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Biodiversity with Special reference to Genetic Biodiversity and Sustainable Development- A brief review

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ABSTRACT

Biodiversity is the variety and variability of life on Earth. Biodiversity is the variability among living organisms from all origins, including terrestrial, deserts, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems. The diversity in the genetic makeup of a species is called genetic diversity. There are often a number of varieties or strains within a species that differs from each other. The differences are due to very minute variations in their genetic setup. The greater diversity in genetic constitution within a species enables it to adopt and survive the changing environment more effectively. Effective conservation of plant genetic resources there must be a clear understanding of extent genetic diversity of concerned species and it distribution, structure and material that it to be conserved either ex situ or in situ conservation. Sustainable development is the need of the present time not only for the survival of mankind but also for its future protection. By conserving, restoring and sustainability using biodiversity, we ensure that we have viable solutions to present and future challenges, including climate change, food scarcity, water scarcity, sustainable development, peace and security.

Introduction

In nature there we find a composite structure of flora and fauna along with abiotic components which ultimately constitutes a natural ecosystem. At present this ecosystem is clearly facing a wide and disconcerting array of environmental problems and ultimately culmination of biodiversity loss in their natural habitats.Until recently, biodiversity was a word not widely heard outside circles of ecologists and conservationists but now it is almost a buzzword used by a wide spectrum of environmentalists and policy maker.

Actually Biodiversity is the abbreviated word of Biological Diversity. Norse and McManus (1980) first defined biodiversity. Its abbreviation into ‘biodiversity’ was apparently made by Walter G. Rosen in 1985 during the first planning meeting of the ‘National Forum on Biodiversity’ held at Washington DC in September 1986 (UNEP 1995). Later Wilson and Peters 1988 introduced the notion of biodiversity in their book of Biodiversity and popularized the word among the scientific community as well as the common people.In a word Biodiversity is the totality of genes, species, and ecosystems in a region.In simple terms, biodiversity is a measure that attempts to describe a holistic way the total variety of life on the planet.

Biodiversity describes the richness and variety of life on earth. Biodiversity includes the number of different organisms and their relative frequencies in an ecosystem. It is the variation among living organisms from different sources including desert, terrestrial and marine ecosystems, and the ecological complexes of which they are a part.There are three levels of biodiversity. These are-

Species richness and species diversity in a particular area or ecosystem; species richness is the simpler one, as it only counts the number of species; but species diversity is more complex in that it also takes the number of organisms for each species into account. Species diversity refers to the variety of different types of species found in a particular area. It is the biodiversity at the most basic level. It is the biodiversity observed within a community. It stands for the number and distribution of species. The number of species in a region varies widely depending upon the varied environmental conditions. It includes all the species ranging from plants to different microorganism (Hamilton, 2005).

Ecosystem diversity represents the entire biological and physical content of a locality (Sloep and Dam, 1995). Ecological biodiversity refers to the variations in the plant and animal species living together and connected by food chains and food webs. It describes the assemblage and interaction of species living together and the physical environment a given area. It relates varieties of habitat, biotic communities and ecological processes in biosphere. It also includes the diversity within the ecosystem.

Genetic diversity represents the biological variation or capacity for variation, within each species, genetic diversity is vital to the maintenance of ecological stability enabling different species to respond to environmental change and to fulfill different functions within the biosphere. It also helps speciation or evolution of new species and important for agricultural productivity, development, etc. Genetic diversity describes how closely related the members of one species are in a given ecosystem. In simple terms, if all members have many similar genes, the species has low genetic diversity. Because of their small populations, endangered species may have low genetic diversity due to inbreeding. This can pose a threat to a population if it leads to inheritance of undesirable traits or makes the species more susceptible to disease. Having high genetic diversity helps species adapt to changing environments.

Besides the above mentioned levels, the biodiversity concept incorporating the multiple levels of organisation and many different spatial as well as temporal scales (Noss, 1990).

I. Structural: It encompasses landscape patterns, physiognomy habitat structure, population structure and genetic structure;

II. Compositional: It includeslandscape types, communities ecosystems,species populations and genes;

III. Functional: It comprises—landscape processes and disturbances land use trends,inter-specific interactions, ecosystem processes,demographic processes, life histories andgenetic processes.

The terms alpha, beta, and gamma diversity are used to describe the spatial component of biodiversity.*Alpha diversity* refers to the average species diversity in a habitat or specific area. Alpha diversity is a local measure.Beta diversity represents the differences in species composition among sites.It is the variation of the species composition between two habitats or regions. It takes into account the alpha diversity of the habitats and the number of unique species on each habitat. Gamma diversity is the diversity of the entire landscape (regional species pool).It is a measure of the overall number of species (the diversity) within a region. It is basically the sum of all the species of all habitats within the region of interest. Landscape ecology is the science of studying and improving relationships between ecological processes in the environment and particular ecosystems. This is done within a variety of landscape scales, development spatial patterns, and organizational levels of research and policy.

Genetic diversity

Gene diversity is the total number of genetic characteristics in the genetic makeup of a species, it ranges widely from the number of species to differences within species and can be attributed to the span of survival for a species. It is distinguished from genetic variability, which describes the tendency of genetic characteristics to vary.

Genetic diversity refers to the variation in the nucleotides, genes, chromosomes, or whole genomes of organisms. Genetic diversity serves as a way for population to adapt to changing environments. With more variation, it is more likely that some individuals in a population will possess variations of males that are suited for the environment. Those individuals are more likely to survive to produce offspring bearing that allele. The population will continue for more generations because of the success of these individuals. The huge varieties of different gene sets also define an individual or a whole population's ability to tolerate stress from any given environmental factor.

While some individuals might be able to tolerate an increased load of pollutants in their environment, others carrying different genes, might suffer from infertility or even die under the exact same environmental conditions. Whilst the former will continue to live in the environment the latter will either have to live it or die. This process is called Natural selection and it leads to the loss of genetic diversity in certain habitats. However, the individuals that are no longer present might have carried genes for faster growth or for the ability to cope better with other stress factors.

Any change in the environment natural or human induced causes a selection of events that only the fittest survive. Anthropogenic impacts are particularly apparent in the coastal zone and increase the number of changes occurring to individuals and populations. Such pressure is exerted by artificial selection (harvesting, aquaculture), degradation of habitats (leading to a reduction of total stocks and thus increasing the likeliness of inbreeding) and the release of framed fish into the wild. These activities reduce the sum of genes available, thus leaving behind the population that is less capable of tolerating any further natural and anthropogenically caused changes in the environment. These activities reduce the sum of genes available, thus leaving behind the population that is less capable of tolerating any further natural or human disturbances in the environment (Zavaleta, 2000; Vellend, 2005).

The loss of genetic diversity is difficult to see or measure. In contrast, the reduction and extinction of population is far easier to see. Extinction is not only the loss of whole species, but is also preceded by a loss of genetic diversity within the species. This loss reduces the species ability to perform its inherent role in the whole ecosystem. Furthermore the loss of genetic diversity within a species can result in loss of useful and desirable traits (resistance to parasites). Reduced diversity may eliminate options to use untapped resources for food production, industry and medicine.

Darwin's The Origin of Species begins with a discussion of variation. Without variation, populations cannot evolve. Soon after Mendel's principles were rediscovered, biologists began to document genetic variation in natural populations. Initially, these efforts focused on conspicuous features of the phenotype-pigmentation, size, and so forth. Later, they emphasized characteristics that are more directly related to chromosomes and genes.

A population is group of individuals belonging to the same species that live in a defined geographic area and actually or potentially interbreed. The genetic information carried by members of a population constitutes that population's gene pool. At first glance, it might seem that a population that is well adapted to its environment must be highly homozygous because you assume that the most favourable allele at each locus is present at a high frequency. In addition, a look at most populations of plants and animals reveals many phenotypic similarities among individuals. However, a large body of evidence indicates that, in reality, most populations contain a high degree of heterozygosity. This built in genetic diversity is often concealed because it is not necessarily apparent phenotypically; hence, detecting it is not a simple task. Nevertheless, the diversity within a population can be revealed by several methods.

The larger the gene pool, the larger the genetic diversity. The higher the chances are that some members of the population will survive or even flourish in time of environmental change and challenges. Basically, the bigger the population, the more likely there will be individuals with some unique combination of genes that will allow their survival. But what happen when the gene pool is much smaller, in other words, when the gene pool is shallow. In the wild, in a small isolated population of organisms, the choice of mates with whom to breed tends to be restricted to closely related members of the same population. So the genetic makeup of the individuals becomes more and more uniform. And what's a worse, flaw or disabilities that those individuals might be carrying in their genetic information become expressed or appear in the population more frequently and this is known as inbreeding. Evidence shows that maintaining not only large numbers of species in ecosystems, but large numbers of individuals within populations of those species is important to preserving biodiversity overall. Lots of different studies have shown that extinction, permanent loss of a species is preceded by a drop in genetic diversity a decrease in the gene pool, within the threatened species. Degradation of habitats can cause a decrease in population size and promote inbreeding. When the population size of a species is reduced to the point that is almost goes extinct, the species is said to have gene through a genetic bottle neck. American bison are a classic example of such a bottle neck. The drop in the bison population reduced their genetic diversity which makes them more vulnerable to environmental changes and diseases. Just as we cannot get back species that's been lost to extinction , it's very difficult , and in most cases impossible , to get back the genes that are lost when that species goes extinct or when individuals carrying unique genetic combinations die. As human encroach on wild habitats, populations consequently become smaller and so does the gene pool. This represents a loss of options for a population to respond to stresses, whether those are natural stresses or stresses caused by humans. Ecosystem services arguments go straight to this idea of conserving genetic diversity. Gene controls the production of substances that human use in medicine and food and even as energy sources. Preserving genetic diversity increases the likelihood that new substances can be found among wild populations and that the supplies of useful substances human already have can be maintained. The erosion of genetic diversity in agriculturally important species can come in two forms. One is due to artificial selection for species traits that humans find desirable to the exclusion of other traits. The other source of erosion is that we've focused our dependence on only a few organisms. For example, only about 100 or so species of plants account for 90% of our food crops and only three different species corn, rice and wheat account for something close to 70% of the calories consumed by humankind and these include 50% of the plant proteins human eat (Rao and Hodgkin, 2002; Pal, 2012).

One of the most significant questions addressed in population genetics is how much genetic variation exists within natural populations. Genetic variation within populations is important for several reasons. First, it determines the potential for evolutionary change and adaptation. The amount of variation also gives us important clues about the relative importance of various evolutionary processes because some processes increase variation while others decrease it. The manner in which new species arise and contemporary populations become extinct may depend on the amount of genetic variation harboured within populations. In addition, the ability of a population to persist over time can be influenced by how much genetic varitionm it has to draw on should environments change. For all these reasons, population genetics are interested in measuring genetic variation, attempting to understand the evolutionary processes that affect it, and understanding the effects of human environmental disturbance that may alter it.

Genetic diversity serves as a way for populations to adapt to changing environments. With more variation, it is more likely that some individuals in a population will possess variations of alleles that are suited for the environment. Those individuals are more likely to survive to produce offspring bearing that allele. The population will continue for more generations because of the success of these individuals.

The academic field of population genetics includes several hypotheses and theories regarding genetic diversity. The neutral theory of evolution proposes that diversity is the result of the accumulation of neutral substitutions. Diversifying selection is the hypothesis that two subpopulations of a species live in different environments that select for different alleles at a particular locus. This may occur, for instance, if a species has a large range relative to the mobility of individuals within it. Frequency-dependent selection is the hypothesis that as alleles become more common, they become more vulnerable. This occurs in host–pathogen interactions, where a high frequency of a defensive allele among the host means that it is more likely that a pathogen will spread if it is able to overcome that allele.

Gene diversity is the proportion of polymorphic loci across the genome. Heterozygosity is the fraction of individuals in a population that are heterozygous for a particular locus. Allele per locus is also used to demonstrate variability. Nucleotide diversity is the extent of nucleotide polymorphisms within a population, and is commonly measured through molecular markers such as micro- and minisatellite sequences, mitochondrial DNA, and single-nucleotide polymorphisms (SNPs). Furthermore, stochastic simulation software is commonly used to predict the future of a population given measures such as allele frequency and population size (Govindaraj *et al.*, 2015).

Genetic diversity can also be measured. The various recorded ways of measuring genetic diversity include i. Species richness is a measure of the number of species, ii. Species abundance is a relative measure of the abundance of species, iii. Species density is an evaluation of the total number of species per unit area.

Actually where biologists found variation there is the every possibility the evolution of new species. Variations are the raw materials for the evolution of new species according to Darwin's view. Evolutionary importance of genetic diversity: i. Adaptation: Variation in the population's gene pool allows natural selection to act upon traits that allow the population to adapt to changing environments. Selection for or against a trait can occur with changing environment – resulting in an increase in genetic diversity (if a new mutation is selected for and maintained) or a decrease in genetic diversity (if a disadvantageous allele is selected against). Hence, genetic diversity plays an important role in the survival and adaptability of a species. The capability of the population to adapt to the changing environment will depend on the presence of the necessary genetic diversity. The more genetic diversity a population has the more likelihood the population will be able to adapt and survive. ii. Small population: Large populations are more likely to maintain genetic material and thus generally have higher genetic diversity. Small populations are more likely to experience the loss of diversity over time by random chance, which is called genetic drift. When an allele (variant of a gene) drifts to fixation, the other allele at the same locus is lost, resulting in a loss in genetic diversity. In small population sizes, inbreeding, or mating between individuals with similar genetic makeup, is more likely to occur, thus perpetuating more common alleles to the point of fixation, thus decreasing genetic diversity. Concerns about genetic diversity are therefore especially important with large mammals due to their small population size and high levels of human-caused population effects. iii.Mutation**:** Random mutations consistently generate genetic variation. A mutation will increase genetic diversity in the short term, as a new gene is introduced to the gene pool. However, the persistence of this gene is dependent of drift and selection. Most new mutations either have a neutral or negative effect on fitness, while some have a positive effect.A beneficial mutation is more likely to persist and thus have a long-term positive effect on genetic diversity. iv.Gene flow: Gene flow, often by migration, is the movement of genetic material. Gene flow can introduce novel alleles to a population. These alleles can be integrated into the population, thus increasing genetic diversity (Govindaraj *et al.*, 2015).

The maintenance of genetic diversity is essential to facilitate adaptations of species to this environmental change in order to increase the probability of longterm sustainability of ecosystem structure. Preserving the genetic diversity of species can enhance species' ability to adapt to new environmental conditions and thus influence their survival over these time frames.Genetic diversity originates as a result of recombination or mutation during the process of cell multiplication. Genetic diversity is the only way to comprehensively describe bacterial diversity in any ecosystem. Molecular data have revealed the lot of scope of microbial diversity. Often sequences of 16S ribosomal RNA (rRNA)—or of the corresponding DNA—are determined to assess genetic diversity in bacteria. Unique rRNA sequences are termed ribotypes. Genetic diversity is the basis for all evolution. It provides the means for populations to adapt to their ever-changing environment.

The more genetic diversity, the better the chance that at least some of the individuals within the population will have an allelic variant that is suited for the new environment, and will produce offspring and continue the population into subsequent generations. Populations with low genetic diversity can become so well adapted to local conditions that any environmental change may suffice to destroy them. Thus, for preserving biodiversity at all levels, genetic diversity is of great importance.

Biodiversity assessments have included rudimentary studies of genetic diversity, mainly limited to species counts because morphologically differentiated forms are easily recognized and the evolutionary significance of species is understood. Genetic diversity studies based on molecular population genetic and phylogenetic methods, the database itself is sparser and more diverse because molecular population genetics and evolutionary genetics are new fields. Numerous allozyme studies have been conducted in all types of aquatic environments; the database of genetic diversity using mtDNA RFLP data is large and still growing; microsatellite DNA studies are becoming the standard for investigating population genetics using nuclear DNA; and the database for DNA sequence data is expanding exponentially (Bert *et al*., 2002).

Because genetic variation is the raw material of natural selection, biodiversity ultimately is genetic diversity. Populations are natural entities that should be preserved for sustenance and they are essential components of ecosystems that provide basic life-support systems and ultimately depend on preserving genetic variation both among and within species (Bert *et al*., 2002).

The causes of biodiversity depletion-by anthropogenic activity-over exploitation of natural resources, indiscriminate felling of trees causing wanton clearance of forest cover, rapid urbanization in consonance with industrialization, gradual increasing of Global Trade through over exploitation of natural bio-resources, increasing population in an alarming rate, environmental influences i.e. acidification & Climate Change and natural calamities like tsunami, cyclone, super cyclone, forest fire, earth quake,land-slides, ozone depletion, etc are also the warning signals for the gradual habitat changes which in the long run invite the extermination of valuable species from our earth.

Biodiversity Conservation is worthwhile, this can be done by sustainable management of ecosystems, by taking afforestation programme terrestrial as well as coastal areas so as to stop tsunami, cyclone etc, by judiciously using natural resources and by introducing MAB, sanctuary, National Parks etc (Krishnamurthy, 2004).

Genetic diversity Conservation

Genetic diversity has a great importance from the individualistic and population point of view. All the phenotypic plasticity is dependent on the genetic variability of any organisms which also helps it to adapt to and evolve in different environmental pressures. Mainly three lines of evidences are there which support the ecological consequences on genetic diversity. Information about genetic diversity is necessary for the development of appropriate strategies in conservation biology as well as in many other applied fields. From a basic evolutionary standpoint, genetic diversity is assumed to be crucial for the evolutionary potential of a species (Mukhopadhyay & Bhattacharjee, 2016). An understanding of genetic diversity and its distribution pattern is essential for its conservation and use. It will help scientists and policy makers in determining what to conserve as well as where to conserve, and will improve our understanding of the taxonomy and origin and evolution of valuable plant species. In order to mange conserved germplasm better, there is also a need to understand the genetic diversity that is present in collections. This will help us to rationalize collections and develop and adopt better protocols for regeneration of germplasm seed. Through improved characterization and development of core collections based on genetic diversity information, it will be possible to exploit the available resources in more valuable ways (Rao and Hodgkin, 2002). The most powerful catalyst in the field of conservation has been the advances in genetic and molecular technologies, leading to a wide variety of molecular methodologies for application in conservation and population genetic studies. Recently, molecular methods have been applied intensively in conservation biology and genetic diversity studies, primarily as selective molecular tools, in resolving the empirical questions of conservation and evolutionary concern. Several analytical statistical tools and genetic diversity indices are now available to estimate or quantify genetic diversity of an organism with more sophisticated way (Mukhopadhyay &Bhattacharjee, 2016).

The genetic wealth and traditional knowledge of India need to be protected through patenting. Our traditional knowledge of plants should be protected for which efforts need to be taken on priority basis. In situ conservation of agricultural bioheritage can be accomplished by the maintenance of the various cultivars, races and the genetic diversity present in and among populations of the many species used directly in agriculture or used as sources of genes, in habitats were such diversity arose and continues to grow (Zavaleta, 2000; Balakrishnan, 2012). Scientists and other citizens should collaborate with governmental organizations, from local to national levels, in developing and implementing policies and regulations that reduce environmental deterioration and changes in biodiversity. For example, more stringent restrictions on the import of biotic materials could curb the rate of biotic invasions, and improved land and watershed management could reduce their rates of spread (Chapin *et al.*, 2000).

Conclusion

Biodiversity conservation and sustainable development are two inter-related branches focusing on social progress, economic growth and environmental protection on one side, and ecosystem conservation on the other.

Conservation includes the efforts carried out in protected areas such as national parks and community reserves, and in other areas with reach and important biodiversity where conservation is not the main focus. It is in these latter productive landscapes where sustainability is needed most. Sustainable agriculture, sustainable fisheries and sustainable management of natural resources are main approaches for preserving these landscapes for long-term social, economic and ecological benefits.

So considering the overall threats on our earth it is the need of the hour that if we don't take necessary precautionary measures for the conservation of our natural bio-resources (i.e. biodiversity) the time is not far away when our future generations have to face a lot of consequences and subsequently there will be no next button to them to restore conducible environ on the earth. So the first and foremost point is the massive involvement of the local people as an aid to not only conserve our biodiversity but also for the interest of environmental stability and subsequently to ensure the sustainable development by extensive local area exploration, documentation of floral and faunal components and their utilisation for the future generation. The most important measure would be an impartial and true assessment of the impact of human activity on the environment and formulation of optimization and management schedules, since a cleaner environment is sure to be conducive to maintain biodiversity at the optimum level, conserving our bio-heritage intact (Matta *et al*., 2011; Mukherjee andChakraborty, 2017).

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