

## 2 Determinants of Tropical Savannas

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### 2.1 Introduction

Tropical savannas, defined as ecosystems formed by a continuous layer of graminoids (grasses and sedges) with a discontinuous layer of trees and/or shrubs, are the most common vegetation type (physiognomy) in the tropics. Tropical savannas are found over a wide range of conditions: rainfall from approximately 200 mm to 1500 mm a year, temperature from subtropical regimes such as the South American Chaco and the South-African savannas with temperature seasonality and cold-month average temperatures below 10 °C, to low-latitude savannas with no temperature seasonality, and soils from volcanic soils such as in parts of the Serengeti plains in Tanzania to dystrophic soils such as in the Brazilian cerrados. The one constant climatic characteristic of tropical savannas is rainfall seasonality. Yet the duration of the dry season can vary from 3 to 9 months, with a mode of 5 to 7 months.

Savannas can be subdivided into a number of savanna types (Table 2.1; Sarmiento 1984) based on rainfall, seasonality characteristics, and density of woody vegetation. These types are not always persistent in time, and natural and anthropogenically induced changes in climate, in nutrients, in fire regime, and in herbivory, can displace the borders of the areas occupied by the various types of savanna vegetation, and the borders with other types of vegetation: humid forests and semideserts. A good example is provided by the border between the Brazilian savanna known as the cerrado and the tropical forest. It is well documented (van der Hammen 1989; Furley et al. 1992) that during the Pleistocene dramatic expansions and shrinkage in the extent of the cerrado took place.

**Table 2.1.** Physiognomic types of savannas (Sarmiento 1984)

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1. Savannas without woody species taller than the herbaceous stratum: *grass savannas* or *grasslands*.
  2. Savannas with low (less than 8 m) woody species forming a more or less open stratum.
    - a) Shrub and or trees isolated in groups; total cover of woody species less than 2%: *tree* and *shrub savanna*.
    - b) Total tree/shrub cover between 2 and 15%: *savanna woodland*, *wooded grassland*, or *bush savanna*.
    - c) Tree cover higher than 15%: *woodland*.
  3. Savannas with trees over 8 m.
    - a) Isolated trees with less than 2% cover: *tall tree savanna*
    - b) Tree cover 2 to 15%: *tall savanna woodland*.
    - c) Tree cover 15 to 30%: *tall wooded grassland*.
    - d) Tree cover above 30%: *tall woodland*.
  4. Savannas with tall trees in small groups: *park savanna*.
  5. Mosaic of savanna units and forests: *park*.
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Savannas from different continents share very few Linnaean species particularly among the woody elements. The invasion of American and Australian savannas by African grasses is a recent phenomenon of human origin. Within an area, however, different savanna types often share common species (Sarmiento 1984; Cole 1986; Medina and Huber 1992). From a floristic point of view, savannas from different continents are quite distinct and show more similarities with other local vegetation types than with savannas in other continents. So, for example, the phylogenetic affinities of the flora of the Brazilian savannas known as *cerrado* are with the Amazonian flora, rather than with the flora of West Africa; however, physiognomically, the *cerrado* is more similar to the savannas of West Africa than to the Amazonian forest. In turn, African savanna vegetation types are floristically more related among themselves than they are with savanna vegetation in other continents. The conclusion is inevitable: the biota of different savannas are the result of convergent evolution from different floristic and faunistic stocks. As such they provide an interesting puzzle for the evolutionary ecologist: to identify the selective forces that create this unique and widespread tropical physiognomy.

Savanna ecologists have emphasized the similarities rather than the differences in savanna ecosystems. One such approach was the RSSD (Responses of Savannas to Stress and Disturbance) program of the Decade of the Tropics sponsored by IUBS, that developed a set of hypotheses to explain the function of tropical savannas (Frost et al. 1986; Walker 1987; Sarmiento 1990; Werner 1991). They postulated four principal selective forces – which were called determinants – to explain some of the common features and differences in savanna structure and function. These are: