TERRESTRIAL VERTEBRATE DIVERSITY AND DEMOGRAPHY IN TROPICAL ECOSYSTEMS

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Summary

Biodiversity includes many aspects such as species diversity, genetic diversity, landscape diversity, ecosystems and the interactions among the different species in a community. Understanding the mechanisms that have produced life's diversity has been a pursuit of biologists for a long time. It is imperative to understand these mechanisms as they will aid conservationists in making decisions about which areas to preserve and how to manage these areas for the preservation of their biodiversity. The tropics are well known for their high diversity of animals and plant species, including terrestrial vertebrates, especially when compared to temperate regions. Several theories

have been proposed to explain this difference, some of which are based on differences in abiotic factors such as ecological and evolutionary time, productivity, area, climate, geometric constraints, and Rapoport's rule. Differences in biotic factors such as spatial-heterogeneity and competition (species interaction), have also been seen as important in theories explaining the higher diversity in the tropics as compared to temperate areas. Some of these explanations are tightly linked, but it is important to know which of these are correct and to what degree they are promoting diversity, since this information can then be used for the conservation of terrestrial vertebrates. Rainforests have been at the centre of discussion when it comes to species diversity, with many hypotheses proposed to explain the high levels of speciation. These hypotheses can be divided into evolutionary and ecological processes, most of which are related to speciation occurring via allopatry and include ecological and historical factors, such as the presence of river barriers and climatic fluctuations leading to the contraction of forests into small refuges. This chapter will discuss several of theses theories that are evoked to explain species diversity in the tropics and how they apply to terrestrial vertebrates and conservation issues in the tropics.

1. Introduction

Understanding the mechanisms that have produced the abundant diversity of life on Earth has been a goal of biologists for a very long time. This goal is far from being achieved, but nowadays, this topic is of great public interest as well as of scientific importance. The term *biodiversity* is widespread in the media and is well known. Its definition encompasses life's manifestations, including genetic, population, community, and ecosystem variation, also the ecological processes linking them and the most recognizable measurement of diversity, species diversity. Despite the fact that there are many species concepts in the scientific literature, here the one referred to as the biological species concept will be used, where two individuals are considered to be the same species when they are capable of producing fertile progeny. Basically, for the definition we will use, reproductive isolation defines different species. Two other concepts worth mentioning are "richness", which is the variety of species present in a given locality, and "diversity", which takes into consideration the number of species present as well as the abundance of each species. Diversity can be measured over different spatial scales, and when it comes to comparing diversities of different places there is: alpha (α) diversity, which is used when comparing the differences of diversity within habitats; beta (β) diversity, which compares the differences of diversity between types of habitats or ecosystems, and; gamma (γ) diversity, which compares the diversity between two geographical regions. Gamma diversity is also defined as the product of alpha and beta diversity.

The total number of species inhabiting the globe is still unknown. However, scientific efforts were able to describe 58,000 vertebrate species so far, according to the IUCN Red List. It is also known that the Earth's biodiversity varies greatly across the globe. It is possible to identify regions with high levels of endemic species, the so called "hotspots", which makes these regions prone to conservation concerns. These specific regions, for example, are inhabited by 27,298 species of four vertebrate groups: mammals (4,809), birds (9,881), reptiles (7,828) and amphibians (4,780). The tropical region contains most of the world's hotspots, 16 in total.

In the present chapter we will explore the nuances of the tropical region. This region amazed several early naturalists with its diversity of species and also influenced the early evolutionary thinking of Charles Darwin and Alfred R. Wallace during their journeys through the region (one should read Darwin's *Beagle Diary* for a taste of that). We will present the characteristics that make this region unique, the possible explanations for the existing diversity in the area and demographic patterns of tropical species, all with a focus on the terrestrial vertebrates. Finally, conservation issues are discussed, since the tropical biomes, in many cases, are heavily threatened.

2. General Characteristics of the Tropical Region

The tropical region is located in the vicinity of the equator, more specifically between the latitude of 23.5º N and 23.5º S, forming a vast area in the centre of the globe. The temperature is usually elevated, with a mean average of 18º C, and there are two seasons: rainy and dry. However, there is great variation among the different tropical ecosystems, largely because of the extreme heterogeneity, with each ecosystem having its own temperature, humidity, and rainfall characteristics.

Species diversity is one of the main features of the tropical region, with most groups of organisms having a higher diversity in the tropics. Factors such as habitat heterogeneity, altitude and climate affect the distributional pattern of species. Characteristics such as high temperatures and abundant rainfall usually favor biological production, and are linked to greater diversity in terrestrial vertebrates.

The current global pattern of species diversity is related to the historical factors that are unique to each biogeographical region. In the tropical region, the South American, African and Australian continents experienced prolonged isolation from the other continents, during which distinctive life forms evolved. However, the tropical region of Southeastern Asia, which remained isolated from Africa and South America, is much more closely associated with the temperate region of Asia, at least in terms of species diversity, than temperate North America is with tropical South America.

The tropical environments are rich in the number of species, as well as in the number of ecosystems in which the species occur. The tropical region is generally composed of tropical forests, savannas, tropical grasslands and deserts. Furthermore, each locality of the tropics has its own exclusive ecosystems, which gives each tropical region its own uniqueness.

Tropical rainforests are composed of high, evergreen and dense vegetation, which limits the amount of light that can reach the ground. Nowadays this type of vegetation covers only 6% of the earth's surface. The climate is warm with only slight seasonal fluctuations in temperature, and a monthly mean temperature of 27º C. The dry season, which is associated with the cooler weather, is very short or absent, with the exception of the tropical deciduous forests which lose their leaves during the dry season. Annual rainfall is high, with a mean of 200 to 400 cm, and in some localities over 1000 cm.

All else being equal, the tropical rainforests would be present across the entire equatorial zone of 5 to 10º north and south. However, factors such as the direction of

winds, montane regions, variation in sea surface temperature, among others, prevent the tropical rainforests from occurring continuously along the equatorial region.

Tropical rainforests are well developed in three main areas of the world, with approximately half of the tropical forests located in tropical America, or Neotropics. A second main area of tropical rainforest is located in Africa, centered in the Congo River basin. Half of this tropical forest is located in the Democratic Republic of the Congo, with most of the remaining forests in the Republic of Congo, Gabon and Cameroon. The third largest area of tropical rainforest, until recently, occupied most of the Malaysian peninsula and the larger islands of Borneo, Sumatra and Java. This region, which is also known as Sundaland, has very uniform forests. In the same area is the island of New Guinea, which is almost completely covered by tropical rainforest, and Australia which also presents a small, very fragmented area of tropical forest in the North East which is restricted to the coast and mountains.

Tropical grasslands and savannas are other biomes which are widely distributed in the tropical region. The vegetational physiognomy is fairly variable, with areas presenting arboreal and shrub vegetation to areas completely dominated by grass. Savannas may also provide corridors of tropical rain forest (gallery forests) following the watercourses. These biomes, which are usually found in very warm areas, have two well defined seasons, rainy and dry, and are prone to natural fires that often occur in the dry season. The savannas have a much lower annual rainfall, around 90 to 150cm, when compared to tropical rainforests. There is also greater variation in the mean monthly temperature, which is related to the dry season.

The ability to migrate to more favorable areas during the dry season is a very important behavior for birds and mammals in the tropical savanna. The largest areas of savannas and tropical grasslands are encountered in Africa, although considerably large areas also occur south of Asia, north of Australia and in South America (Llanos, Chacos and Cerrado). The savannas of East Africa maintain the richest fauna of large herbivorous mammals in the world. Also, Tropical flooded grasslands are found in South America, which flood during the rainy season, covering substantial parts of the region such as Llanos and Pantanal.

There are also deserts and semi-arid regions in the tropics. The greatest deserts of the world are found in localities that have high atmospheric pressure, where annual rainfall is minimal, around 20cm or completely absent. Due to the fact that vegetation is very sparse, the heat usually radiates very fast from the deserts in the night, creating huge fluctuations in temperatures that can vary from less than 0º C at night to 40º C during the day. Plants and animals that live in the deserts have developed special adaptations to cope with these harsh climatic conditions. Vast deserts are located north of Africa and in the meridional part of Africa and Australia. In South America, the Atacama Desert stretches from the coast of Peru to the north of Chile, and has an average rainfall of less than 2 cm a year.

Tropical scrub forests are located in tropical semi-arid regions in central and meridional Africa, Southwest of Asia, Australia, Northeast of Brazil (Caatinga) and north of the Yucatan peninsula of Mexico. These are usually large transitions between deserts and

savannas or between deserts and tropical deciduous forests. These areas are seasonally dry, with high temperatures and mean annual rainfall of 30 to 60 cm and can experience large deviations from one year to another. The perennial vegetation is resistant to dry weather, with succulent or deciduous plant species. In Australia, this is a region of great biological diversity. The Caatinga, the driest biome in Brazil, covers almost 10% of the Brazilian territory and contains moderate levels of biological diversity, but the region still lacks sufficient studies.

Other tropical ecosystems also contain high biological diversity. The mangroves are rich ecosystems comprised of woody plants located in the upper intertidal zones, but its structure and complexity depends on the adjacent terrestrial habitat. Another ecosystem located in the coastal area, with its vegetation composed by shrubs and weeds is the Restinga, which is of vital importance to migratory birds.

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Biographical Sketches

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