



Fazenda Dona Soledade, in the Brazilian state of Paraíba: environmental diversity is a distinguishing feature of the Caatinga





The many faces of the *sertão*

Lack of water and a semi-arid climate have elicited sophisticated adaptive responses among species in the Caatinga

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During an 1818 Austrian expedition to Brazil – a scientific investigation that brought over researchers and artists to study and depict species and landscapes characteristic of Brazilian biodiversity – two naturalists, Carl Friedrich von Martius and Johann Baptiste von Spix, were struck by the diversity of vegetation in a forest that was theoretically rare for the region around the banks of the São Francisco River, in what is now the municipality of Januária, Minas Gerais State. Their fascination largely arose from the fact that the vegetation was in an area that was part of the Caatinga, an ecosystem identified by a predominantly semi-arid climate and scarce, highly variable water availability. Like many others, the two German naturalists probably thought that the Caatinga was a homogeneous environment, but that is not the case. “The region has a wide variety of environmental conditions that are essential to the emergence and sustenance of a number of species well adapted to the regional climate,” said biologist Bráulio Almeida Santos of the Federal University of Paraíba (UFPB), in a lecture he presented at the fifth BIOTA-FAPESP Education Conference Cycle, on June 20, 2013 in São Paulo.

The Caatinga, he explained, presently occupies 11% of Brazilian territory, an area approximately 845,000 square kilometers (km²) in size. It is divided into eight ecoregions – each having very distinct landscapes, soil types and vegetation – that can receive rainfall of less than 1,000

millimeters over a year. “In some areas, a dry spell can last as long as 11 months,” he said. The region is currently experiencing its worst drought in 30 years, affecting the lives of 27 million people. In the state of Bahia alone, over 214 municipalities have declared a state of emergency this year.

During the course of thousands of years, these environmental factors have elicited specific adaptive responses from the local plants, enabling them to survive in an increasingly hot and dry environment. One response in certain species involves an adjustment in leaf retention – and for good reason: the fewer leaves on a plant, the less water it loses during the driest seasons. Some of these plants are able to fix carbon dioxide (CO₂) at night and use it for photosynthesis during the day when their stomata-structures in the leaves that enable water and gas exchange – are closed. “These are just some of the mechanisms these species have found for preventing water loss via transpiration through the leaves. [This is] a simple strategy, but it enables them to retain water for the driest periods,” said biologist Luciano Paganucci de Queiroz of the Federal University of Feira de Santana in Bahia, a guest speaker for the conference cycle.

According to Queiroz, this type of rationing is a determining factor in the size of these plants and their leaves because this mechanism not only enables them to better adapt to the semi-arid climate but also limits the emergence of large trees. “The plants in the Caatinga do not grow



Left to right, biologists Bráulio Almeida Santos, Luciano Paganucci de Queiroz and Adrian Garda

continuously because sufficient water is not available to them throughout the entire year,” the biologist noted.

Another adaptive response of these plant species to the varied semi-arid environments is the protection they have developed for their leaves. Protection is afforded by means of thorny or pointy protrusions on the surface of the plant stem and trichomes, small “hairs” containing itchy or stinging substances that can cause allergic reactions upon contact with skin. Many plants in the Caatinga, such as cactus, are armed with these natural shields. “It is a very interesting defense mechanism against herbivorous animals,” Queiroz commented. “These species retain their leaves for only a short time during the year, and consequently they are very precious and need to be protected.” The conditions to which these plant species have been subjected, he says, are becoming an important environmental filter, influencing the evolutionary process of the species in this ecosystem over time.

ABUNDANCE OF SPECIES

Despite these unfavorable circumstances, the Caatinga has an enormous variety

of plants – about 6,000 species, including 1,333 genera, of which 18 are native (endemic) to the region. Of the 87 species of cactus in the Caatinga, 83% are exclusive to this ecosystem. Examples include *mandacaru* (*Cereus jamacaru*) and *xique-xique* (*Pilosocereus gounellei*), species that are threatened primarily “because they are removed from their environment when they are still small and sold as souvenirs at road-side restaurants,” Queiroz warned.

Leguminosae, the most diverse plant family in the Caatinga, includes several species exclusive to the semi-arid region, such as *mucunã* (*Dioeclea grandiflora*) and *jurema-preta* (*Mimosa tenuiflora*). Many of these plants perform important ecological functions. Owing to their association with some types of bacteria, these plants help fix nitrogen in the soil, thereby raising the available nutrient levels. However, even with the progress achieved in identifying new species such as *Prosopanche caatingicola*, a parasitic plant catalogued in 2012, data on the floristic biodiversity of this ecosystem is still very limited.

This knowledge gap also extends to the fauna of the Caatinga, particularly the invertebrates. The point was emphasized by biologist Adrian Garda of the Federal Uni-

versity of Rio Grande do Norte (UFRN), one of the June 2013 conference speakers. According to Garda, it was long held that the Caatinga was an ecosystem devoid of character, with low rates of endemism and species diversity. “It was thought that the Caatinga was a subsample of other ecosystems,” he said. Today, we know that it is the world’s most diverse semi-arid region.

THREAT TO DIVERSITY

According to data from the Ministry of the Environment (MMA), the semi-arid region of Caatinga has 591 bird, 241 fish and 178 mammalian species. According to estimates, 41% of species in the Caatinga are still unknown, and 80% have been insufficiently studied. “There is a shortage of data on animal diversity in this ecosystem,” Garda noted. However, the rates of endemism recorded there suggest that the fauna have gone through an independent local evolutionary process, with many species adapted to the region.

For example, *Corythomantis greeningi*, a tree frog typical of the region, spends months during the drought periods hiber-

Lizards of the species *Rubricauda parna* and *Ameiva ameiva* (below) and a tree frog (*Corythomantis greeningi*): complex adaptations to climate adversities





Above, a snake of the species *Epicrates assisi*, which is common in regions such as Cabaceiras, in Paraíba State (right)

nating in small rocky niches shielded by its highly modified skull, protecting itself from predators and storing water. *Scriptosaurus catimbau*, a lizard adapted to regions with sandy soils, “literally buries itself and ‘swims’ beneath the sand,” he commented. Other species, such as *Pleurodema diplo-lister*, a type of frog, can bury themselves over 1.5 meters deep to look for water during drought periods. “But we still need a better understanding of what we are trying to preserve,” Garda concluded.

According to the MMA’s Department of Biodiversity and Forests, 15,000 km² were deforested in the semi-arid region between 2002 and 2008, amounting to a little more than 2,000 km² per year. Today, just 54% of the original vegetation in the Caatinga remains. According to Santos, of the 364 conservation units registered with the MMA, 113 are designated for ecosystem protection and preserva-

tion, but these account for only 7.5% of the Caatinga’s total area of 845,000 km².

Santos believes that the principal cause of deforestation in the Caatinga region is energy production. When cut down, a native forest yields wood and charcoal for steel plants in the states of Minas Gerais and Espírito Santo or for the gypsum and ceramics industries operating within the semi-arid region. In his assessment, the consequences of misuse of the region’s natural resources are loss of habitat and fragmentation of ecosystems. “It is not a question of ceasing to use the Caatinga’s natural resources but rather of identifying to what extent we can use them without compromising the region.”

Santos noted that the unregulated raising of goats and sheep has also contributed to degradation of the vegetation in the Caatinga. Approximately 17 million goats and sheep consume the local veg-

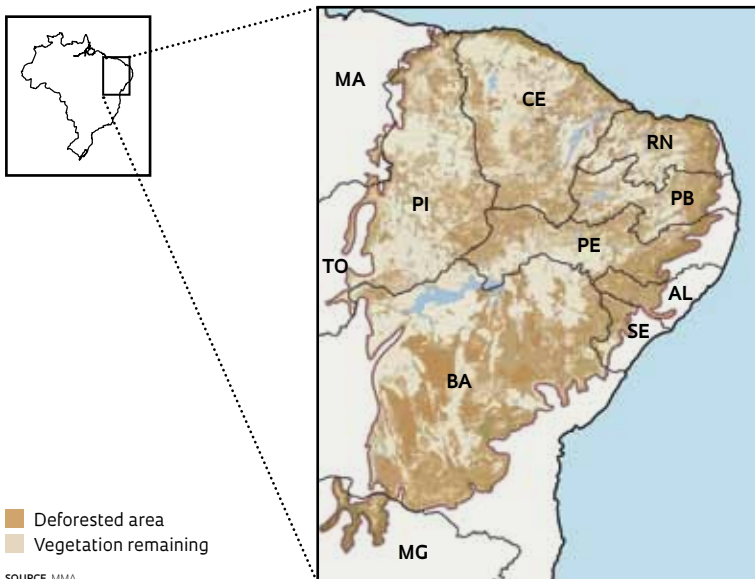
etation each day. “Often the fencing needed to keep the herd confined within an area costs more than the land. As a result, many farmers let their animals run free, and they consume vegetation indiscriminately.” He believes that unplanned use of natural resources is already leading to desertification in the Caatinga.

“The remaining vegetation needs to be preserved by expanding the network of protected areas,” Santos said. “It is important to promote proper management of areas influenced by human activity, and to educate everyone who lives among the region’s natural resources or uses them, to promote the idea that these resources belong to the Caatinga.” To achieve that goal, he concluded, it is critical that we expand support for research and education as well as oversight, so that we can preserve the biological diversity of the Caatinga that German naturalists discovered long ago. “We imagine ourselves transported to an entirely different country. Instead of dry, defoliated forests or high, open wilderness, we find ourselves surrounded on all sides by verdant forests that border extensive lakes abundant with fish,” they wrote in the narrative *Reise in Brasilien* (Travels in Brazil) in which they recount their 1817-1820 excursions there.

The BIOTA-FAPESP Education Conference Cycle is an initiative of the BIOTA-FAPESP program in partnership with *Pesquisa FAPESP*, focused on discussing the challenges involved in preserving Brazil’s principal ecosystems, Pampa, Pantanal, Cerrado, Caatinga, Atlantic Forest and Amazonia, in addition to the marine and coastal environments and biodiversity in anthropic environments, urban and rural. The lectures are intended to present knowledge gathered by researchers throughout Brazil and are aimed at improving the quality of environmental and science education for high school teachers and students in Brazil. ■

Unprotected semi-arid region

Conservation units account for only 7.5% of the Caatinga



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