

BIODIVERSITY – AN OVERVIEW

By

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Abstract:

The concept of biodiversity is discussed. It is stated that it covers all the plants, animals and micro-organisms from all sources (terrestrial, marine or other aquatic systems), at all levels (genes, genomes, species and ecosystems). It has direct relevance to all human activities, be they scientific, economic, moral, philosophical or political. The intimate relationship between environment and biodiversity is discussed. It is pointed out that the biodiversity mostly resides in those areas which have least capacity to support it. The destructive role of man is briefly discussed, particularly with reference to biodiversity loss, global warming, Kyoto Protocol and climate change.

In 1992 the global community met in Rio de Janeiro to discuss global problems concerning environment and development known as the United Nations Conference on Environment and Development (UNCED). One of the end results of this Conference was the adoption of a text for an international convention of biological diversity. Since that time, over 160 nations have ratified the Convention on Biological Diversity (CBD), making it one of most global of all international treaties. A secretariat for the Convention has been established in Montreal.

The term Biodiversity was probably first used by Walter R. Rosen while organizing the conference which came to be known as the National Forum on Biodiversity in 1986. The proceedings of this conference were edited in 1987 under the title of Biodiversity by E. O. Wilson in 1988 (Perlman & Adelson, 1997). The term biodiversity is widely used in the national and international circles. It is used by environmentalists, conservationists, industrialists, economists, politicians, journalists etc. with the result that the word has become fashionable with no clear understanding of what it means. Such loose usage has given the word so many different meanings, connotations and intentions that the actual concept of biodiversity may have been lost in obfuscation (Krishnamurthy, 2003). Hence it is necessary to explain the concept of biodiversity with the help of a few definitions.

The researchers and conservationists employ a working definition of biodiversity shaped by their values, interests and goals. There is a great variety of human perception about what biodiversity is. Biodiversity has been most generally defined as the “*full variety of life on earth*”. (Takacs, 1996). According to A. Bennett (1990) biodiversity refers to the variety and variability of all plants, animals and micro-organisms on earth and can be considered at three levels: genetic diversity (variability within species), species diversity within an ecosystem and the variety of habitats on the planet.

“Biological diversity” means the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species between species and the ecosystem (Convention on Biological Diversity, 1992).

It may be noted that the concept of biodiversity is not confined to the enumeration of all taxa met within a particular region and their relationships with the environment of which they are part but also takes into account the whole concept of the genetic systems, emphasizing all the components with a view to explain the basis of variability at the level of genes, chromosomes, genomes on the one hand and species, populations, communities and ecosystems on the other.

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Genetic Diversity

Genetic diversity is the degree of variability of the genetic material of an organism. High genetic diversity indicates populations that can more easily adapt to changing situations. Some argue that the fundamental unit of biodiversity is the *gene* (Williams & Humphries, 1996).

Direct assessment of genetic diversity involves the isolation of the genome, the complete set of genetic material of an organism present in each cell of all living individuals.

Genes make each of us what we are. Each cell in our body contains our genome, a code of more than 3 billion letters contained in DNA. Sequencing of DNA means figuring out what order the letters appear in – in their sequence. Knowing the sequence helps scientists what kind of genetic information is carried in a particular section of DNA. Some sections contain genes, other sections don't. Some sections show changes in sequence, called mutations.

The DNA Code is made up of four “bases”, the letters of the genetic alphabets. A is for adenine, C is for cytosine, G is for guanine, and T is for thymine. When an organism's genome is sequenced, the result is thousands to billions of these letters. A virus of *Escherichia coli* bacterium has around 5000 base pairs while Pompeii worm's is estimated to be about 800 million. The human genome is estimated to have over 3 billion. Yet the humans do not have the largest known genome. The record for the largest genome is held currently by an amoeba (*Amoeba dubia*) which has about 670 billion base pairs. The story of all the living beings of the world is written in a language which has only 4 letters. The different sequences of these letters are responsible for the identity of the taxa and its biodiversity (variation). However, exact assessment of genetic diversity is both time-consuming and prohibitively expensive, requiring modern laboratories and expensive chemicals (Karp, 2008; Venter, 2001). The genetic diversity is almost fully known only in a few taxa such as *Arabidopsis*, *maize*, *E. coli* and man.

Fortunately Genetic Diversity can be estimated by species diversity. Species are easily identifiable natural biological units. Their diverging appearances were the basis by which they were classified in the 18th century, and modern phylogenetic techniques produce more or less the same results.

'The biodiversity or the diversity of life in all its forms and “all levels of organization” which indicates that biodiversity refers to the diversity of genes and ecosystems as well as species diversity (Hunter, 1996).

When viewed from this point of view, the biodiversity and the availability of the chemical substances synthesized or modified in the plants, animals and microorganisms should also be accepted as another aspect of variability of biodiversity.

'Many biologists who study biodiversity confine themselves to the objective assessment of ecological processes. Others believe that scientists should comment on the *moral, philosophical* and *political* aspects of biodiversity.

Summarizing the discussion, I may be permitted to add that:

- i. Conceptually biodiversity includes every type of study that may be conducted on any (and all) biological entities.
- ii. Biodiversity has direct relevance to all human activities be they scientific, economic, moral, philosophical, political etc.
- iii. It should also be realized that biodiversity which plays a critical role in overall sustainable development and poverty eradication is essential to our planet, human well-being and to the livelihood and cultural integrity of people (World Summit on Sustainable Development – WSSD Plan for Implementation, Paragraph 44, 2002).

Environment and Biodiversity

As the biodiversity involves all the microorganisms, plants and animals, it is intimately affected by the environment. It is difficult to define the environment which is all pervasive and can only be defined with reference to an organism. According to the Concise Oxford Dictionary, revised XI edition (2008) it is “the surrounding or conditions in which a person, animal or plant lives or operates”. Depending upon the individual (plant, animal or microorganism) all other factors that are likely to affect its well-being will be considered as part of the environment. The survival and the well-being of the individual are affected by the environment.

All living beings obtain their life support materials from their environment. Hence the well being of the individuals gets affected by the environmental factors. In case the environmental factors are not suitable for survival, some of the organisms may even die. As all the individuals are not exactly alike, more hardy individuals may survive. Thus the environment acts as a selective agent.

It is well established that environmental factors also affect the mutational frequencies as well as the recombination systems. Therefore, the environment also acts as mutagenic agent. Hence the environment may also be responsible for changing the individual. In the simplest case the change in the individual is purely the result of the environmental action. But modified characters as a result of continued environmental selection may get genetically fixed. Hence environment acts as a selective agent as well as a mutagenic agent. Hence it may be argued that environment may cause the change and subsequently select it (Ali, 1963). However, generally when we talk about changes in the environmental factors (temperature, humidity, sunlight, oxygen, carbon dioxide, water, soil, pollution etc.) we normally do not take into account the multiple roles of the environment (Ali, 1963).

Biodiversity particularly the green plants perform a very important role by purifying the polluted environment through the process of photosynthesis.

Biodiversity in the Developing and the Developed World

It is interesting to note that the biodiversity and its potential in the developing countries and the developed countries are very different. The developing countries are rich in biodiversity whereas the developed countries are relatively poor. All the Vavilovian Centres of biodiversity, very rich in the genetic resources of economically important plants, are located in the developing countries. The local technical knowledge and the indigenous systems are available in the developing world where as these are largely non existent in the developed world. The developing countries are rich in cultural diversity based on indigenous biodiversity whereas in developed countries the cultural diversity is comparatively rather poor. The developing countries technology (genetics, breeding and biotechnology) base is weak whereas the developed countries are rich in technology. The *in situ* conservation is more common in the developing countries. In the developing countries sustainable utilization of biodiversity is not possible, whereas in the developed countries the capacity already exists. The developing countries are deficient in education, training, research, technology and proper utilization for nation building resources, whereas the developed nations are on a much firmer ground (Khoshoo, 1996; Krishnamurthy, 2003).

“The global facet of the biodiversity problem lies in the fact that much of global biodiversity resides precisely in those states which have the least capacity to support it. In addition, it is not inexpensive to support resources. This requires commitments of lands and management as well as commitment to the resource itself.” (Swanson, 2005).

According to the convention (CBD) ‘the developed country Parties shall provide new and additional financial resources to enable developing country Parties to meet the agreed full incremental costs to them of implementing measures which fulfil the obligations of the Convention...’ (Article 20(20)).

Further the convention also states that each party should take action 'with the aim of sharing in a fair and equitable way the results from research and development and the benefits from commercial or other utilization of genetic resources with the party providing such resources.' (Article 15 (7)). This implies that the suppliers of genetic resources should be accorded a *share* in the value that results from their subsequent use and development. The idea of sharing benefits from final products implies an agreement to develop a property-rights-based mechanism for rewarding investments in biodiversity conservation for subsequent use.'

Causes of Biodiversity Loss

Life has existed on our planet for four billion years or so. Man has existed as a component for about four million years. However very recently (in the past 10 millennia or so) we humans have placed ourselves outside that system and commenced reshaping the biological diversity. The coming of the human race has endangered wide spread extinctions. Although extinction is an essential component of evolutionary process, human-sourced extinction have become a phenomenon far apart from the natural ones. (Wilson, 1988).

When humans first arrived in Australia 50,000 years ago, that continent lost nearly all of its mammals, snakes, reptiles, large flight birds. When humans migrated to North America about 11000 years ago North America lost 73 per cent and South America 80 per cent of their large mammal species (Swanson, 2005). The causes of more recent extinctions (i.e. over the past two thousand years) have been categorized under the three human induced causal factors: over exploitation, habitat destruction and species introduction (Diamond, 1989). Some of the more familiar examples may also be referred to in this connection; continued increase in human population (developing countries) which leads to encroachment on wild habitats through urbanization, expansion of agricultural land, deforestation, water shortage, habitat fragmentation, pollution, ignorance, climatic change (Global Warming), leading to poverty, hunger, spread of diseases etc. Reference may be made to Wood, Stedman-Edwards & Mang (2005) for a detailed analysis of the root causes of biodiversity loss.

Biodiversity Loss

It is well established that the biodiversity is being lost at a very fast rate and man has not been able to even identify all the biological resources. One estimate of all the organisms named over the past centuries is stated to be 1.5 million and the organisms yet to be 3.0 million. A report recently circulated with reference to Encyclopedia of Life (EOL) states that the Global biodiversity or web of life is estimated to include 13 million species – only 10% have been identified thus far.

Nearly more than half of the world's species of plants, animals and micro-organisms will be destroyed or severely threatened before we come to know about their existence. Clearly, more than half of our plants, animals and micro-organisms that are expected to vanish forever may hold exceptional promise for producing life saving drugs or other factors that may improve the quality or stability of human existence on earth. There may be undiscovered miracles in the disappearing biological resources of the world.

Global Warming

About 200 years ago, the use of fossil fuel was almost negligible. However, now an average American uses as much energy as released by the burning of 7000 kilograms of oil. By early 80s, activities such as generating electricity, driving cars and producing steel were releasing over five billion tons of carbon (nearly one ton for each of the earth's inhabitants) nearly 100 million tons of sulphur and lesser quantities of nitrogen oxide into the atmosphere every year.

The Scandinavian countries were the first to report in the 60s the first signs of long range ecological damage from these pollutants in the form of dwindling fish populations in the lakes. In some lakes, the marine life has completely disappeared. Dying lakes may now be recorded across Europe and America. In 80s, evidence of the damage to trees from the precipitation of acid rain started accumulating by 1986, forests covering an area of over 75 million (nearly one

fifth of the total) were damaged by acid rains in Europe. In addition to acid rain, consequent to fossil fuel burning, the average temperature of the world has gone up. The average temperature over the surface of the earth in 1996 was 15.8 degrees Celsius, an all time high. It is obvious that if the use of fossil fuels continues at this rate, the earth will gradually warm up and the polar ice caps will melt, raising ocean levels, drowning vast coastal areas and affecting the rainfall patterns; some areas may become desert, others may become more humid. Reference in this connection may be made to the Earth Summit, Rio de Janeiro, 1992, the Second Earth Summit, New York, June 1997, the Kyoto Conference, December 1997 and the Buenos Aires Conference, November 1998 (Ali, 2000).

The report based on Computer Simulation Studies conducted by Hadley Centre, Berkshire, U.K. and presented to 170 countries on November 1, 1998 in Buenos Aires indicates that the Earth is heating up fast with 1998 already the hottest year since reliable records began 140 years ago; land temperatures will go up by 6°C by the end of next century. As a result of melting of ice, rise in global sea level will be 21 cm by 2050. The coasts of southern Mediterranean, Egypt and East Africa, South and South East Asia will be the most vulnerable. The number of people on the coast subject to flooding each year will rise from 5.0 million to 100 million by 2050 and 200 million by 2080. Another 30 million people will be hungry in 50 years because it will be too dry to grow crops in large parts of Africa. Worst affected will be Brazil, where the Amazon rain forest will turn into desert. The eastern United States and parts of southern Europe will also become virtual desert at the same time. An extra 170 million people will live in countries with extreme water shortages. By 2050, malaria will threaten much larger areas including Europe than at present. The whole Central and South Africa will have reduced ability to grow staple food. In U.S.A., extra heat leading to evaporation will result in up to 10% drop in maize and wheat yield (Brown, 1998).

Kyoto Protocol (1997)

Before the Industrial revolution the atmosphere was made up to 250 parts per million of carbon dioxide. Now this figure has reached 370.9 parts per million, the highest level for the past 420,000 years and probably for 20 million years. It is already producing meteorological effects, a steady increase in devastating storms raising sea levels and dwindling glaciers and ice caps. Unprecedented increase in temperature was experienced in Europe resulting in the death of thousands of persons, particularly in Portugal, Spain, France, tsunami in Indonesia etc.

The Kyoto Protocol requires 38 rich industrialized countries to cut greenhouse gases – mainly the carbon by-products of burning oil, gas and coal – by 5.2 percent compared with 1990 levels between 2008-2012. The Kyoto Protocol is a protocol of the United Nations Framework Convention on Climate Change (UNFCCC) aimed at fighting global warming. Most of the world's industrialized nations support the Kyoto Protocol. One of the notable exceptions is the United States of America. It releases more greenhouse gases than any other nation and accounts for more than 25 per cent of those generated by humans. Australia also declined. As U.S. presidential candidate, George W. Bush promised to reduce carbon dioxide emissions. Shortly after in office, however, he withdrew U.S. support to Kyoto Protocol. While his decision dealt a serious blow to the possibility of U.S. participation in Kyoto Protocol, Bush was not the only opposition. Prior to negotiation of the Kyoto Protocol, the U.S. Senate passed a resolution saying the U.S. will not sign any protocol that failed to include binding targets and timetables for both developing and industrialized nations that “would result in serious harm to the economy of the United States.”

On July 27, 2005 “The Asia Pacific Partnership on Clean Development and Climate-grouping, major pollutants United States of America, China, India, Japan, South Korea and Australia met to seek new technology to cut greenhouse gases without sacrificing economic development. The six nations, which account for nearly half of the world's greenhouse emissions, agreed to address energy, climate change and air pollution issues within a paradigm of economic development.” But the environmentalists said the deal was a limited trade and technology accord and no challenges to the United Nations treaty, which came into force in February, 2005,

because it does not have anything to do with reducing emissions. There are no targets, no cuts, no monitoring of emissions, nothing binding, said Steve Sawyer of Greenpeace.

On 17th April, 2008 US President George Bush unveiled a plan to halt the growth of U.S. emissions by 2025. The general comment is that Bush climate plan is too little, too late.

In spite of the fact that two Nobel Peace Prizes (Albert Arnold Al Gore) and Inter-Governmental Panel on Climate Change (IPCC) in 2007 and Wangari Maathai, a Kenyan Environmental Activist, in 2004 were awarded in four years and concurrently many multinational meetings are being held to replace 1997 Kyoto Global Warming Protocol. It seems that we are fighting a losing battle because many irreversible changes have already taken place leading to many unpredictable catastrophes. Probably most of the people expected that the New American President will promise to follow the Kyoto Protocol in Copenhagen (2009) but the participants (US, China, Brazil, India and South Africa) agreed to set a mitigation target to limit warming to no more than 2 °C and importantly to take action to meet this objection.

Climate Change

It is obvious that the global warming has already set in. It is a reality. All we can do is to take due steps to mitigate its consequences.

It may be noted that the worst sufferers will be the poor nations. The last decade has intensified poverty everywhere. According to the information released by United Nations more than 2400 million people now live without sanitation, a considerable increase over the last decade and 1200 million have no safe drinking water. Similar numbers have inadequate housing, health and education services; more than 1500 million are under-nourished, not because there is no food, or there is too much drought, but because of increasing marginalization of the poor. Unfortunately, the gap between the rich and the poor is increasing. Free-market economic policies imposed on indebted countries by the west worsen the situation by forcing them to develop export industries for supplying the rich rather than protecting, educating or caring for the weakest. The poorest countries now spend more for servicing their debt to the richest countries than they do on health and education in their own countries.

Though in developing countries the environmental degradation may not apparently appear to be so globally devastating, the consequences may be quite serious for the survival of the human population in view of overall limited resources and lack of adequate facilities necessary for dealing with any catastrophe.

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