

CERRADO

Augusto Cesar Franco

Departamento de Botânica, Universidade de Brasília, Brazil

Mundayatan Haridasan

Departamento de Ecologia, Universidade de Brasília, Brazil

Keywords: Biodiversity, cerrado, fire behavior, invasive species, latosol, savanna

Contents

1. Introduction
 2. Vegetation
 - 2.1. Vegetation Forms
 - 2.2. Floristic Composition
 3. Climate and soil as determinants of cerrado vegetation
 4. Ecosystem functioning
 5. Seedling establishment, growth and productivity of native plants
 - 5.1. Woody Plants
 - 5.2. Grasses and Herbs
 6. Fire as a determinant of ecosystem functioning
 7. Anthropogenic impacts, biodiversity threats and global change
 8. Conclusion
- Glossary
Bibliography
Biographical Sketches

Summary

Cerrado biome occupies the central plateau of Brazil in South America. The total extent is over 200 million hectares. The region, characterized by a seasonal climate, has a rich flora and fauna and nutrient poor soils with few exceptions. Different physiognomic forms of vegetation with varying proportions of woody and herbaceous components, known by different local names, form a mosaic in the landscape. Though it is often compared with and even given the name of savanna, it is different in many ways and probably more complex than savannas in Africa and other continents. Its existence is traced back to nearly 40000 years before present, long before any human settlements had a chance to alter it. The variations in physiognomies are caused by differences in topography, soil depth, water regimes and presence of concretions which restricts root growth. The vegetation is resilient to fires during the dry season and individual plant species and communities show different adaptations for survival in a fire-prone environment. Native species have developed adaptive strategies to stride over the long dry season and to grow with very little nutrients. While cerrado has been left almost intact by the indigenous population and colonial settlers, human settlement during the twentieth century has altered the face of the cerrado beyond recognition in many places and less than 20% of native vegetation remains today. It is recognized as one of the *hot spots* of the world and considerable effort is being directed towards the conservation of

what is yet left in terms of native biodiversity.

1. Introduction

Cerrado, in the popular sense of the word, is the savanna vegetation of Brazil. The cerrado region extends over 200 million hectares and is surrounded by the Amazon forests in the north and the west, Caatinga dry forest in the north-east and the evergreen and semi-deciduous Atlantic forest in the east and the south. The Pantanal flood plain lies to the south west of the cerrados. The continuous core region of the cerrado extends from the Equator to 23°S and from 40 to 55°W, being the second largest biome of Brazil after the Amazons. Discontinuous patches of savanna like vegetation surrounded by Amazon forests outside the core region are also designated cerrado because of the floristic similarity of the woody component of the vegetation within the core area. The altitude varies from 300 to 600 m in more than 50% of the core area and less than 6% of the cerrado occurs over 900 m.



Figure 1. A cerrado landscape in the Federal District of Brazil. The trees are short and the canopy is not continuous in the cerrado *sensu stricto* (center).

The cerrado region, however, is not composed of a single vegetation type or phyto-physiognomy as it is often designated in technical literature. The cerrado landscape is a mosaic of different physiognomies ranging from open fields with no trees at all to forests of different densities and seasonal deciduousness. The term *cerrado* itself is used to signify a vegetation type (physiognomy), a biome or a region (domain) by different authors in the context of *savanna* vegetation of Brazil. It is often contrasted and

compared against similar neotropical savannas in other south American countries like Colombia and Venezuela (*llanos*) and elsewhere in Africa and Australia. Although *biome* is a global concept, many Brazilian authors treat *cerrado* as a biome by itself contrasting against savannas in Africa and Australia. Even in the narrowest definition, the cerrado biome includes different vegetation types (physiognomies) including *cerradão*, *cerrado sensu stricto*, *campo sujo* and *campo limpo*. In terms of vegetation structure, the cerrado vegetation is essentially composed of a continuous herbaceous layer with varying densities of tree and shrub vegetation (Figures 1 and 2).



Figure 2. A continuous herbaceous layer interspersed with shrubs and small trees is the main characteristic of a *cerrado sensu stricto*.



Figure 3. A dry deciduous forest during dry season in the Federal District of Brazil. The *campo limpo* is at one extreme with no tree and shrub components while the *cerradão* is often defined as woodland or a forest formation which is not included among other forests such as gallery and deciduous forests of the cerrado landscape (Figures 3, 4) since the floristic composition of the *cerradão* includes mostly cerrado species. The gallery forests and deciduous forests in the cerrado domain are characterized by floristic compositions different from the cerrado, though a few forest species may occur in the cerrado physiognomies.



Figure 4. An evergreen gallery forest in the Federal District of Brazil.

2. Vegetation

2.1. Vegetation Forms

Three major river basins (Tocantins, São Francisco and Prata) constitute the central Plateau of Brazil which forms the core region of cerrado. One important aspect of drainage of these basins is the presence of small watersheds throughout the biome which provides the framework for an infinite variety of soil and vegetation mosaics. Whereas climate is the principal determinant of vegetation on a global scale, local variations in vegetation physiognomy and floristic composition are determined by soil properties and soil water regimes. Geology, geomorphology and drainage play an important role in determining edaphic variations in any watershed. Gottsberger and Silberbauer-Gottsberger (see Bibliography) in their recent book on cerrado have reproduced various excellent photographs of cerrado vegetation including many originals by George Eiten who worked over three decades in the cerrado region. These photos show how the vegetation form varies with terrain. As the authors correctly emphasize, “when the whole range of physiognomies is taken into consideration, the cerrado is much more than a savanna, and therefore cerrado has to be considered a vegetation different from savannas”.

One way to look at variations in vegetation is to analyze vegetation changes along transects. However, analysis of single transects even in small watersheds often leads to oversimplifications and misconceptions of soil-plant associations. A more efficient way would be to look at the variations which exist along different directions (transects) in

watersheds at different scales. There is no single physiognomic type which covers the whole of a watershed in the cerrado landscape. Associated with variations in relief, ground water table level, drainage patterns and soils, the vegetation form also changes. The more important edaphic determinants of vegetation are soil fertility (availability of major plant nutrients) and effective soil depth as determined by the presence of concretions in the soil profile and nearness of seasonal or permanent water table to the soil surface. There is no single toposequence of vegetation types and soils since geological substrates and drainage patterns are seldom uniform. The cerrado *sensu stricto* in the level ground in the middle in Figure 1 is surrounded by small plateaus all around but the soil under the cerrado is deep and well drained throughout the year (Figure 5). In the toposequence in Figure 6, concretions in the soil and waterlogging during the rainy season restrict the tree density giving rise to a *campo sujo* in the foreground. The determinant of the *vereda* in the background is the absence of a stream and permanent waterlogging at the valley bottom.



Figure 5. The most common soil of the cerrado *sensu stricto* is well drained deep dark red latosol rich in iron and aluminium oxides.

The predominant vegetation type of the cerrado domain is the cerrado *sensu stricto* (Figure 2) which is mostly associated with deep well drained red latosols (Figure 5). A continuous herbaceous layer with different densities of tree and shrub species is the main feature of this vegetation, the tree and shrub cover varying from 10 to 60%. Other forms popularly designated as *cerradão*, *campo sujo* and *campo limpo* in Portuguese refer to variations in physiognomy, characterized mainly by the presence or absence of trees and shrubs and the extent of canopy cover, height and density of trees. *Cerradão* (augmentative of *cerrado* in Portuguese) is a forest physiognomy with taller trees and

greater canopy cover than cerrado *sensu stricto* but is considered part of the cerrado biome since its floristic composition is very similar to that of cerrado and very different from that of gallery and deciduous forests. *Campo sujo* has very few isolated short trees and shrubs with a continuous layer of grasses while *campo limpo* has only an herbaceous layer with no shrubs or trees. However, one must be aware that different authors call these vegetation forms by different names in other languages and even in Portuguese, providing varying details of the tree, shrub and herbaceous communities and the substrate on which the plants grow. The determinants of these vegetation forms are mainly edaphic factors and variations in soil water regime as discussed later in this chapter. The tree and shrub species of the cerrado do not tolerate long periods of anaerobic conditions and therefore do not occur on hydromorphic soils which are generally associated with *campo limpo*. Obviously dense stands of tall trees do not occur on nutrient poor shallow soils which is the reason for *campo sujo* in moist situations.



Figure 6. When the soil is not deep or well drained, a *campo sujo* with few isolated shrubs (foreground) or *vereda* (in the back with buriti palms) form as in this toposequence in the Federal District of Brazil.

2.2. Floristic Composition

The cerrado flora is very rich in biodiversity. Nearly 7000 plant species are reported for the cerrado biome of which nearly 45% are supposed to be endemic to the region. Both local and regional diversities are very large in the cerrado biome. Thus any small area of cerrado presents up to 120 tree species with up to 1100 individuals per hectare (alpha diversity). This does not mean that there are no geographical patterns in the distribution of cerrado species at the continental level. Recent studies using multivariate techniques

have revealed the existence of at least five regions (southern, southeastern, central, central-western and northern) within the core area with distinct groups of woody species, besides a distinct pattern in the Amazonian cerrados, separated geographically from the core region. However, none of the species found in specific studies in different regions of the biome occurs at all sites. Some idea of the extent of heterogeneity among the regions (southern, southeastern, central, central-western, northern and Amazonian) within the cerrado biome can be had from the fact that out of the 951 woody species encountered in one of the analysis, more than half (494 species) occurred in only one of these provinces. Only four percent (37) are reported from all provinces. The relative abundance of even these species varies from site to site.

These estimates do not include shrub species. A hectare of cerrado may present more than 70 shrub species besides arboreal species. One interesting aspect is the existence of same woody species in different strata of native communities, as shrubs and trees. The herbaceous layer of the cerrado is also very diverse in terms of floristic composition and life forms. The number of species is high with current estimates of nearly 4700 species for the cerrado region as discussed later in this chapter. It is not dominated by any particular grass species. Even in seasonally or permanently flooded margins of gallery forests or buritizais, there is no known monodominance as in the case of *Paspalum fasciculatum* which comprises 15% of flooded savannas of Venezuela. The grass component varies in response to edaphic factors and drainage conditions.

An important characteristic of the open forms of cerrado vegetation is that they share very few species with the forests formations which occur in the same landscape. A few gallery forest species occur isolated in the open cerrado but they are not common. The cerradão with greater canopy cover and even the cerrado *sensu stricto*, on the other hand, often have some species of the gallery forests. It is also interesting that dry deciduous forests which occur in the cerrado domain has greater floristic similarity with dry *caatinga* forests than with cerrado physiognomies.

Another aspect of the biodiversity of the cerrado vegetation is that the coexistence of the plant species is not guaranteed by an ample supply of nutrients. The cerrado vegetation as a community at the ecosystem level and the species at population levels are capable of surviving and reproducing with low quantities of nutrients and competitive interactions for these limiting soil resources are apparently not strong enough to result in the exclusion of species. However, many woody species develop more copious canopies and greater stem diameters when neighboring trees are cut and only a few isolated trees are left or when they are fertilized. Thus many species are capable of responding to higher resource availability. Many species are also exploited commercially by local communities.

-
-
-

TO ACCESS ALL THE 26 PAGES OF THIS CHAPTER,
Visit: <http://www.eolss.net/Eolss-sampleAllChapter.aspx>

Bibliography

Castro, A.A.J.F., Martins F.R., Tamashiro, J.Y., Shepherd G.J. (1999). How rich is the flora of Brazilian Cerrados? *Annals of the Missouri Botanical Garden* **86**, 192-224. [This article tries to address the question of biodiversity and species richness of the cerrado flora.]

Eiten, G. (1972). The cerrado vegetation of Brazil. *The Botanical Review* **38**, 201-341. [This is one of the most comprehensive and widely quoted review articles dealing with the cerrado vegetation.]

Folch, R. (ed.) (1995). *Enciclopedia de biosfera. Vol. 3. Sabanes*. 460 pp. Barcelona: Enciclopèdia Catalana, S.A. [This volume of the encyclopedia with excellent photographs, first published in Catalan and later in other languages, provides a comparison of the Brazilian cerrados with savannas in other continents.]

Folch, R. (ed.) (2000). *Encyclopedia of the biosphere. Vol. 3. Savannahs*. 460pp. Detroit: Gale Group. [This edition is the English translation of the original volume in Catalan.]

Gottsberger, G., Silberbauer-Gottsberger I. (2006). *Life in the cerrado: a south American tropical seasonal ecosystem*. Vol I. Origin, Structure, dynamics and plant use. 277pp., Vol II. Pollination and seed dispersal. 383pp. Ulm: Reta Verlag. [The authors of this book worked for over 16 years in Brazil and the opinions reflect their long term experience in the cerrado. The color photographs are of excellent quality]

Oliveira, P.S., Marquis, R.J.(eds.) (2002). *The cerrados of Brazil: Ecology and natural history of a neotropical savanna*. 398 pp. New York: Columbia University Press. [This book provides a synthesis of current views of Brazilian researchers on the determinants and functioning of the cerrado ecosystems.] <http://www.earthscience.org/r3/ES14606/> (Consulted August 10, 2007).

Pinto, M.N. (ed.) (1990). *Cerrado: caracterização, ocupação e perspectivas*. 657pp. Brasília: Editora Universidade de Brasília/SEMATEC. [This book, in Portuguese, deals comprehensively with different aspects of the cerrado biome.]

Ratter J.A., Bridgewater S., Ribeiro J.F. (2003). Analysis of the floristic composition of the Brazilian cerrado vegetation III: Comparison of the woody vegetation of 376 areas. *Journal of Botany* **60**, 57–109. [The authors compared the floristic composition throughout the cerrado region, providing an accurate assessment of distribution patterns of woody species in the cerrado biome.]

Ratter, J.A., Ribeiro, J.F., Bridgewater, S. (1997). The Brazilian cerrado vegetation and threats to its biodiversity. *Annals of Botany* **80**, 223-230. [This article alerts to the peril of losing the biodiversity of the cerrado through indiscriminate use and poor management.]

Scariot, A.; Felfili, J. M.; Sousa-Silva, J. C. (eds.) (2005). *Cerrado: ecologia, biodiversidade e conservação*. 439 pp. Brasília: Ministério do Meio Ambiente. [This book, in Portuguese, deals comprehensively with different aspects of the cerrado biome.]

<http://www.mma.gov.br/index.php?ido=conteudo.monta&idEstrutura=14&idConteudo=1918> (Consulted August 10, 2007).

Biographical Sketches

Augusto César Franco is Professor Titular in the Department of Botany of the University of Brasilia, Brazil. His current research interests include physiological ecology of tropical plants with focus on photosynthesis, water relations and on processes that limit plant establishment and growth.

Mundayatan Haridasan is Professor Titular in the Department of Ecology of the University of Brasilia. The emphasis of his past and current research in the cerrados has been on the mineral nutrition of native plants and soil-plant relationships, especially on different aspects of aluminum accumulation among native plants.