, and forest habitats. The occurrence of three ponds bordered by mixed conifer and deciduous forest creates a combination of wildlife resources that is scarce in this region of western Washington.

In the last 150 years, nearly 90 % of the ponds and wetland systems in Washington State have been degraded and 50 % have been filled or otherwise destroyed. In the Puget Sound basin wetland losses reach nearly 70 % of the estimated wetlands present before settlement. Most remaining wetlands are not forested, found within a matrix of lands developed for agriculture or housing. The integrity of the wildlife community served by these ponds depends on the continued protection of the surrounding forest.

The majority of the Earth Sanctuary property is wetland or within a wetland buffer. The streams and waters that drain through Earth Sanctuary's natural filtering wetlands provide enormous benefits to South Whidbey Island and to Useless Bay, in particular. These benefits include mitigating flooding; maintaining water quality and quantity; recycling nutrients; providing spawning and bird breeding sites, native plant nursery areas, and travel corridors through the landscape; and providing habitat for plants, animals, and microbial life. In fact, there are more animals on Earth Sanctuary than there are humans on our entire planet Earth.

Much of Earth Sanctuary was logged some 20 years ago. To heal the degradation caused by that intrusion, an innovative, ecologically sensitive, and holistically minded restoration guided by a "500 Years Plan", is under way. The Plan, a scientific study of Earth Sanctuary's environment, documents its biosphere in detail from water drainage to bird species. The goal is to gently nurture the 72 acres back to their previous state, preserving, protecting, and restoring the biodiversity of the old growth forest, waterfowl ponds, wetlands, streams and aquatic ecosystems.

Prior to developing the plans for restoration, as well as plans for environmental artworks and adjacent landscaping, extensive mapping was conducted of Earth Sanctuary's wetlands, streams, and ponds and their regulatory buffers – environmentally critical areas regulated under Island County, Washington State, and federal environmental ordinances. The resulting Island County Critical Areas Map has served as a guideline for developing the Earth Sanctuary master plan including location of landscape design elements such as: trail locations, landscape plantings, parking, road access, and environmental artworks.

NATIVE PLANTS

At Earth Sanctuary you'll find forests containing red alder, Douglas fir, and western hemlock trees – as well as grand fir, big leaf maple, Sitka spruce, and western red cedar. Beneath the trees there is a variety of shrubs, ferns, herbs, mosses, liverworts, and lichens. Most of the trees arose after the 1970s, when this plot of land was logged. A goal of Earth Sanctuary is to encourage the forest back to its previous old growth profile, with mature trees, many canopy layers, and snags and downed logs that provide ideal habitat for wildlife.

Earth Sanctuary's Fen is a unique wetland ecosystem containing a bog surrounded by marsh and moat. The raised bog is a great rarity in western Washington. The dwarf shrub community is perhaps the most visually striking plant community of the bog. This community – composed of abundant heaths, sedges, ferns and even a carnivorous plant, the sundew – forms a floating mat of consolidated peat.

FOREST RESTORATION

Historic logging practices have diminished forest plant diversity and structure at Earth Sanctuary. The goal of the Sanctuary's forest restoration is to return it to its natural profile, with a greater presence of conifers and shrub diversity. Toward that goal, the dominance of over story red alder and under story salmonberry is being reduced. This will accelerate growth rate of existing under story conifers. Felled red alder will be left on the forest floor, which will provide cover and insects for wildlife as well as returning nutrients to the soil. Likewise, standing dead trees are being preserved. These "snags" are a major component of wildlife habitat within the forest.

Two non-native plants, Himalayan blackberry and holly, are established at Earth Sanctuary. These opportunistic plants thrive in sites like Earth Sanctuary's where the land has been disturbed by logging. The removal of these very invasive and aggressive plants (Himalayan blackberry canes can grow 21 feet in one year) is an important part of the Sanctuary's work toward vegetation restoration. Cutting them repeatedly to the ground until their viability falters is a very labor-intensive activity. By removing the non-native species space is being created for the reintroduction of rose, thimbleberry and blueberry species native to this area. The reintroduction

of native plants will increase forest under story diversity and provide berries, nesting materials, and cover for birds and mammals.

While blackberry bushes are being cleared, conifers and large numbers of smaller plants are being reintroduced: over 5,000 have been planted so far. Most of them are species native to South Whidbey Island and the Puget Sound lowlands. The landscape planting around the megaliths alone has drawn from 59 native plant species.

PRESERVING OUR FORESTS IS OUR DUTY

Friends of the Forest Preserves are grateful for your editorial supporting the review of the Forest Preserve District of Cook County's land policy. Even though the issue has been delayed another month, we are looking forward to working closely with the district board as they create a policy that applies to today. Without the protections that a new policy and ordinance will provide, our valuable natural lands will continued to be nibbled away at every turn.

Ninety-one years ago, people of my great-grandfather's generation had the foresight to know the time would come when natural lands such as those in our preserves would be in great demand in our county. And people of my grandfather's generation in 1946 and my father's in 1962 understood the need for the preserves and reiterated the need to protect them through land policies set forth then.

Now is the time for us to do the same: to continue to protect these lands for children like my 3-year-old daughter and my 5-year-old son, who do not yet know the implications of decisions that we make today.

Not everybody in Cook County can travel to Yosemite or Yellowstone, or even to Michigan or Wisconsin, to enjoy the great outdoors. But, we can all do it right here in our county preserves – for free. We can hike, bike, canoe, ski, fish, watch birds and even scramble for frogs, right here in our county. The preserves offer the opportunity to see a hawk, deer or wild orchid, not to mention more than 100 of Illinois endangered species, right here in our county.

In addition, the preserves serve a vital role as both the lungs and water storage in our county. They enhance our quality of life through recreational opportunities and by cleansing our air and water – irreplaceable services for the county's 5.3 million residents. And we still don't have enough. Illinois ranks 48 out of 50 states in open space.

Understand that the core mission of the Forest Preserve District is to protect and preserve the natural lands, plants and animals of this county in their natural state for the education, pleasure and recreation of the public.

We as citizens hold these lands in sacred trust for ourselves and generations to come. Please, let's get out and enjoy them. And please, let's work together to protect them.

NATURE IN SHORT

Japan's ancient forests live on. Called Shishigami no Mori after the antlered spirit that resides there, the pristine forest is dark, moist and extremely dense, covering the entire mountainside with billow after billow of rounded crowns. Light penetrates only in occasional narrow shafts that somehow find a path through the tightly packed leaves and branches.

Dark forests are comprised of evergreen broadleaved trees. They once covered nearly half of Japan, from the Ryukyu Islands north through Kyushu, Shikoku and western Honshu. Until about 2000 years ago, they thrived in the lowlands and hills, even well up into the middle stretches of the mountainsides. Further north, and higher up on the mountainsides, they were replaced by airier, more open forests of beech and other deciduous trees.

Botanists and ecologists refer to these forests as subtropical and warm temperate evergreen broadleaved forests. Actually, Japan represents the extreme eastern and northern edge of their distribution, which starts along the eastern slopes of the Himalayas and stretches in a broad swath clear across southern China to Taiwan.

Normally, Japan would be too far north for these warmth-loving forests. Thanks to the ameliorating effects of the warm waters of the Kuroshio Current, however, the extents of the subtropical and warm-temperate zones are pushed well to the north. This makes it possible for the broadleaved evergreens to grow as far up as Ibaraki Prefecture on the Pacific Ocean side and Niigata Prefecture on the Sea of Japan side.

Evergreen broadleaved trees, such as live oaks, chinquapins and laurels, are angiosperms (as opposed to conifers with needle or scale-like leaves) that keep their wide, flat leaves throughout the year. The leaves are

not very big, but instead are incredibly thick and leathery. As a result, they allow almost no light to pass, keeping the forest dark and damp even on a midsummer afternoon.

Like old-growth forests throughout most of the world, Japan's evergreen broadleaves take a long time to develop. Most of the tall trees grow relatively slowly. Botanists estimate a typical forest cycle here, from clearing to climax, as between 150 and 200 years. Once established, however, the trees are long-lived, and a mature forest can last for centuries. It was these forests' long-lived stability that eventually spelled their doom.

Paddy rice culture was introduced into Japan around the third century B.C., and spread rapidly through the subtropical and warm temperate zones. The enormous productivity of the paddies supported a sharp increase in human population. Small villages soon turned into walled towns, which in turn developed into the first cities. This newly developing urban civilization required huge amounts of wood for building materials and fuel.

As the demand for wood grew, the stable but slow-growing evergreen broadleaved old-growth forests were quickly cut down, and replaced by faster-growing secondary woodlands of pine and oak. These secondary forests could be harvested regularly and would soon grow back. The high turnover rate, usually only two or three decades, provided a steady supply of wood.

In the course of only a few centuries most of the old-growth forests were lost. Analysis of fossil pollen shows a sharp increase in pines around 2,000 years ago in the Kansai area, and about 1,500 years ago in the Kanto region. By the time of the Mononoke story (probably around the 15th or 16th century), substantial tracts of old-growth forest were already rare.

Loosely based on a portion of the Mesopotamian legend of Gilgamesh, "Princess Mononoke" relates the saga of one of the last remnants of an old-growth evergreen broadleaved forest. As was the case with Gilgamesh, a growing urban civilization requires the resources of the old growth forest, but is unable to gain access until the guardian deity of the wood has somehow been vanquished. In the Mesopotamian classic, Gilgamesh and his sidekick Enkidu fight with and kill Funbaba, the fierce guardian of a huge cedar forest. In "Princess Mononoke" it is the Shishigami who must be banished so that the forest can be cut down to fuel an iron forge.

Today, old-growth evergreen broadleaved forests are few and far between. To sketch forest scenes for "Princess Mononoke," Miyazaki and the staff of Studio Ghibli traveled all the way to the island of Yakushima, south of Kyushu, where some large sections of pristine forest still remain.

Smaller, miniaturized versions of these forests, however, can still be found in the agricultural countryside, and surprisingly, even in central Tokyo, in the sacred groves surrounding Shinto shrines and Buddhist temples. For centuries the trees of these groves have been protected from cutting. "My Neighbor Totoro," another popular Studio Ghibli anime, features the guardian spirit of just such a sacred grove.

THE ANTI-CANCER DRUG TAXOL: A CASE FOR OR AGAINST CHEMICAL PROSPECTING

Chemical prospecting has developed recently as an argument for preserving biodiversity. The idea is that in biodiversity lie unknown molecules and genes that have potential uses such as drugs for human diseases. The development of the anti-cancer drug taxol from the Pacific Yew tree (Taxus brevifolia) in the United States is discussed as an example of the process of chemical prospecting. By examining the history and current status of taxol, positive and negative aspects of chemical prospecting are considered.

Most people would agree that biodiversity is important and are concerned with its rapid rate of destruction. However, it appears that often it is difficult to justify exactly why biodiversity is so valuable. Why not slash and burn the rainforest for agricultural purposes? What is the value in the biodiversity found in a healthy rainforest ecosystem? One argument that strives to put a value on that diversity is based on the molecular and genetic potential it represents. Specifically, as sources of future drugs and chemicals that have unlimited potential to further mankind. In recent literature, Tom Eisner has given this line of reasoning the name "chemical prospecting".

Chemical prospecting is a multi-step process that begins by screening organisms for molecules or genes for a particular function, often-potential sources of drugs to treat diseases. Once a natural product has been identified as useful, at least some of the source organism is collected for further study. This natural product then has value to pharmaceutical companies because it can be developed into a marketable drug either made directly from the source organism, or by synthetic processes. This monetary windfall from the drugs then leads to money that will be reinvested into conservation of the original benefactor, biodiversity.

While rainforests are often the focus of biodiversity discussions, a superb illustration of the process of chemical prospecting is on going in the United States. The story involves a tree of little appreciation and the powerful anti-cancer agent found in its bark. The tree is the Pacific Yew (Taxus brevifolia) and the drug is a diterpenoid named taxol. The discovery and development of taxol for the treatment of cancer warrants is in depth look, not only for illustrating how chemical prospecting works, but also how it doesn't work.

DISCOVERY OF TAXOL

Taxol was discovered through a prospecting venture begun in the 1960s by the National Cancer Institute (NCI) in cooperation with the US Department of Agriculture. These agencies began screening plant tissues in North America for anti-tumor activity in the hope of discovering new treatments for cancer. In 1962, tissues from the Pacific yew tree were collected by USDA workers and sent in for analysis. The initial screening showed extracts from the yew to have cytotoxicity activity against human cancer cells. This success caught the attention of the NCI and the yew extracts were targeted for more intensive research at one of the NCI's research institutions.

A research team led by Dr. Wani at the Research Triangle Institute received the yew assignment and began to isolate the active compound. This process was begun by water-chloroform fractionation of bark extracts directed by bioassay results.

The primary bioassay used to detect activity in the fractions was a test against leukemia cells. Once the compound in the active fraction had been isolated, Dr. Wani's team began to determine the structure of the compound. Mass spectrometry showed the molecular weight of the compound to be 853. X-ray analysis was then used to determine the structure of the molecule. However, this was not possible on the entire molecule, and it had to be cleaved by base catalyzed methanolysis into subunits that could be identified with x-rays. The final structure was completed with alkaline oxidation with MnO_2 to define the structure of the molecule named Taxol. In 1971, Wani et al. published their results on taxol as the first molecule at that time with a taxane ring to have anti-cancer activity.

Despite this achievement, NCI then lowered the priority in continuing research on taxol. The compound was difficult to obtain because it is present in relatively low concentrations in the bark of the Yew tree, (.5 g for 12 kg of bark) and the anti-leukemia activity was not considered dramatic enough to warrant continued research. Taxol research then remained stalled until 1977. Around this time it was realized that the leukemia bioassay used to asses taxol's effectiveness was relevant towards human leukemia, but was not a good test for activity against solid tumors. Another bioassay that had also been used by Wani's group on melanoma cells (solid tumors) had much more dramatic positive results and this stimulated interest in taxol again and led to its development.

The research on taxol then proceeded on two fronts, one to determine how taxol worked and the other to determine its effectiveness in cancer patients. By the late 1970s, the mechanism of taxol was known to be enhancement of microtubule polymerization such that the dividing cells were stalled in the G-2 phase and do not depolymerize. Clinical trials then proceeded through the 1980s on various forms of cancer. Specifically, taxol has proven to be effective against ovarian, breast, lung, head and neck, and esophageal cancers. The use of taxol has been approved by the Food and Drug administration for use in treatment of two of these cancers, ovarian and breast.

Due to the success in clinical trials, the NCI offered the right to develop the drug competitively to drug companies. In 1991, the company Bristol-Meyers Squibb (BMS) won this right. Since the source for taxol was the Pacific Yew tree, BMS and the NCI entered into an alliance with the US Forest Service and the Bureau of Land Management, the two agencies who had access and control of the yew tree supply on public lands. The initial step in this process was to determine the supply of yew bark in the US. Even though the yew tree ranges along the west coast of North America from British Columbia to California with inland populations in Idaho and Montana, relatively little was known about its abundance. T. Brevifolia had previously been considered unimportant economically and therefore no money had been invested by government agencies to record any information on the tree.

The obvious economic potential of a cancer treatment then stimulated research on the Pacific yew. An Environmental Impact Statement prepared by the US Forest Service identified several roles of the yew in its environment. Specifically, habitat for the spotted owl, winter food for large herbivores and microhabitat for invertebrates were identified. It is not surprising that the yew tree is important to many different aspects of the environment, as most organisms are tightly intertwined within their respective ecosystems.

Harvest of the Pacific Yew may have proceeded unabated, despite its role in the forest ecosystem, if not for one problem. The concentration of taxol in the bark of the tree is extremely low. A 100-year-old tree might

yield 3 kg of bark, which provides enough taxol for one 300 mg dose. By 1991, harvest of bark was up to around 425,000 kg, at 3 kg a tree that is over 100,000 trees that year. The public became justly concerned at such harvest since bark cannot be harvested without killing the tree. This concern in part stimulated the passage of the 1992 Yew Act, which stated that there should be a "sustainable harvest" that provided for the long-term viability of the yew tree but still provided enough taxol for Bristol-Meyers Squibb.

Such determinations are difficult to make, what BMS requires for its research may overlap significantly with what may be considered a "sustainable harvest". Furthermore, it is interesting that the Environmental Impact Statement was not completed until 1993, a year after the Yew Act was passed. This casts doubt on how "sustainable harvest" was defined when the basic ecology of the tree had not yet been determined. In addition, as the figures from 1991 harvest indicate, significant amounts of bark were being harvested without any knowledge as to how that might impact the environment. The policy of taxol collection appeared to be driven immediately, but demand and environmental concerns were an afterthought. This clearly demonstrates one difficulty with natural products prospecting, in that the enthusiasm for a new treatment can preclude any consideration of the effects of collection. The very biodiversity that was defended to provide the drug initially was degraded. For example, along with the yew trees may have gone an equally important invertebrate that depended on the yew tree's habitat, with unknown medicinal properties in its own right.

SOLUTIONS TO THE SUPPLY PROBLEM: ALTERNATIVE SOURCES OF TAXOL

In defense of the prospectors developing taxol, it was readily apparent to them that long-term use of taxol was going to require an alternate, probably synthetic, source of the drug. Unfortunately, the complex structure of this molecule does not lend itself to simple or rapid synthesis. Only recently (1994), has the total synthesis of taxol been reported. Although this synthesis was a formidable achievement, reviews by other workers do not support this as a practical or economical way to dramatically increase the supply of taxol.

One way to circumvent this problem is with a semi-synthesis starting with a more readily available precursor. This is currently being investigated with the precursor's baccatin III and 10-deacety baccatin III that are isolated from the needles. These compounds can be found in several Taxus spp., which alleviates some of the pressure on T. brevifolia. However, taxanes isolated from the needles degrade more rapidly than taxol from the bark, which can be stored for longer periods of time due to its increased stability.

Yet another possible solution to the supply problem is developing plant cell cultures to produce taxol. Progress in this area has not been rapid because taxol is difficult to generate in this way. A primary difficulty is the relatively slow growth of plant cells, but research continues to overcome this. Apparently, this line of research may be more advanced than is widely known because it is believed that corporate developments may be withheld until success is achieved.

One unique potential supply of taxol has arisen through work of Gary Strobel and his lab. They have identified entophytic fungi of the yew tree, Taxomyces andreanae that produces taxol when grown in culture. Similar to the other synthetic methods, the production by the fungi at this time does not represent a rapid or significantly large supply of taxol. As with the others, time and continued research may correct this.

Implied, if not directly stated, in the reasoning for chemical prospecting is the idea that diverse organisms are needed only for the initial suggestion for a drug.

After discovery, mass production of the drug can be accomplished artificially to reduce the burden on the environment. The difficulty in doing so with taxol demonstrates the flaw in this assumption. Furthermore, there is no reason to expect that taxol is the exception and not the rule. Cragg and Snader from NCI summarized the taxol supply problem in 1991, and stated that it should not be assumed that large scale production of natural products is possible since these molecules tend to be complex and challenging to synthesize in part due to a high degree of chirality.

In addition, each new synthetic version of a drug must undergo its own approval from the FDA, which can take 1 – 2 years. Such delays mean that in the meanwhile, the natural source of a drug must continue to be tapped. They also note in 30 years no synthetic source has been developed for the anti-cancer drugs vinblastine and vincristine, which are still harvested from their original plant source. Thus far, taxol in not much different, it has been 25 years since the discovery of taxol and no large scale, synthetic method has been developed.

CONSIDERATIONS OF "CHEMICAL PROSPECTING"

Research on the drug, for its function, effectiveness and synthesis continues and the promising results against solid tumor cells appear to ensure continued interest in developing the drug. Not having a large supply for the general public certainly does not mean chemical prospecting has failed, it is merely stalled. Therefore, does the development of taxol indicate a success such that future prospecting should go on? Or does it show potential pitfalls in the argument for preserving biodiversity for future prospecting?

Potential trouble spots have already been mentioned in the review of taxol. For example, the immediate exploitation of the source organism before any impact of collection has been assessed. Also, that it cannot be assumed that all natural products lend themselves efficiently to synthetic techniques. While these and other practical matters are of concern, scrutiny of chemical prospecting on a philosophical level raises other issues.

A recurring theme in Eisner's papers is the value in biodiversity because of these potential cures and treatments for human disease. Eisner does acknowledge that species have worth other than chemical potential, but he does not expand on these. This implies that other measures of value are not sufficient to defend biodiversity. Therefore, the assumption within this argument is that intrinsically, biodiversity has no value. This is demonstrated with taxol explicitly. The yew tree was considered so unimportant that it was ignored in surveys done by the US Forest Service and the Bureau of Land Management over the last century. When taxol became important the agencies had no idea even how many trees there were.

Furthermore, when timber was clear-cut, the policy was to burn yew trees along with other scraps and waste. This changed when taxol was discovered and the yew tree now had value, economically and medically. Logging practices shifted from wasting yews as trash to developing management techniques for "sustainable yield". So it seems chemical prospecting saved the yew tree and some of the biodiversity associated with it. However, it may also be said that chemical prospecting furthers the attitude that the destruction of a species is wrong only if it has some economic value or potential. So biodiversity is still left with no inherent value, and therefore is still difficult to defend.

Somewhere along the way Western culture placed humans well above all other animals and consequently above all other organisms. This disregard for "lower" organisms makes it difficult to use and not abuse biodiversity.

A critical response to chemical prospecting by Downes and Wold noted this tendency of "industrial societies" to destroy biodiversity through its use, unlike indigenous peoples who use biodiversity within its boundaries. Steven J. Gould expresses this phenomenon as a "picket fence around Homo sapiens" that rests on the beliefs that "humans have not only transcended the ordinary forces of nature, but all that came before was a preparation for out eventual appearance". It is a philosophy deeply entrenched in policy, especially in conservation issues. It is this elevation that enables people to assume they have the intelligence and capability to "manage" biodiversity. The environmental impact statement drawn up for the Pacific Yew tree carried an implicit assumption that there was one set of the right guidelines that would enable a "sustainable yield" such that all parties would be satisfied and the forest would be in ecological balance.

It may be argued that the goal of sustainable yield is not to be perfect, but to do the least damage. If so, then the idea of chemical prospecting as an argument for preservation is flawed. If it is not possible to avoid altering an ecosystem to collect a newly discovered drug then how is the biodiversity of the system to be maintained? It would seem the purpose of chemical prospecting to preserve biodiversity until something useful is found. The further loss of biodiversity in the harvest of the useful organism is secondary.

Another flaw with using prospecting to defend biodiversity is that it is short sighted in its vision. The main loss of biodiversity is through loss of habitat for an expanding human population and its perceived needs. Eisner even recognizes this when he writes, "human expansionist demands can be expected to wreak environmental deterioration and biotic destruction well into the next century". For example, ovarian cancer, against which taxol is particularly effective, is the fourth highest cause of death in American women. Eliminating this could contribute further to an ever-expanding human population. Stepping back a bit, suppose large areas of northwestern forests were set aside as reserves of biodiversity due to the example set by taxol. The new drugs developed from these reserves might lower mortality rates and thus the population would increase. Where this increased population is going to live? With what resources are they going to sustain themselves? From what forests are they going to get wood to build houses?

The problem with maintaining biodiversity is largely habitat destruction from expanding human populations. Developing drugs to further this expansion means in the distant future biodiversity will be harder to defend due to prospecting, not easier.

Despite this, preservation of biodiversity is not hopeless. Clearly, for the short term, the potential of biodiversity for life-saving drugs is appealing and may stall current destruction of areas like the Amazon rainforest. Legislation may also provide temporary fixes, but later generations can always rewrite laws when they really

need all the timber in previously designated wilderness areas. Chemical prospecting needs to be considered for the long term and in a global context. Plans need to be made for harvesting source organisms to maintain biodiversity and for the ultimate implications of those products on global population growth. Furthermore, there must be a realization that biodiversity has intrinsic value that is not measured solely in immediate human benefits. Only this kind of fundamental shift in how biodiversity is valued will provide lasting protection far into the future.

THE ROLE OF PLANTS IN ATTRACTING PREDATORS AND PARASITOIDS TO CONTROL HERBIVORE FEEDING

Plants may take an active part in defending themselves from severe herbivore damage by attracting carnivorous arthropods. Studies have shown that plants damaged by herbivore feeding produce chemical cues, which signal natural enemies on where to find prey. Volatile chemical compounds emitted from plant tissue most likely originated to repel the attacking pest, but also serve a secondary function, attractants to parasitoids and predators in search of prey. Plant phytochemical responses are most likely induced by the interaction of substances from the herbivore with plant tissue. These volatiles, primarily determined to be terpenoids, differ from those emitted in response to mechanical damage. Several studies have been conducted on these compounds, termed exogenous herbivore elicitors of plant responses, including work with spider mites and different lepodopterous caterpillars. These chemicals are specific volatiles, which affect predator foraging behavior in a range of behavioral responses. The ability of the natural enemy to recognize chemical cues and identify its source of origin determines its effectiveness as a predator. Qualitative differences occur between the odors emitted by different plant species, which the predator can distinguish from each other as well as from background odors. In addition, predators show some ability to learn and distinguish between odors not only from different herbivore species but also between different plant species. Studies have examined these interactions in a variety of systems. Lima bean plants infested with the mite Tetranychus urticae produce terpenoids and methyl salicylate, which attract the predator mite Phytoseiulus persimilis. Substances found in caterpillar regurgitant are necessary for the plant to begin manufacturing and releasing indole, terpenes and sesquiterpenes, which attract the parasitoid Cotesia marginiventris. Investigation of exogenous elicitors continues in order to enhance biological control capabilities by manipulating attraction mechanisms of predators and parasitoids.

Plant defense against herbivores has traditionally been studied in a bitrophic context that is to say in a predator-prey or predator-plant context. But with further research, it has become more evident that the plant can directly influence predator-prey populations on itself. Studies indicate that a plant signals for the influx of natural enemies to eliminate herbivores from feeding on it. When the plant is considered in this intercommunication, then defenses can be studied in a tritrophic context: plant-herbivore-carnivorous arthropod. This acknowledges that there is a signaling interaction between the plant and the insect.

A plant's means of defense has traditionally been viewed and studied as a "direct defense". This comprises a plants production of toxic and repellent chemical compounds to directly dissuade insects from feeding on tissues within a tritrophic framework, plant defense can be viewed as "indirect defense"; the plant may be involved in the control of carnivorous arthropods by attracting their natural enemies.

There remains some question as to what exactly the evolutionary development of these chemical signals has been. Did the plant evolve so as to release volatiles in order to attract the natural enemies of the pest? Or are the insect carnivores eavesdropping on a chemical plant defense system aimed at the attacking pest. It is thought that the plant does undergo physiological changes, which increase the level of toxins expressed in the tissues, thus making the plant unpalatable for further herbivore damage. As seen in corn and cotton plants, herb ivory over time causes the plants to become less palatable to the feeding larvae, corresponding to the increase in production of herbivore induced volatiles.

Studies have shown that foraging behavior of carnivorous arthropods relies on a variety of stimuli to locate hosts. Chemical cues play a major role in information gathering; they may come from the herbivore, from the plant, or from the interaction of the herbivore and the plant. Whichever it may be, it is essential that the carnivore be able to detect these chemicals cues and identify them. The most reliable cues come from chemicals emitted from the herbivore itself. These most directly and clearly inform a carnivore of a suitable prey's presence. But these are difficult to detect long distances away. Plant derived cues are thought to be more detectable, even at longer distances. So if a carnivore is to be successful at foraging, it needs to maximize its ability to recognize foraging cues so it can survive and ultimately reproduce. The process of natural selection then has chosen for those carnivores that can readily detect reliable foraging cues.

Fortunately for the plant, the most reliable long-range foraging cures for predators/parasitoids are the herbivore induced plant volatiles. This form of intercommunication allows for the continued survival of each species – the plant rids itself of damaging pests and the insect carnivore finds food.

SIGNALING

In order for a plant to effectively defend itself against damage done by herbivore infestations, it has to formulate chemical cues that can be heard, understood and acted upon by the natural enemy of the herbivore. These three criteria are the basis for plant chemical defense by attraction of predators and parasitoids and have been witnessed in numerous plant-insect interactions. The plant summons for help by producing volatiles that a predator can separate and distinguish from the bouquet of background odors that exists in an insect's world at all times. Signaling has to be specific enough to target an insect carnivore as well as foretell of available and suitable prey. This communication involves specialized cues that can vary depending on the plant-insect combination. It also entails that these signals be emitted at a time when the insect carnivore is actively seeking prey.

CLARITY OF SIGNAL

Chemical signaling by the plant is going to influence how successful a parasitoid is in locating and recognizing potential hosts, and consequently how effective a plant is in defending itself. Therefore, it is necessary for these signals to be identifiable and distinct enough for the parasitoid to separate from other odors. Parasitoids respond to odors directly linked to the host, reliably indicating their presence, identity, and suitability. The parasitoid may rely on chemical cues emitted by the host itself (leavesdropping on pheromone signals from the host), on the products the host produces (larvae or feces), or on the damaged plant on which the host is feeding. Of these three factors, the volatiles emitted from the damaged plant are the most attractive to the parasitoid. As an example, the female parasitoid, Cotesia marginiventris, was not attracted to odors from beet armyworm larvae, Spodoptera exigua, themselves, but to the volatiles emitted from the damaged corn plant upon which they fed. Overtime, fed on corn plants produced chemical compounds, terpenoids and indole, which attracts the parasitoid. The length of time the plant is fed on determines the type of chemicals produced by the plant, and thus how attractive it may be to Cotesia. Chemicals emitted within one hour of feeding tended to be lipoxygenase-derived volatiles (green leaf volatiles) fatty acid derivatives such as C_6 aldehydes and alcohols while chemicals emitted after 6 hours of feeding were terpenoids. The odor of a plant can be made up of hundreds of chemicals, which can be either very unique to a plant or common among them. For the parasitoid, green leaf volatiles are harder to separate from background odors.

These odors are also more difficult to trace the origin of remittance, and generally not too attractive to parasitoids. Interestingly, artificially damaged tissues release green leaf volatiles, not terpenoids, thus avoiding sending out false alarms to parasitoids. Artificially damaged plants can be induced to emit volatiles if caterpillar regurgitate is added to the wounded site. A substance in the spit interacts with plant tissue to cause the wounded plant to begin manufacturing and broadcasting terpenoids.

Other means the plant utilizes to ensure its distress signal is clear to parasitoids is to release the volatiles systemically. All leaves, whether suffering from direct feeding damage or not emit parasitoid-attracting terpenoids. The plant, in effect, makes itself stand out like a beacon in a wealth of odors so that it can be found by the parasitoid. This systemic effect can be demonstrated by placing cut seedlings into diluted caterpillar regurgitate; after a number of hours there is a significant increase in terpenoids emissions from all the leaves of the seedling.

A plant can also ensure the strength and clarity of a signal by manipulating the amount of volatile released. One herbivore damaged corn plant will emit several micrograms of compounds per hour. A considerable amount when compared to pheromone communication, which only produces a few nanograms per hour.

Studies on spider mite and predatory mite interactions have confirmed the emission of herbivore-induced terpenoids to prevent detrimental infestations by effectively attracting predators to control populations.

Lima bean plants were found to produce a volatile, which was attractive to predatory phytoseid mites, Phytoseiulus persimilis, when the plant was under attack, by the two-spotted spider mite, Tetranychus urticae. Similarities between the corn and lima bean plants are prevalent, even though the systems appear to be quite different: monocot vs. dicot host plants, arachnids vs. insect herbivores, and an arachnid predator vs. a parasitoid. However, spider mite infested lima bean plants have been actively defending themselves against attack in similar ways. Lima bean plants also produce terpenoids as well as the phenolic methyl salicylate. The strength of the signal is heightened by releasing them systemically; volatiles are transported out of infested leaves into

uninfested parts of the plant. These volatiles are not emitted with mechanical (artificial) damage either, indicating the herbivore-plant interaction.

The clarity of the signal emitted by the lima bean plants was demonstrated by placing petioles from infested leaves into water, removing them and then replacing them with the petioles of uninfested control leaves. In an olfactometer 83 % of the predatory mites preferred those leaves, which had been placed in previously infested leaf water to control leaves, which had never been infested. Overall, 82 % of the mites preferred infested leaves to uninfested control leaves.

Clearly, the signal the plant is emitting is not to be mistaken by P. persimilis and it utilizes these chemicals to search for prey. This indicates that there is a water soluble systemic volatile produced by the plant which was transferred through the water into leaves that had never been directly infested with mites. In addition, mites given a choice between water in which the petioles of infested and uninfested leaves had been placed showed no preference, indicating the attractants are not contained in the water itself.

Plants seem to be successful in ensuring that chemical cues are discernible to predators and parasitoids. Terpenoids were probably originally produced as a direct defense against the herbivores themselves, but served a secondary function of signaling and attracting carnivorous arthropods. In turn, these volatiles have been exploited by predators and parasitoids to locate prey and hosts.

Over time, the selection process and adaptation has refined the signaling capabilities of these chemicals in plants, which has resulted in the present day form of chemical communication between plant and insect. Because terpenoids are produced only upon herbivore damage, not from artificial damage, the plant signals to the parasitoid that hosts are present. Whereas with mechanical damage only, green leaf volatiles are not discernible from background odors and provide no communication for the parasitoid. As these cues are emitted systemically and expressed throughout the entire plant, the strength of the chemical signal is intensified. Add to this a large quantity of the volatile produced, and the reliability of the signal is ensured. These chemical cues need now only to be interpreted by C. marginiventris or by P. persimilis; they need to indicate that there is suitable hosts or prey for them.

SPECIFICITY OF SIGNAL

It has been determined that insect carnivores can differentiate between chemical cues emitted by uninfested plants, mechanically damaged plants, and plants infested by a specific herbivore species. It is thought that predators and parasitoids are led to their prey by general stimuli and then learn more specific stimuli to assist them in narrowing down the options.

Herbivore induced volatiles provide these specific cues for the carnivorous arthropods to follow. However, this evolves into quite the formidable task when the hosts may feed on a number of different plant species. In agricultural settings, this may not present that great of challenge as cropping tends to consist of monocultures. Still, the carnivore has developed the ability to differentiate chemical signals in a sea of possibilities. This ability could be attributed to different concentrations of chemical cues, which cause different behavioral actions in the hunter. This preferential searching may also be influenced by the plant species or the quality of volatile emitted which is determined by the growth stage and cultural conditions of the plant, the part of the plant is being attacked, and the species of herbivore is doing the attacking.

Specialist parasitoids such as Microplitis croceipes whose hosts feed on a range of different plant species have shown the ability to differentiate between different types of damage on different plant species. Cotton, cowpea and soybean each produce a particular blend of chemicals when fed on by the same herbivore, corn ear earworm caterpillars. Volatiles may also differ depending on which part of the plant is being damaged: flower volatiles differ from chemicals of damaged leaves. C. marginiventris, which as a generalist feeds on different species of moth larvae for example, has to be able to recognize two different volatiles produced from the same plant, one emitted from the fall armyworm and one emitted from the beet armyworm. Predatory mites have also been shown to discriminate between different blends of signals emitted from varying spider mite species and plant combinations.

Because of the large variability in chemical cues, it serves the insect carnivore well to be able to learn different volatile mixtures. Studies with M. croceipes revealed that the more experience wasps gained the better able they were to discriminate between odors. Wasps were able to learn odors and associate them with specific populations of hosts. With one experience, wasps were unable to differentiate between known and unknown odors and would fly to a known odor just as often as to an unknown odor. But, after three experiences, the wasps would choose the known odor. They were able to discriminate between the odors and chose the odor where they had previously been successful in finding hosts. However, some research has shown that wasps have difficulty in determining host damaged plants form non-host damaged plants. Specialist parasitoids have

been shown to learn different odors emitted from different caterpillars feeding on the same plant variety. C. Marginiventris was able to distinguish between volatiles emitted from S. exigua and S. frugiperda feeding on corn.

SIGNALING THE FORAGER

As has been demonstrated predators rely on a large amount of chemical information in order to be effective at foraging. Larvae had evolved so at to be quite inconspicuous and difficult for insect predators or parasitoids to detect; they are difficult to detect with visual stimuli and they do not emit chemical signals. However, the larvae need to feed and it is at this point where they inadvertently give themselves away. Exploitation of insect herbivore-induced chemicals provides the basis of information for predators and parasitoids. In this case, it is essential that the plant respond with its distress call at a time when the predator or parasitoid is available to receive the signal. Recent studies indicate that there may be some variability in the rate of emission of volatiles over the course of the day. Peak emissions were found to occur during the photo phase, which also is the time of carnivore foraging. Additional studies have shown fluctuating emission of volatiles during different growth stages of the plant, as well as with different parts of the plant.

Corn seedlings respond to herbivore damage by a delayed release of terpenes and sesquiterpenes. Terpenoids are probably stored in glands in the leaves and are ruptured upon feeding. Release of these compounds stops as damage stops, i.e. when the caterpillar no longer chews on them. However if the caterpillar is not removed the emission slowly wanes over time as quantities lessen and caterpillars feed less. The release of these terpenoids begins only after several hours of being fed on. Terpenoid emissions seem to be strongest during daytime hours and when caterpillar regurgitates were placed on damaged tissue, terpenoid emission was detectable three days later.

Plants do respond readily to damage and with enough alacrity to signal for predators or parasitoids. In addition to releasing volatiles systemically, the volatiles are released during the day when carnivores tend to forage. There is still some question as to whether these emissions are released at that time because that plant has adapted to predators searching hours or if the predators search during the photoperiod because that is when the majority of chemical cues are available.

PROSPECTS FOR APPLICATION

With the knowledge of how these communication systems operate, they can be manipulated by man to maximize performance of biological control measures in agriculture. If the mechanisms of what attracts and retains a predator or parasitoid to a field are understood, they can be developed and enhanced to optimize control possibilities. The insect carnivore can be retained in the field after mass is released and the efficiency of search and attack is maximized.

Exogenous elicitors may be developed synthetically, applied to a crop and utilized to increase the time of searching by the natural enemies. Plant breeding may produce crops that are able to produce more volatiles making them even more effective in attracting natural enemies. The application possibilities from herbivore induced volatiles research will prove to be as intriguing as the research itself.

TECHNOLOGY, SYSTEMS AND SALIENTS

Students of technology sometimes speak of "salients" and "reverse salients." The idea is that technological evolution is an advancing front, like a wave on a beach. Some parts of the wave run ahead, but eventually are held back by others (the "reverse salients").

This systematic model can be applied to specific technologies, such as bicycles or telephones. It can also be applied broadly to suites of technologies such as those that, taken together, constitute the Industrial Revolution.

This idea of technology, technological evolution, and industrialized cultures is different from the usual linear approach. We tend to think of technology as artifacts – a car, a computer – or perhaps as techniques. The "salient" approach sees technology as an integrated system: an expression in a time and place of a complex set of artifacts, production and consumption methods, material and energy systems, mental models, cultural constructs, institutions, and even ideologies.

The Industrial Revolution, for example, was not just the spinning jenny (invented by James Hargraves around 1765). Rather, it involved new technologies across the system required to turn raw cotton into printed

cloth: cleaning, carding, preparation of roving, spinning, weaving, bleaching, printing, and marketing and transporting cloth.

At different times, the technology of a particular activity might lag, creating a "reverse salient" – usually overcome by the strong economic pressures caused by progress in the coupled technologies. Today's example might be the coupled evolution of computer software, hardware, and networks.

Technological evolution is not easily bounded. For example, the evolution in the textile sector could not have occurred without, and was a causal factor in, the breakdown of the older production model of home-based work, replaced first by small shops, then large factories. It was also a factor in generating demand for new materials and energy sources, so factories could be sited without regard for waterpower – and thus was coupled to the industrialization of iron production and the shift from wood to coal. Among the results were the demographic shifts from rural to urban work patterns, the rise of new institutions, and the globalization of Eurocentric culture.

What does this have to do with environmentalism? To return to our example, it is interesting that the jenny's introduction caused civil disobedience – riots, in this case, rather than destroying crops, but the parallels with biotech are at least suggestive. Similar patterns may be emerging with nanotechnology, a technology system that has yet to be really defined, much less commercialized, but that has already been attacked by environmentalists, and with aquaculture, and an emerging technology that has been dismissed as unsustainable by deep greens. History and the "salients" analysis, however, suggest that such absolute opposition to specific technologies is both tactically and strategically unwise.

> Tactically, because absolutist opposition to specific technologies, while emotionally satisfying, overlooks the coupled nature of technological systems, bound not just to other technologies, but to economics, culture, and ideology. These technologies arise not in a vacuum, but as a part of an evolving pattern (in our case, an intensive focus of technology, economics, and culture on information structures), and opposition to a particular salient is unlikely to succeed. It may well preclude rational and desirable shifts in the way a technology evolves.

Strategically, because the world as it is now, and as it must be to support six billion-plus people, is technological. At its highest level, the system is heavily coupled, and even major cultural and technological trends are themselves salients. Trying to pick and chose technologies profoundly misunderstands the nature of technological and cultural evolution.

This does not mean principled, ethical action is not feasible. But it does mean that, absent of more sophisticated sense of the evolutionary patterns and drivers of these systems, any effect is likely to be minimal. Not raw emotion, but rather a full understanding of the processes underlying technological evolution, is a key to living responsibly and rationally on an anthropogenic Earth – our true challenge.

A BLAST FROM THE TASMAN SEA

Met Service meteorologists have issued heavy rain warnings for many areas. This is in addition to the heavy rain warning already in force for the Mt Cook area.

For Westland and Buller rain is expected to reach a peak tonight. The heaviest rain is then forecast to cross western and northern parts of the North Island during Wednesday and reach Bay of Plenty Ranges by Wednesday night. A severe weather watch has also been issued for central Canterbury and the eastern Otago hills.

"There is a large complex area of low pressure covering the Tasman Sea", – commented Met Service Weather Ambassador, Bob McDavitt. – "One of the low centers in this complex is rapidly deepening as it moves southwards from near New Caledonia. This low is forecast to arrive in the area west of the South Island on Wednesday. The frontal band associated with this low is being blocked over New Zealand by a large high-pressure system to the east. This directs the wind and rain patterns mainly onto places open to the north or northeast."

Wind and rain from this low should clear New Zealand on Thursday. Another low-pressure system is being forecast to cross the North Island on Friday bringing some more rain but not as much wind. This situation is still evolving and regional details are likely to change.

RECENT DEVELOPMENTS IN PLANT-DERIVED COMPOUNDS FOR PEST MANAGEMENT

Although the use of plant species to control insect pests has been in practice for centuries to a limited extent, it has been only recently that interest has renewed in the pest management potential of natural products. These products are the compounds that have evolved in plants for defense against phytophagous insects.

Interestingly, a quite convincing case has been proposed suggesting that these secondary plant products have actually co-jevolved with insects that would potentially exploit them as a food resource. One can imagine the plant kingdom striving to slow down the attack of the herbivores over evolutionary time by formulating novel compound after novel compound and tirelessly conducting bioassays in order to find out what works and what does not. The herbivores in return develop new strategies over evolutionary time to break down some of these chemical defenses to exploit the plants if they can. It is because of this never ending back and forth struggle that this vast number of chemical compounds have evolved in the plant kingdom. The modern researcher now has the technology to exploit the toxic properties of some of these compounds and use them against organisms that were never originally intended. Namely, the pests of modern man.

One group of compounds that has demonstrated significant toxic effects on some pests of modern man has been discovered in the neem tree (Azadiricta indica).

The most active constituent, azadiractin (AZA), a triterpenoid, has been shown to have properties including feeding and ovipositional deterrence, repellency, growth disruption, reduced fitness, and sterility in a number of species of hemimetabolous and holometabolous insects. Research has been focused on controlling agricultural pests as well as medically important arthropods with products derived from neem.

Perhaps the most medically important arthropod worldwide is the mosquito, which transmits diseases such as the malarias, dengue, and yellow fever to name but a few.

Because mosquitoes and many other insects have become resistant to pesticides, heavy and frequent applications are required leading to problems of toxic residues contaminating the environment and adversely affecting non-target organisms. This dictates the need to develop safe, less expensive, and preferably locally available materials for pest control. In this vain, NeemAzal, a product derived from the neem seed kernel, was evaluated as a potential means of control for Aedes aegypti. Boschitz and Grunewald used the larval stage of the mosquito to measure mortality rates depending on concentration and then looked at the effects of sub-lethal doses on the fecundity of the surviving larvae. They hypothesized that if sterility could be proven, then the advantage of sub-lethal doses would be the obvious reduction of risk of damage to non-target flora and fauna. Other control projects that have been conducted with neem tree products have also targeted other medically important mosquito vectors such as Anopholes stephensi, Culex quinqefasciatus, Culex pipiens, Aedes togoi and Aedes aegypti. These studies reported strong variations in susceptibility of a muito species towards neem tree products.

Neem and its products have also been the focus of agricultural pest control research as well. Dimetry et al. (1995) have been working with neem azal-F to inhibit the growth and reproduction in the cowpea aphid (Aphis craccivora). This particular product contains 5 % azadiractin and produced an antifeedent effect, which hindered larviposition of the adults and decreased the reproductive period as well as the longevity of the adults.

In addition they were able to show an aphicidal effect as the concentration increased. In another application, Naumann and Isman (1995) used three concentrations of an oil-free neem seed extract to deter oviposition in noctuid moths. They found that most commercial neem-based products are not effective noctuid oviposition deterrents. Their studies suggest that the results demonstrated in other research using neem-based deterrents were effective because the compounds were removed by a higher level of processing and thus not found in commercial products. Another approach using neem products has involved integrating neem with endomychorrhiza to control root knot nematodes on tomato plants. In this effort researchers planted mychorrizal seedlings of tomato into soil that was treated with neem cake. Vesicular arbuscular mycorrhizal fungi (VAM) have been established as a reducer of nematode parasites of many plant species. By combining neem cake in the soil with the VAM the investigators sought to elevate the level of protection for the seedlings. Yet another application for this product has been tested by a group of researchers in Winnipeg, Canada on three stored-product beetles. The beetles in question – the rusty grain beetle (Cryptolestes ferrugineus) (Stephens), the red flour beetle (Tribolium casteneum) (L.), and the rice weevil (Sitophilus oryzae were exposed in the laboratory to several extracts of neem. In this case the researchers were looking for repellency effects as well as toxic effects. The variance in susceptibility between the species was expected as several investigators working with mosquitoes observed similar phenomena.

Neem is not the only plant-derived chemical that has demonstrated arthropocidal and toxic effects however. Several species of Juniper have also been studied and the active constituents isolated. A broad-spectrum study was conducted using extracts from twelve different species of Juniper to look for termiticidal activity and then to isolate the active components. Oda et al. 1977 conducted a systematic survey of Juniper species across

the United States and reported the isolation of two sesquiterpene alcohols, cedrol and widdrol, as the most active ingredients. Other research, involving Lyme disease vectoring ticks (Ixodes scapularis) (Acer: Ixodidae) (Say) has demonstrated that two species of Juniper, western and eastern, (J. occidentalis) and (J. virginiana) respectively, had considerable acaricidal activity. Moreover it was shown that these two species had toxic effects on the Oriental rat flea (Xenopsylla cheopis) (Insecta: Syphonaptera) an important vector of the plague bacterium Yersinia pestis, in laboratory. In addition to species of Juniper, Panella et al. demonstrated significant biological activity in several different plant extracts against ticks and fleas.

DISCUSSION

It is clear by the review of recent research listed above that there is an unlimited number of applications for secondary plant compounds and their derivatives and many different methods have been used to study their biological activity. Boshitz and Gruwenwald (1994) placed larval Ae. Aegypti mosquitoes in beakers containing deionized water with differing concentrations of NeemAzal. This bioassay technique sought to simulate real ecological parameters that exist in nature to a certain extent. Probably the best bioassays are conducted in the field under real life circumstances, but when that is not possible the researcher must use creativity and resourcefulness to obtain a high quality bioassay. Perhaps the most interesting observation made by Boschitz and Grunewald was that the toxic effect of the product decreased as the larval stage increased. Boschitz and Grunewald also reported that there was not a significant reduction in fecundity among the mosquitoes that were exposed to sub-lethal concentrations and allowed to molt into adults. These results were inconsistent with results published by other researchers that claimed a significant reduction in fecundity after neem exposure.

This variation could be due to the difference in bioassay techniques. Boschitz and Grunewald put the NeemAzal directly into water allowing the larvae to come into contact with it by normal locomotion whereas the other studies mentioned above administered the toxin by either blood meal or direct injection into the hemocoel. It was clear in either case though that NeemAzal inhibited growth of the early instars larvae.

Detrimental physiological effects have also been observed in insect agricultural pests such as aphids. Dimetry et al. (1995) tested various concentrations of Neem Azal-F (a commercial product of the neem seed kernel extract containing 5 % azadiractin) on the cowpea aphid (Aphis craccivora) to measure inhibition in growth and reproduction. Lowery and Isman (1994) also tested neem seed oil on several species of aphids to measure the same effects. The results obtained by Dimetry and Hawary (1995) demonstrate that Neem Azal-F was effective at reducing fecundity in the adults and inhibiting successful molting. They also determined that the aphicidal effect is concentration dependent, which is consistent with the published results of other studies done with aphids. Lowery and Isman (1994) in an earlier study also found similar results among the species they tested, but also reported that susceptibility varied among the life stages. Both studies employed bioassays that required the larval aphids to ingest treated plant materials. It is still unclear whether or not direct contact with neem will induce the same results. Another interesting observation made by Dimetry and Hawary (1995) was that when the Neem Azal-F was not in lethal concentration it caused the surviving larval aphids to increasingly molt into the winged form as concentrations increased. This suggests that the Neem Azal-F even in non-lethal doses can trick the aphid's physiology into thinking that conditions at its present location are unfavorable and develop the winged form to perhaps leave and look for a more suitable host plant.

In contrast to the fecundity reducing effect neem has on aphids, Naumann and Isman (1995) found that their same neem seed oil extract had little or no effect on three species of noctuid moths: Trichoplusia Ni, Peidroma saucia, and Spodoptera litura.

In this experiment captive moths were given cabbage plants treated with the three extracts of varying concentrations (10,50 and 100 ppm of azadiractin) and then oviposition was measured for the life span of the female which is 8 – 13 days. There was no significant difference in the amount of eggs laid by the female on the plants of varying treatments. When the researchers presented the female moths with a choice of treated and non-treated cabbage plants to oviposit on there were no differences observed in the number of eggs laid. According to Naumann and Isman (1995) this is in contrast to what has been suggested in many reports, including those for S. litura. Again the question of processing and formulations of both the products and extracts is raised. The pesticidal power of neem is not just limited to phytophagous insects. Roa et al. (1995) were able to achieve control of the root knot nematode on tomato plants by integrating a known nematocide, vesicular arbuscular mychorrhiza, with neem cake. The bioassay used in this study could easily be applied in the real world because plants don't move much so changes are usually easily observable to the trained eye. Roa et al. (1995) placed tomato seedlings with the (VAM) already growing on the roots into soil amended with neem cake. They then removed a sample of five plants at pre-determined time intervals to look for infestations of nematodes. What

they found was quite remarkable. Not only were the root knot nematodes virtually wiped out, but the soils amended with neem cake caused an increase in plant growth parameters and an increase in the mychorrizal population on the roots, thus affording the plants even greater protection.

The other classes of plant-derived chemicals that have been shown to demonstrate biological activity in arthropods are several plant species in North America. Research conducted with extracts from Juniper species have proved to be effective in controlling termites. Termites were exposed to the heartwood, bark/sapwood, and leaves initially and then to a methanol and hexane extract of twelve different species of Juniper found throughout the United States. Adams et al. (1988) found that the bioassay they used for the raw materials was 100 percent effective for all species after 4 weeks of exposure heartwood. This bioassay consisted of placing 1.5 g of raw materials in a zipper case with 50 g of sand, 7 ml of distilled water and 100 termites. Mortality was checked every 7 days and in all instances 100 percent mortality was achieved after 4 weeks. Adams et al. (1988) fail to mention what kind of control they ran so it is hard to be sure that it was the plant material that was exhibiting all the activity. With the Hexane and Methanol extracts, the investigators treated filter paper with a 1 mg/ml solution and placed 25 termites on it. These bioassay trials yielded mixed results. The Hexane extracts only produced 100 percent mortality after the 4 weeks in 5 species, while the Methanol extracts were 100 percent effective in only 4 species. From these results Adams et al. (1988) concluded that perhaps the Hexane and Methanol extracts were not extracting all the antitermitic properties of the compounds found in the heartwood.

Other research using the extracts of Juniper as well as other plant species has been focusing attention on two medically important arthropods: ticks and fleas. In these studies several extracts of heartwood, bark/sapwood and leaves have been evaluated as to their biological effectiveness against the afore mentioned arthropods. The bioassay technique used for this research is known as the disposable pipet method first developed by Barnard et al. (1982). This method consists of serially diluting the extract in acetone solvent into as many concentrations as desired. Once the formulations are complete the solutions are sucked into the pipet a number of times to ensure complete coating. The pipets are left for 24 hours to dry and then the ticks or fleas are introduced via a vacuum pump. After 24 hrs the arthropods are checked for mortality. Thus far, it appears that two of the crude extracts show a lot of promise. Those extracts being from Alaska yellow cedar (Chamaecyparis nootkatensis) and Eastern red cedar (Juniperus virginiana). Both of these extracts have exhibited impressive values and could potentially be commercially important. It is worth noting that these extracts are much more toxic to the larval stage of ticks than the nymphal stage, which is current with what other researchers have encountered while testing other compounds such as neem on different stages of insects. The active chemical compounds in these extracts have yet to be elucidated, but that is the focus of current research.

To understand how these compounds are working on the physiological level, investigations into the behavioral and sensory effects have been carried out on some neem-based products. Three extracts: toosendanin, salanin, and azadirachtin, from plants of the genus Melia were compared in their ability to deter feeding and evoke neurophysiologic responses with Maragosan-OR, a commercial product based on an ethanolic extract of seeds from Azadirichta indica (Lin-er et al. 1995). The anti-feedant bioassay consisted of placing treated and untreated cabbage discs in a petri dish and then introducing caterpillars of the species Pieris brassicae. The discs were checked at intervals to measure the amount the larvae consumed of each disc over a 4-hour period. The degree of material consumed was then converted to an anti-feedant index established by the authors. They found that Margosan was the best anti-feedant, but the other extracts were not significantly worse. To measure sensory responses in the insects the investigators used the tip technique, which recorded the action potentials of the two sensilla styloconica when stimulated with various concentrations of the 4 compounds mentioned above. By doing this the authors were able to get a picture of what was happening on the cellular level in specific sensory cells. They noted that some of the compounds were causing a change in the insect's sensory code. They were able to observe if the compounds were inhibiting the sugar cell, glucosinalate cell or the amino acid cell. At higher concentrations the responses were greater for all compounds. In conclusion the authors determined that toosendanin was the strongest neem-derived compound tested.

Moreover, their tests indicated a good correlation between the action potential frequency in the caterpillar's medial deterrent receptor and the anti-feedant bioassays conducted with the compounds.

As research continues in the rapidly growing field of plant-derived chemicals, many more applications will arise that have not been discussed in this review. As researchers gain more understanding as to how these compounds affect organisms on the behavioral and physiological level the potential for eco-friendly products

to control pests is enormous. Future research in this field should expand out of the laboratory and into the real world. In this way these novel products can be evaluated as viable alternatives to the persistent, less environmentally friendly products on the market currently.