**Savanna Formation**

**萨王纳的形成**

Located in tropical areas at low altitudes, savannas are stable ecosystems, some wet and some dry consisting of vast grasslands with scattered trees or shrubs. They occur on a wide range of soil types and in extremes of climate. There is no simple or single factor that determines if a given site will be a savanna, but some factors seem to play important roles in their formation.

萨王纳（热带草原或热带稀树草原）位于热带低海拔地区，干湿气候皆有。它

稀疏分布着树木和灌木的广阔大草原，是一个稳定的生态系统。它的气候极端，

且含盖了广泛的土壤种类。对于热带草原的形成原因，虽无一个简单唯一的解

释，但似乎仍有一些因素对他的形成起到了重大作用。

Savannas typically experience a rather **prolonged** dry season. One theory behind savanna formation is that wet forest species are unable to withstand the dry season, and thus savanna, rather than rain forest, is favored on the site. Savannas experience an annual rainfall of between 1,000 and 2,000 millimeters, most of it falling in a five- to eight-month wet season. Though plenty of rain may fall on a savanna during the year, for at least part of the year little does, creating the drought stress ultimately favoring grasses. Such conditions prevail throughout much of northern South America and Cuba, but many Central American savannas as well as coastal areas of Brazil and the island of Trinidad do not fit this pattern. In these areas, rainfall per month exceeds that in the above definition, so other factors must contribute to savanna formation.

热带草原通常会经历一个十分漫长的旱季。热带草原形成理论之一，就是湿润的

森林物种无法承受这个干燥的季节，因此这更有利于热带草原，而不是热带雨林

的形成。热带草原的年降水量在 1000 到 2000 毫米，绝大多数降水都集中在一

个长达 5 到 8 个月的雨季。虽然每年的降水总量充足，但至少会有几个月会几

乎无降水，这引起的干旱胁迫最终也只适合草地的生长。这样的条件广泛地分布

于南美北部和古巴的大部分地区，但也有例外，比如在中美洲的稀树大草原，巴

西的沿海地区和特立尼达岛气候的类型就不一样。在这些地区，每月的降水量超

过了之前定义的降水量范围，所以，一定还有其他因素影响着热带草原的形成。

In many characteristics, savanna soils are similar to those of some rain forests, though more extreme. For example, savanna soils, like many rain forest soils, are typically oxisols (dominated by certain oxide minerals) and ultisols (soils containing no calcium carbonate), with a high acidity and notably low concentrations of such minerals as phosphorus, calcium, magnesium, and potassium, while aluminum levels are high. Some savannas occur on wet, waterlogged soils; others on dry, sandy, well-drained soils. This may seem contradictory, but it only means that extreme soil conditions, either too wet or too dry for forests, are satisfactory for savannas. More moderate conditions support moist forests.

虽然有点极端，但在大多数特点上，热带草原和雨林的土壤还是相似的。比如说，和许多热带雨林土壤一样，热带草原的土壤通常为含酸量高的氧化土（某些氧化

物矿物占主导）和老成土（不含碳酸钙的土壤）。在这些土壤中，磷、钙、镁、

钾这样的矿物质含量非常低，而铝的含量却很高。有些热带草原的土壤潮湿，呈

渍水状态；而有些的土壤却干燥、多沙、易排水。这看起来矛盾，但却意味着只

有像过度湿润或过度干旱这样的极端土壤条件，才适合热带草原。温润的气候适

合湿润的森林。

Waterlogged soils occur in areas that are flat or have poor drainage. These soils usually contain large amounts of clay and easily become water-saturated. Air cannot penetrate between the soil particles, making the soil oxygen‐poor. By contrast, dry soils are sandy and porous, their coarse textures permitting water to drain rapidly. Sandy soils are prone to the leaching of nutrients and minerals and so tend to be nutritionally poor. Though, most savannas are found on sites with poor soils (because of either moisture conditions or nutrient levels of both), poor soils can and do support lush rain forest.

渍水土壤出现在地形平坦和排水性差的地方。这些土壤通常含有大量的黏土，这

就会使它们很容易处于饱水状态。由于空气不能渗入土壤颗粒中，土壤的含氧量

就低了。与之相对，干燥土壤是多沙和多孔渗水的。它们的粗质结构可以让水很

快排干。砂质土壤更易于营养物和矿物质的过滤渗漏，这就导致土壤缺乏营养。

虽然大多数热带草原都位于贫瘠土壤区（无论是因为各自的水分条件还是营养等

级），但贫瘠土壤也的确能够长出繁茂的热带雨林。

Most savannas probably experience mild fires frequently and major burns every two years or so. Many savanna and dry‐forest plant species are called pyrophytes, meaning they are adapted in various ways to withstand occasional burning. Frequent fire is a factor to which rain forest species seem unable to adapt, although ancient charcoal remains from Amazon forest soil dating prior to the arrival of humans suggests that moist forests also occasionally burn. Experiments suggest that if fire did not occur in savannas in the Americas, species composition would change significantly. When burning occurs, it prevents competition among plant species from progressing to the point where some species exclude others, reducing the overall diversity of the ecosystem. But in experimental areas protected from fire, a few perennial grass species eventually come to dominate, outcompeting all others. Evidence from other studies suggests that exclusion of fire results in **markedly** decreased plant‐species richness, often with an increase in tree density. There is generally little doubt that fire is a significant factor in maintaining savanna, certainly in most regions.

大多数热带草原都可能经历着频繁的文火焚烧，而大约两年就有一次大火燃烧。

许多热带草原和干燥林的植物种类都被叫做耐火植物，意思是它们善于用各种方

法来抵御偶尔发生的燃烧。虽然追溯到人类初至时亚马逊森林土壤中遗留的古木

碳表明湿润林带也会有不定期的燃烧，但频繁的大火还是热带雨林物种所不能适

应的因素。实验表明，如果美国的热带草原没有发生大火，物种的构成就会变得

完全不一样。焚烧的发生防止了植物之间的竞争，这就避免了因植物间的排挤而

减少整个生态系统的多样性。但是在防火实验区，一些多年生植物物种最终占得

主导地位，胜过了其他物种。其他调查证据表明，没有火的焚烧则导致植物物种

丰富性的显著减少，通常还会伴随着树的密度增加。这就可以确定，火是维持热

带草原的重要因素。当然，是在大多数地区。

On certain sites, particularly in South America, savanna formation seems related to frequent cutting and burning of moist forests for pastureland. Increase in pastureland and subsequent overgrazing have resulted in an expansion of savanna. The thin upper layer of humus (decayed organic matter) is destroyed by cutting and burning. Humus is necessary for rapid decomposition of leaves by bacteria and fungi and for recycling by surface roots. Once the humus layer disappears, nutrients cannot be recycled and leach from the soil, converting soil from fertile to infertile and making it suitable only for savanna vegetation. Forests on white, sandy soil are most susceptible to permanent alteration.

在某些地区，特别是在南美洲，热带草原的形成可能和为了建造牧场而对湿润林

地进行频繁的砍伐和焚烧有关。牧场的增加和随之而来的过度放牧导致了热带草

原的扩张。稀薄的腐殖质（腐烂的有机物）上层被砍伐和焚烧行为所破坏。腐殖

质是树叶被细菌和真菌迅速分解和根部表面循环的必需品。一旦腐殖质层消失

了，营养物质便不能循环并渗入土壤中了，土壤由肥沃变得贫瘠，这就使它只适

合热带草原植被的生长了。白土和砂土上的森林最容易受永久变更的影响。