Spatial-temporal and factors influencing the distribution of biodiversity: A Review

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Abstract

Biodiversity is constantly changing over different scales due to the turnover of biological units across all spatial and temporal scales. The objective of this term paper is through undertaking a systematic review to demonstrate the distribution of biodiversity at different spatial and temporal scales on species component of biological diversity of better-known plant, animal species, microorganism and ecosystem diversity and factors affecting the distribution of biodiversity. Biodiversity is best defined by patterns we see in the world around us and these patterns are the raw material for understanding biological diversity. The distribution of biodiversity is not uniform throughout the world but shows a rather uneven distribution. So that, species diversity decreases as we move away from the equator towards the poles. These indicate that, in the tropical region, unlike temperate ones, there is more solar energy, water availability, and a relatively more constant and predictable environment. The distribution of biodiversity is influenced by a large number of environmental factors, such as the geological history of the area, environmental stability, ecosystem productivity, habitat heterogeneity and suitability, competition, and predation. Therefore, the understanding of the spatial and temporal distribution of biodiversity are urgently required to formulate short and long term resource management strategies as well as biodiversity education and training activities are superior in disseminating innovative techniques and also sustainable use of biodiversity, building local capacity and increasing public understanding for biodiversity management can contribute to overcoming these rapidly changing.

Keywords: Biodiversity, distribution, spatial and temporal scales

Introduction

Biodiversity is constantly changing over different scales. The influence of regional, biogeographical, historical, and evolutionary processes occurring at large spatial and temporal scales determines biodiversity dynamics on a broad spectrum of time and space (Harrison et al., 2014; Ricklefs, 2004). Biodiversity is best defined by patterns we see in the world around us and these patterns are the raw material for understanding biological diversity (Huston, 1994). Patterns of species diversity have long been of interest to biogeographers and ecologists, but an explanation of these patterns remains an unresolved scientific issue (Brown, 2014). Today, scientific interest in patterns of species diversity can be related directly to three goals common to all branches of science that are interested in improving our understanding of the Earth. These goals are to better understand the functioning of the Earth as a planetary system; predict global changes resulting from human use of the environment and derive practical benefits from scientific knowledge (Stoms and Estes, 1993).

From a systematic point of view, biodiversity is determined by the interaction of many factors that differ spatially and temporally. Biodiversity is determined for example, by a) the mean climate and climate variability; b) the availability of resources and overall productivity of a site; c) the disturbance regime and occurrence of perturbations of cosmic (e.g. meteorites), tectonic, climatic, biological or anthropic origin; d) the original stock of biodiversity and dispersal opportunities or barriers; e) spatial heterogeneity of habitats; f) the intensity and interdependency of biotic interactions such as competition, predation, mutualism and symbiosis; and g) the intensity and kind of sexual reproduction and genetic recombination. Biodiversity at all levels is not static, as the dynamics of natural evolinducey and ecological processes induce a background rate of change(Huston, 1994. Therefore, drivers of biodiversity can vary geographically and management at regional and local scales necessitates the use of methods that can partition biodiversity change both temporally and spatially (Magurran et al. 2010; Renwick et al. 2012b).

Even though interactions among species, like interspecific competition and mutualism, play an essential role in the generation and the dynamics of biodiversity. On an ecological time-scale, interspecific competition can restrict the number of co-existing species but simultaneously lead to a diversification of species traits. Even though predation has direct negative effects on the prey consumed, it can cause a notable increase in prey diversity. Such interactions and many more functional relationships are widespread in most ecosystems and vital for the dynamics of biodiversity(David Storch, 2003; Tockner & Riede, n.d.; Wormworth & Mallon, 2006). As these relationships link species to each other, a loss of one species could easily cause the loss of other species, and changes in the ecosystem are a kind of domino effect. At an evolutionary time scale, interspecific interactions account for the evolutionary generation of biodiversity; in the course of the coevolution of species new biological traits develop continuously(White et al., 2010).

To date, biodiversity research has primarily focused on the assessment and description of existing biodiversity patterns and the rapidly advancing biodiversity decrease due to anthropogenic impact. Knowledge on the dynamics of biodiversity has predominantly been derived from data assessed by the classical disciplines of biogeography, geobotany, population biology, evolutionary biology, and genetics, often before biodiversity research was established as a discipline(Tockner & Riede, n.d.; Varga et al., 2019; Wormworth & Mallon, 2006). Spatial and temporal patterns of species diversity are urgently required (Vitousek et al., 2008) to formulate short-term resource management strategies, to develop and test

scientific hypotheses, and to serve as baseline data in monitoring (Stoms and Estes, 1993). Therefore, the focus of this paper is to demonstrate the distribution of biodiversity at different spatial and temporal scales on species component of biological diversity of better-known plant, animal species, microorganism and ecosystem diversity and factors affecting thedistribution of biodiversity, because they tend to be of considerable direct importance to humanity and the interrelations of biodiversity dynamics and ecosystem functions are related to the temporal and spatial dimension.

The design of this paper is carried out by understanding a systematic review of published and unpublished research papers related to the spatial and temporal distribution of biodiversity. The data collected, interpreted and evaluated here comes from secondary data sources. Different authors and researchers have written on the issue of biodiversity dynamics; government and non-government agencies have produced reports on the distribution of biodiversity in the world. Finally, the most appropriate research articles and postgraduate thesis works were reviewed and their major findings were extracted and presented in the paper**.**

Discussions

Definitions and concepts of spatial and temporal

In nature, organisms are neither distributed uniformly nor at random, forming instead some sort of spatial pattern (Legendre and Fortin, 1989). This is due to various energy inputs, disturbances, and species interactions that result in spatially patchy structures or gradients. This spatial variance in the environment creates diversity in communities of organisms, as well as in the variety of the observed biological and ecological events (Legendre and Fortin, 1989). The type of spatial arrangement present may suggest certain interactions within and between species, such as competition, predation, and reproduction (Perry et al., 2002). The structure of communities and ecosystems (e.g. the number of individuals and species present) can vary in different parts of the world. Similarly, the function of these communities and ecosystems (i.e. the interactions between the organisms present) can vary from one place to another. Different assemblages of ecosystems can characterize quite diverse landscapes, covering large areas. These spatial patterns of biodiversity are affected by climate; geology, and physiography(Redford & Richter, 1999).

On the other hand, temporal changes of the environment enhance the potential for the co-existence of species like in gap-forming processes that provide species requiring open space with new potential habitats. This interplay of recurrent disturbance and (re)colonization creates a shifting mosaic of patches at different successional stages. Many systems tend to show highest species diversity at intermediate disturbance intensity and frequency(Harrison et al., 2014; Ricklefs, 2004). Although, the structural, functional, and spatial aspects of biodiversity can vary over time; therefore there is a temporal component to the analysis of biodiversity. For example, there can be daily, seasonal, or annual changes in the species and number of organisms present in an ecosystem and how they interact. Some ecosystems change in size or structure over time (e.g. forest ecosystems may change in size and structure because of the effects of natural res, wetlands gradually silt up and decrease in size). Due to this fact, biodiversity also changes over a longer-term, evolutionary, and time scale. Geological processes (e.g., plate tectonics and erosion), changes in sea level (marine transgressions and regressions), and climate changes cause significant, longer-term changes to the structural and spatial characteristics of global biodiversity. The processes of natural selection and

species evolution, which may often be associated with the geological processes, also result in changes to local and global flora and fauna (Harrison et al., 2014; Ricklefs, 2004).

Succession is an orderly unidirectional process of community change in which communities replace each other sequentially until a stable (self-reproducing) community is reached and goes along with notable diversity changes and is thus an important natural cause for biodiversity dynamics at local to regional levels(C. C. Chang & Turner, 2019). The explanation of why and how succession is directed has changed over its more than hundred-year history, but most arguments share the notion that species are adapted to different stages in successions and in some way make the environment unsuited for themselves and more suited for the species in the next stage. Despite succession being a foundation of ecological theory, few studies have sought broad generalizations across a range of successional sites. Such comparative studies are necessary because they provide insight into the relative importance of community assembly mechanisms (e.g. environmental filtering, biotic interactions, priority effects, and dispersal limitation) at different stages of succession(C. Chang & HilleRisLambers, 2016), in different successional types (e.g. primary versus secondary succession), and across broad spatial and temporal scales (Walker, 2011; Walker & Wardle, 2014). Broad comparative studies also provide the opportunity to understand successional trajectories, including whether communities recover to a previous state or diverge to a new state(Prach et al., 2016), which provides a basis for understanding and informing restoration management(Suding & Hobbs, 2009). This special issue contains four papers that specifically address the theme of generalizations in succession. Understanding how patterns of succession differ across a disturbance severity gradient (e.g. primary versus secondary successional sites) provides context for how disturbances and their severity influence community trajectories and recovery rates. By explicitly comparing primary and secondary succession across a broad range of ecosystems in the published literature,(Prach & Walker, 2019) report that primary successional sites more often increased in species richness, had more divergent trajectories, and suffered less impact of alien species compared to secondary succession sites. On the other hand, during secondary succession, the velocity of biodiversity dynamics is generally higher, compared to primary succession. Soil formation has already taken place and the soil seed bank and an often considerable amount of vegetative propagules accelerate the (re)establishment of secondary vegetation. In both types of succession the quality of the adjoining habitat types and the size of the succession area influence the temporal dynamics: the smaller the distance from a seed source the faster the succession and diversity dynamics will be. Their meta-analysis also reveals that recovery rates differ among ecosystem types, for instance between cold and warm biomes, suggesting that global climate changes will influence community recovery rates and restoration management practices in the future (C. C. Chang & Turner, 2019).

Patterns of Biodiversity at the species level
Latitudinal gradients

The diversity of plants and animals is not uniform throughout the world but shows a rather uneven distribution. For many groups of animals or plants, there are interesting patterns in diversity, the most well-known being the latitudinal gradient in diversity. The pattern of increasing biological diversity from high latitudes to the equator latitudinal diversity gradient (LDG) has been recognized for > 200 years(Sarukhán & Dirzo, 2013). Empirical studies have documented this pattern across many different organisms and locations. Although many hypotheses have been proposed to explain the LDG (Brown, 2014; Chown et

al., 2004) each hypothesis is confounded with one or more of the others. The explanations for the LDG can be categorized broadly into four groups: those proposing spatial and purely null mechanisms (Kerr, 2001), climatic/energy mechanisms(Sibly et al., 2009), historical and evolutionary mechanisms(Jansson et al., 2013), and biotic mechanisms (Freestone et al., 2011). Despite its long history and the identification of potential mechanisms, no broad consensus on the causes of the LDG has emerged.

The accumulation of spatially explicit biodiversity data has stimulated numerous attempts to document LDG patterns better and to evaluate hypotheses broadly or for particular groups of organisms. (Drakare et al., 2006) explained that, meta-analysis, which synthesized the results of gradients from many parts of the world and many species, supported the generality of a global LDG. However, there was wide variation in LDG patterns, which was attributed to characteristics of specific organisms, habitats, and ecosystems (Drakare et al., 2006). Since many hypotheses have been explained that species diversity decreases as we move away from the equator towards the poles. With very few exceptions, tropics (latitudinal range of 23.5° N to 23.5° S) harbor more species than temperate or polar areas. At its simplest, this means that there are more species in total and per unit area in the tropics than in temperate regions, and more here than in Polar Regions. For example, Colombia located near the equator has nearly 1,400 species of birds while New York at 41° N has 105 species and Greenland at 71° N only 56 species. India, with much of its land area in the tropical latitudes, has more than 1,200 species of birds. A forest in a tropical region like Equador has up to 10 times as many species of vascular plants as a forest of equal area in a temperate region like the Midwest of the USA. The largely tropical Amazonian rain forest in South America has the greatest biodiversity on earth- it is home to more than 40,000 species of plants, 3,000 fishes, 1,300 birds, 427 mammals, 427 amphibians, 378 reptiles, and more than 1,25,000 invertebrates. Scientists estimate that in these rain forests there might be at least two million insect species waiting to be discovered and named(Sarukhán & Dirzo, 2013).

 Moist forests in the tropics are in general the most species-rich environments on Earth. If recent estimates of the number of as yet unknown species, mainly insects, in tropical forests are accepted, these regions, which extend over perhaps 7% of the world's surface, may hold up to 90% of the world's species. If tropical forest small insects are discounted, then coral reefs and, especially for flowering plants, areas of Mediterranean climate in South Africa and southwest Australia, maybe similarly rich in species (Global Biodiversity Outlook, 2002; Ertzky et al., 2014) Similarly, the eastern and southern African region contains remarkable species richness and diversity. Species richness is not evenly distributed throughout the region. For example, (Vié et al., 2009) explained that the number of terrestrial mammal species is the highest, and the largest number of marine mammal species is found in eastern Africa and the eastern coast from Kenya to Mozambique and around the Western Indian Ocean states respectively. While Madagascar and the Western Cape have the highest number of plant species (UNEP, 2006). In terms of bird species, Tanzania (1,050 species), Kenya (1,019 species), Uganda (988 species) and Angola (894 species) are the richest and rank among the top 20 countries in the world with the highest numbers of bird species (Vié et al, 2009). Although Southern Africa has a rich and varied insect and arachnid fauna, with at least 580 families and about 100, 000 species recorded. Namibia is thought to be one of the global centers of arachnid richness (Barnard, 1998). On the other hand, (Burgess et al., 2004)and (Vié et al, 2009) explained that there is a high diversity of butterflies in the Central Zambezian Miombo woodlands and also they are in the top 20

list of countries for amphibian species richness with 242 and 178 species in Madagascar and Tanzania, respectively.

Therefore, ecologists and evolutionary biologists have explained that greater biological diversity in tropics proposed various hypotheses; some important ones are (a) Speciation is generally a function of time, unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification, (b) Tropical environments, unlike temperate ones, are less seasonal, relatively more constant and predictable. Such constant environments promote niche specialization and lead to greater species diversity and (c) There is more solar energy and water availability in the tropics, which contributes to higher productivity; this, in turn, might contribute indirectly to greater diversity. These factors potentially lead to increased net primary production (NPP) by photosynthetic organisms and a possible explanation for variation in species number is that this broader resource base may allow more species to coexist.

Species-Area relationships

The species-area relationship is one of the oldest known and most documented patterns in ecology. It describes the general pattern of increase in species richness with increasing area of observation but can take on different forms and be explained by various mechanisms. Research exploring species-area relationships has taken multiple directions since coming to prominence in the ecological literature in the early 19th century. Most early discussions focused on quantifying the relationship through mathematical functions, particularly Arrhenius's power function and Gleason's exponential relationship (Arrhenius, 1921). More recently, ecologists have attempted to infer ecological processes from the form and parameters of these models. The impact of habitat heterogeneity and increased risk of extinction in small areas have been explored most often, but other key ecological processes (e.g. speciation, dispersal, fragmentation, and habitat specificity) also have been suggested to influence the relationship(Palmquist & Peet, 2017).

In addition, several studies have examined how species-area relationships are often quantified differently based on the goals of a study. For example, (Connor & McCoy, 1979) explored that, popularity among animal ecologists with the seminal work on species abundance, distributions and with (MacArthur & Wilson, 2015) explored that, how isolation and island area influence species-area relationships using Arrhenius's power-law. Isolated areas have steeper slopes because they are not as accessible to transient species as non-isolated areas. Smaller areas have lower population sizes and consequently a higher probability of extinction. An excellent historical review is provided by (McGuinness, 1984) which connects debates over the form and function of species-area relationships with emerging ecological theory. (Connor & McCoy, 1979) also, review the evidence linking species-area relationships to biological and ecological explanations, but focus on the statistical validity of attempts to use the form and parameters of species-area curves to discern ecological causality. (Rosenzweig, 2010) explores in detail several examples of species-area curves and uses them to discuss the many factors that influence the shape of these curves, while(Drakare et al., 2006) build on the work of (Rosenzweig, 2010) and others through a meta-analysis of species-area relationships to show that the relationship is influenced by habitat, type of organism, sampling scheme, and spatial scale. Because of the variety of research goals inherent in studies of species-area relationships, sampling, and analytical methods, as well as definitions of what constitutes a species-area relationship, often vary among studies. According to (Scheiner, 2003) they were defined that six types

of species-area curves that differ based on the spatial arrangement of samples, whether larger samples are constructed in a spatially explicit fashion from adjacent smaller samples, and whether means or single values are used for a given spatial scale. However, (Dengler, 2009) considers that true species-area relationship to have a narrower definition because in his view area is only a biologically meaningful variable when it implies that samples are spatially contiguous. Therefore, looking forward, ecological research is expanding from its past species-centric perspective with a greatly increased focus on traits of organisms and their phylogenetic relationships, which is leading to an examination of how these factors also vary with the area (Palmquist & Peet, 2017).

Biodiversity dynamics at the microorganisms' level
Microalgae Diversity
The role of microbial diversity in ecosystem functioning is becoming increasingly recognized. Microalgae are a large group of organisms that are extremely diverse and heterogeneous from evolutionary and ecological viewpoints. However, estimates of their diversity are nebulous and require substantial input from systematics, dispersal analyses, and biogeography (Andersen 1992). Even though microalgae occupy a dominant position in global ecosystems, estimates for their global species richness remain vague. The number of total algal species is estimated to be 1 to 10 million, the majority of which are microscopic (i.e., microalgae) (Andersen 1992). On the other hand, algae exhibit great diversity in their shape and size, level of organization, life history, and metabolism (Lee, 2005). The thallus organization ranges from unicellular planktonic forms (0.2 mm in diameter) to macroscopic giant kelps (fronds up to 60 m in length) (Lee, 2005). The cellular organization of the group varies from prokaryotic (cyanobacteria), prokaryotic (dinophyceae) to eukaryotic (the rest of the group). The ''mesokaryotes'' are intermediate forms and arose due to the loss of histone from eukaryotes, but are recognized as eukaryotes (Lee, 2005). Primarily aquatic, algae inhabit almost every habitat of our planet from deep oceans to hot and cold deserts, highly acidic post-mining sites to Antarctic soils, air, and man-made subaerial surfaces (K. Sharma et al., 2006).
Microalgae are the major primary producers in many aquatic systems and are an important food for consumers. They are photosynthesizing microscopic organisms that inhabit the upper sunlit layer of almost all oceans and bodies of freshwater. They are agents for primary production, the creation of organic compounds from carbon dioxide dissolved in the water a process that sustains the aquatic food web(Ghosal et al., 2000). They are responsible for much of the photosynthetic activity on the Earth and hence responsible for the oxygen present in the Earth's atmosphere (NASA, 2009: NASA, 2005). They are one of the major biological components of aquatic ecosystems, play important roles in water bodies, not only as primary producers and hence as the base of food chains, but also as one of the dependable indicators of lake fertility and environmental changes.
The diversity of a microalgae community can be used to characterize its structure (number of species present, their physiological properties, and by the genetic potential of the organisms making up the community) (Elber and Schanz, 1989). Understanding the chemical and physical factors controlling population dynamics of phytoplankton is essential for the understanding of how human activities affect the water quality of freshwater ecosystems (Levinton, 2013). The seasonal fluctuations in phytoplankton abundance and species composition in any water body are due to differential response of different species to changing levels of light, temperature, nutrients, grazing pressure, the onset of parasitic infection,

extracellular metabolites of plants and animals with a change in season during a year (Adon et al., 2011). According to (Reynolds, 1988), seasonal changes in a natural phytoplankton community are best interpreted as alterations between true succession and intermediate disturbances (such as floods, episodes of increased wind mixing or they are biotic, including factors like grazing). Therefore, it may be expected that structurally stable lakes follow rather gradual seasonal changes. However, such seasonal changes may be overridden in lakes subject to intermediate disturbances. As there is some indication that temporally variable disturbances increase diversity(Padisák et al., 1988). Therefore, Spatial and temporal variations in microalgae distribution are widely affected by the water chemical and physical factors such as temperature, salinity, pH, nitrate, nitrite, ammonia, and silicate(Babugaya, 2020). The influence of these factors on the microalgae community changes species composition and their diversity in the freshwater ecosystem(Madhu et al., 2007).

Biodiversity dynamics at the ecosystems level
Forest ecosystems

The forest biome in the eastern and southern African region (ESA) region is highly diverse ranging from the high rainfall tropical moist forests to dry savannah woodlands. Montane forests are found in pockets in high-altitude, high-rainfall areas of Ethiopia, Kenya, Malawi, Mozambique, South Africa, Tanzania, Uganda, Zambia, and Zimbabwe, while lowland tropical moist forests are mostly found in Angola and Uganda. Moreover, Africa's semi-arid savanna ecosystems are characterized by high spatial and temporal variation in forage resources that influence the mobility of both wildlife and livestock population (Nelson, 2012). Spatially, vegetation variability occurs ranging from very fine-scale (plant level) to regional scale (landscape level), resulting in pronounced patches of quality and availability of forage. On the other hand, the temporal vegetation varies in terms of time ranging from a few seconds to several years. Although wild animals are constrained by nutritional stress, particularly in protected areas, due to seasonal fluctuations in quality and availability of forage and water resources(Adler et al., 2001) and also several factors (such as topography, weather, and climate) influence distribution pattern of animals, the vegetation characteristics (quality, quantity, species composition, plant morphology, and physiology) are the key determinant of ungulate migration(Range et al., 2002).

It is therefore important to understand ecological knowledge and nutritional requirements in both spatial and temporal changes in vegetation. Specifically, it is crucial to know existing potentials and the drivers for wildlife migration outside protected areas and the knowledge of interactions between native species and human impacts is an important step towards wildlife conservation.

Similarly, arid and semi-arid, freshwater and coastal, and marine ecosystems in the eastern and southern African region (ESA) are highly diverse, and also the ecosystems are characterized by high spatial and temporal variation in the different parts of the country. For example, according to (Darwall et al., 2015) explained that wetland biodiversity is particularly rich in Eastern Africa. Whereas, (UNEP, 2006 and (Al-suhabany, 2010) reported that ten of the 22 ESA countries on mainland Africa have coastlines; four are islands. These coastlines along the Atlantic Ocean are characterized by long sandy beaches interspersed with rocky outcrops while that of the Indian Ocean is rich in coral reefs and mangroves. These systems host a diversity of species and support important fisheries. Therefore, the Red Sea coral reefs off the coasts

of Djibouti, Eritrea, and Somalia are in the best condition, with 30-50 percent live coral cover and the richest diversity of coral and other reefs species in the entire Indian Ocean (Al-suhabany, 2010).

Habitat preferences

Habitat preference is the habitat most likely to be chosen by a species given the opportunity or which habitat the species is best suited for. According to this definition the global patterns of habitat preferences for amphibian diversity is not uniform (fig.3). The vast majority of amphibians, almost 5,000, depend on forests. Other terrestrial habitats are much less preferred by amphibians, in particular the drier habitats, such as savannas and deserts. These results are not surprising, as amphibians are well known for their preference for moist habitats. Perhaps a more surprising result is that only 4,224 amphibians depend on freshwater during some stage of their life cycle. Amphibians are renowned for their dual lifestyle, starting as youngsters in aquatic habitats then undergoing a metamorphosis to become terrestrial adults. However, although this is the most common life-history strategy for amphibians, many species develop directly from eggs without a larval stage (and a few live-bearing species). Many of these species do not rely on freshwater habitats at any stage of their lives (Ceballos et al., 2010).

On the other hand, the freshwater habitats preferred by amphibians have been split depending on whether they are still or flowing, or swamp/marsh. Flowing freshwater habitats for amphibians are usually streams. Still, freshwater habitats are often temporary rain pools or other small pools of fresh water. This distinction between freshwater habitats has a major influence on the likelihood that a species is threatened. Species that are associated with flowing water are more threatened than those that use still water (indeed, stream-associated species are particularly susceptible to chytridiomycosis for reasons that are still not understood) (IUCN, 2008).
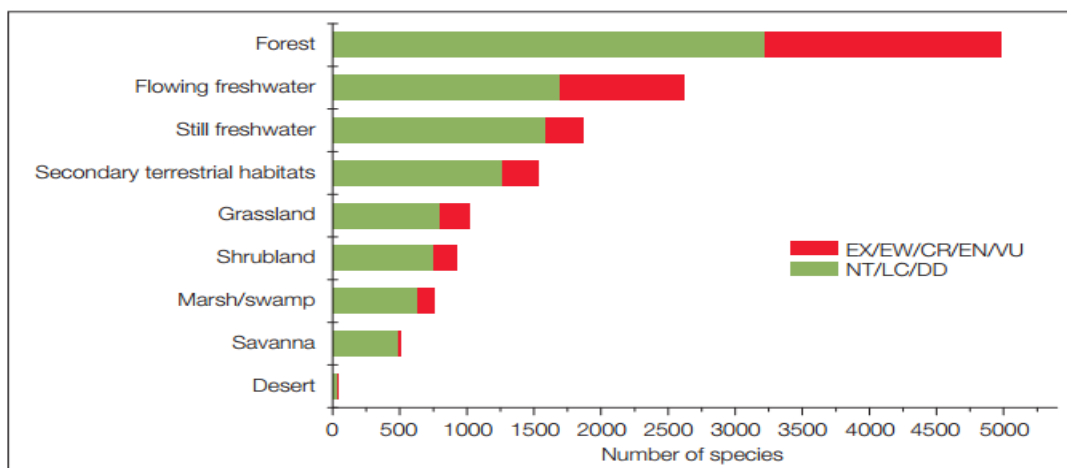

Figure 1: Habitat preferences of amphibians (Source: adapted from IUCN, 2008)

Factors influencing the distribution of biodiversity

The distribution of species is influenced by a large number of environmental factors, such as the geological history of the area, environmental stability (Ward and Stanford, 1979), ecosystem productivity (Lavandier and De´camps, 1984), habitat heterogeneity, and suitability(Santoul et al., 2005), and competition and predation (Pianka, 1978). However, these factors operate at several spatial and temporal scales. For

example, geologic history affects the biogeography of species at a regional scale and examines past events in the geological history of the Earth, and uses these to explain patterns in the spatial and temporal distributions of organisms (usually species or higher taxonomic ranks. The study of historical factors shaping species richness and distribution is often broken into two major categories: vicariance and dispersal. Species can occur in a location because their ancestors remained there passively as the environment moved around them (vicariance). Alternatively, a species or its ancestors may have arrived at a location via movement from another location (dispersal). Vicariance describes the disruption of the biogeographic range of a group of organisms by changes in the environment. Vicariant events can happen when landmasses move apart through tectonic action, or when mountains emerge to divide the geographic ranges of species. Vicariance typically leads to the emergence of new species through allopatric speciation, in which one ancestral species will result in the production of two new species that evolve apart from one another in geographic isolation, frequently by genetic drift rather than natural selection. Dispersal biogeography focuses on the movement of species from one location to another location. Jump dispersal events, when individuals of a species travel a relatively long distance to a new environment in which they did not previously occur, can result in the adaptive radiation of one ancestral species giving rise to a broad diversity of new species. An understanding of the systematics of the groups of organisms (i.e., the evolutionary relationships that exists between the species) is an integral part of these historical biogeographic analyses and influencing the distribution of biodiversity, whereas physical characteristics of microhabitats may influence local distributions and/or densities (Hastie et al. 2000). During the last decades, there have been many attempts to model the spatial distribution patterns of several species with the broader aim to bring out the influence of numerous biotic and abiotic factors, and the way they may act at various spatial scales (Inoue and Nunokawa, 2002).

Factors influence local distributions of biodiversity

 The problem of the diversity of local ecological communities has attracted the attention of ecologists for several decades. Individual communities differ greatly in their species diversity. Whereas some communities are composed of only a few species, other communities are extremely diverse: several hundred tree species may occupy one hectare of the tropical rain forest, and up to 25 species of plants may be found on a 10x10 cm square of the temperate meadow. Community diversity may be affected by several factors. Interspecific competition may limit species diversity, because the dominant species may out-compete the subordinate ones in the local community. The intensity of interspecific competition is affected by the productivity of a given environment—when productivity is low, the competition between species is stronger, because the amount of resources shared by the species is more limited. Interestingly, very high productivity may also promote competition, because the very productive environment aids in the proliferation of only the best-adapted species, which out-compete many less adapted species. Therefore, intermediate levels of productivity generally promote the greatest diversity, because there are sufficient resources, but interspecific competition is relatively symmetrical (that is, its effect is not so unidirectional, fast, and predictable)(Hillebrand & Blenckner, 2002; Ricklefs, 2004)

Some factors substantially limit the effects of interspecific competition and therefore promote species diversity. The most important are disturbances—unpredictable events that kill individuals and thus reduce population numbers. As in the case of productivity, intermediate levels of intensity and/or frequency of

disturbances promote greater species diversity. When the disturbances are too intense or frequent, they have fatal consequences for population persistence. When the intensity and/or frequency of disturbances are, on the other hand, too low, their effect is not strong enough to have any substantial effect. But when their intensity and/or frequency is appropriate (about many factors and local conditions, such as productivity, life histories of respective organisms, and so on), disturbances may reduce the population sizes of the dominant competitors, enabling the subordinate competitors to survive, and thus promoting species coexistence. Predation could have effects similar to those of disturbance, especially if the predator is opportunistic, i.e. when its prey forms the dominant species. In the case of an appropriate balance of both predation and disturbance, the populations of competitively dominant species are prevented from increasing in size to a level where they out-compete the subordinate species(Ricklefs, 2004; Storch, n d..). One of the major factors affecting biodiversity is environmental heterogeneity. It promotes the coexistence of species, because each species may be better adapted to some particular habitat, where it can out-compete other species. Habitat fragmentation may have a similar effect to that of heterogeneity in the strict sense, because it may limit dispersal of the dominant competitor (or predator, for example) and allow a subordinate competitor (or prey, respectively) to persist in local refuges, at least for some time. (On the other hand, habitat fragmentation may lead to population extinction, because small isolated populations are often unable to resist crises.) Environmental heterogeneity is often generated by disturbances, because disturbances are mostly local, creating mosaics of different habitat patches in different stages of recruitment. Environmental heterogeneity is an important factor in the species-area relationship revealed within one continuous landscape and a larger area can comprise more habitat types and thus harbor more species(Fahrig, 2003; Ricklefs, 2004).

Local diversity is affected not only by local conditions and interspecific interactions but also by the opportunity and ability of individual organisms to colonize a given locality. This opportunity is greatly limited by the isolation of the locality from other "source" localities. This effect is responsible for the lower diversity of island communities. Species impoverishment on islands is caused by the combined effect of isolation, which limits the colonization rate, and limited area, because limited areas harbor fewer habitat types and smaller populations of individual species, which are therefore more prone to extinction. Therefore, smaller and/or more distant islands generally contain fewer species. These so-called "island effects" are also responsible for the steeper regression line in the species-area relationship in the case of isolated areas; because immigration does not compensate for species extinction on the smaller islands. However, the presence and strength of island effects depend on the organisms involved, because "isolation" itself is recognized differently by different species. For some good dispersers (e.g. albatrosses or plants with light spores) even remote oceanic islands are not in fact "isolated," whereas for poor dispersers (e.g. some plants) individual patches of forest within a deforested area could represent true islands(D Storch, n.d.; Ward et al., 2014).

The size of the species pool (i.e. the set of the species able to colonize any given locality) seems to be even more important for local species diversity than the other factors. Some areas are species-poor simply because there are no more species in the entire region that could occupy the area. One hectare of temperate forest in Southeast Asia contains several times more tree species than one hectare of the same forest in Europe. This is not because of any of the factors mentioned above, but simply because the regional tree diversity of Europe is six times lower than the tree diversity of Southeast Asia (due to the geographical

constraint of south-north migration in Europe and the devastating effect of ice ages). Therefore, local distribution of diversity could be largely affected by regional diversity. The most extreme formulation of this statement, the so-called "species pool hypothesis," states that the effects of local factors on local species diversity are mostly minor in comparison with the effects of the species pool, i.e. the regional diversity(Hillebrand & Blenckner, 2002).

Factors influence Regional distributions of biodiversity

Regional diversity is the diversity of regions that are large enough to contain whole species geographical ranges. Therefore, it is supposed that the species originated in these regions (rather than colonizing these areas from outside), and the processes responsible for their origin and maintenance are regarded as important within that scale of diversity. Regional diversity is thus affected by the dynamics of speciation (the origination of species) and extinction. The factors influencing the rate of speciation and extinction affect the resulting regional diversity(Hillebrand & Blenckner, 2002; D Storch, n.d.).

Speciation

Speciation is the process of one ancestral species dividing into two or more new species. A species represents a distinct evolutionary line (i.e. a group of organisms sharing a common evolutionary path), and in sexually reproducing organisms this common path (i.e. species individuality) is ensured by interbreeding (i.e. the flow of genetic information between individuals within a population). Therefore, speciation in sexually reproducing organisms is caused by the division of ancestral species into two or more populations in which individuals can interbreed with each other, but cannot interbreed with individuals from the other population(s)(Ricklefs, 2004). The populations may be divided initially by any geographical barrier (e.g. a mountain ridge, or a sea) and subsequently may evolve separately. Due to their independent evolution, when the populations meet again, they may be reproductively incompatible, thus forming new species. Alternatively, they might interbreed, but due to their differences, the hybrids might be less fit and natural selection could lead (after generations) to the avoidance of mating of individuals from the different populations (species). This type of speciation, caused primarily by geographic separation of populations, is termed allopatric speciation (allopatric: inhabiting different areas). By contrast, in so-called sympatric speciation (sympatric: inhabiting a common area), the species divide without a preceding geographical division of populations. Especially in plants, but also in some fishes and amphibians, the species division may be caused by interspecific hybridization that is often accompanied by the multiplication of chromosomes (polyploidy)(Varga et al., 2019). The individuals differing in chromosome number may be unable to mate successfully with individuals of the ancestral species, thus forming a new species. Another form of sympatric speciation is sometimes called ecological speciation and occurs when the ancestral species can specialize ecologically in several alternative ways. When, for instance, the ancestral species is able effectively to exploit either one resource type or another, but not both types simultaneously, some individuals specialize for one type and some for the other type. Hybrids of the two ecological specialists would not be able effectively to exploit either resource type, and hybridization between the two types of specialists would therefore not be advantageous. Natural selection in that case would lead to the avoidance of interbreeding between the two types of specialists, and thus (after generations) these specialists could form new, ecologically distinct species(McGlynn, 2010).

It was supposed for a long time that allopatric speciation was the major speciation mode. The main pieces of evidence came from the fact that isolated areas such as islands carry plenty of endemic species, i.e., distinct species that are restricted to the isolated area. Therefore, isolation almost always led to speciation within evolutionary time scales. Sympatric speciation appeared to be only a minor speciation mode — interspecific hybridization and polyploidization were too rare, and competitive speciation seemed rather improbable for genetic reasons (there was the theoretical problem of how genetic mechanisms could lead to the avoidance of interbreeding between differently specialized individuals). Contemporary evidence suggests, however, that sympatric speciation is much more probable than was previously thought. There are some groups of closely related species inhabiting common places whose preceding geographical subdivision is highly improbable. In addition, some species are ecologically subdivided although the subpopulations still interbreed. One important factor promoting (or even enabling) this type of speciation is assortative mating, i.e. preferential mating between partners ecologically similar to each other. Sometimes assortative mating may lead to speciation even without complementary ecological specialization(Fahrig, 2003; Sharma & Rai, 2011).

Extinction

Today the number of species is the largest in the history of life; however, a considerable proportion of that biodiversity is endangered and many species have suffered anthropogenic extinctions. Species and population extinctions are natural phenomena, and massive biodiversity declines have occurred five times in the remote geological past. Over the past few centuries, however, human actions such as habitat destruction, toxic pollutant release, overharvesting, and transport of invasive species have caused a massive decline in biodiversity (Vitousek, et al., 1997), and greenhouse gas emissions may make the problem even more acute. The anthropogenic extinctions are now called the "sixth extinction wave "sixth extinction wave," may prove to be the most rapid and devastating with current species extinction rates on the order of 100 to 1000 times as high as in the past(Mayhew et al., 2012; McGlynn, 2010).

However, the risk of extinction will increase for many species that are already vulnerable**.** Species with limited climatic ranges and /or restricted habitat requirements and/or small populations are typically the most vulnerable to extinction, such as endemic mountain species and biota restricted to islands (e.g., birds), peninsulas (e.g., Cape Flora kingdom), and coastal areas (e.g., mangroves, coastal wetlands, and coral reef). In contrast, species with extensive, non- patchy ranges, long ranges dispersal mechanisms, and large populations are at less risk of extinction. While there is little evidence to suggest that climate change will slow species losses, there is evidence it may increase species losses. In some regions, there may be an increase in local biodiversity usually as a result of species introduction the long-term consequence of which are hard to foresee (UNEP, 1995). Generally, rates of species extinction have been greatest on islands and lakes, largely owing to their biological uniqueness and endemic character. Although species have a certain level of resistance to change and may continue to persist in isolated populations, many species have a high probability of eventually becoming extinct.

Conclusion

Biodiversity dynamics refers to the turnover of biological units across all spatial and temporal scales. The need for a broad view of biodiversity dynamics has often been expressed by both ecologists and

paleontologists. Ecologists have tended toward an ahistorical focus on general principles of current biotic interactions at relatively small scales of time and space. Paleontologists (and evolutionary biologists in general) have tended toward the other extreme, taking a historical view of biotic interactions at very coarse scales of time and space. Also, ecologists have often emphasized generality dynamics, whereas evolutionists have tended to emphasize the lack of generality found in contingent "random" events. The distribution of biodiversity is not uniform throughout the world but shows a rather uneven distribution. So that, species diversity decreases as we move away from the equator towards the poles. These indicate that in the tropical region, unlike temperate ones, there is more solar energy, water availability, and a relatively more constant and predictable environment. On the other hand, the distribution of biodiversity is influenced by a large number of environmental factors, such as the geological history of the area, environmental stability, ecosystem productivity, habitat heterogeneity and suitability, competition, and predation. However, these factors operate at several spatial and temporal scales. Therefore, the understanding of the spatial and temporal distribution of biodiversity is urgently required to formulate short and long-term resource management strategies as well as highly needed to develop and test or realize scientific hypotheses and to serve as baseline data in monitoring.

The way forward

In the light of land use and climate change which rapidly alter landscapes and ecosystems worldwide there is an urgent need for standardized and comparable data to detect changes of biodiversity. To help counter such threats, biodiversity conservation has emerged as a global priority to be addressed at multiple scales and includes tactics such as the establishment of protected areas and other effective area-based conservation measures. Measures or actions included in internationally renowned environmental-related conventions (e.g., Convention on Biological Diversity 1992, Convention on the Conservation of Migratory Species of Wild Animals 1973, Convention on International Trade in Endangered Species of Fauna and Flora 1973, etc.) towards conservation of biodiversity need to be followed. Conservation policies are therefore required that not only seek directly to protect biodiversity-rich areas but also to remove barriers in social inequalities and unfairness which eventually drive migration. Educating individuals in developing countries about the need to preserve biodiversity is a must for ensuring human survival. Despite this, the establishment of wildlife sanctuaries should take into account the environmental and nutritional needs of pets. Migratory routes (wildlife tunnels), breeding grounds and dispersal areas should be well constructed and protected. Most importantly, proper range management practices for improving biodiversities such as forest management, dry fire, veld rehabilitation, and water distribution. To maintain sustainable wildlife conservation in both protected and protected areas and to reduce human-wildlife conflicts, we recommend the development of a flexible and flexible community conservation program that includes a diverse range of stakeholders from the community to the regional level. For sustainable wildlife conservation both within protected and outside protected areas and reduction of human-wildlife conflicts, we propose the development of a flexible and adaptive community-based conservation system involving a diverse set of stakeholders ranging from community level to regional levels.

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