Fire and grazers in the West African savanna

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Summary

Africa is often called ´the fire continent´ based on the high frequency and large extent of burning. Over 200 million hectares of land are regularly burned, most of which consist of savanna areas. Although some fires are the result of natural causes such as lightning, most fires are lit by man. Areas are burned for many reasons, including the preparation of agricultural land by removing grasses and shrubs, the stimulation of post-fire regrowth which can serve as a food source for cattle, and to create fire breaks around houses and villages.

These fires are an important component of the ecology of savannas. Fires affect many ecological processes, such as nutrient cycling, soil organic matter content, the cover of trees versus grasses, and the quality and structure of the grass sward. Without fire, many of the West African savannas would transform into dry forest or woodland thickets. Regular burning also has significant ecological effects on the herbivores living in savanna ecosystems. The African savannas are well-known for the high diversity of large herbivores, and in some areas more than 30 species of antelopes and related species coexist. In this thesis the ecological effects of fire on savanna herbivores in Bénoué National Park in North Cameroon are described, in particular the nutritional quality and structure of post-fire regrowth as a food source for herbivores, patterns of habitat selection on burned areas, the sharing of resources between potential competitors, and the diversity of savanna ungulates.

Savanna fires greatly affect the quality and structure of the grass layer. Some nutrients such as nitrogen, phosphorus and potassium are often higher in post-fire regrowth than in unburned vegetation. Ruminants need at least 5–7% crude protein in their food to survive. These protein levels are present in post-fire regrowth but not in unburned vegetation. Fire also increases the digestibility of the grass because the amounts of poorly digestible carbohydrates such as lignin and (hemi)cellulose are relatively low in post-fire regrowth. Finally, the structure of the grass sward is improved by burning, because fire removes a large part of the poorly digestible dead stems from the sward so that the regrowth contains mostly nutritious green leaves.

The high nutrient concentrations, high digestibility and improved sward structure have important consequences for the food and habitat selection by herbivores. Because of the inferior quality of unburned vegetation, I observed significantly more herbivores on burned areas than on unburned areas. Within burned areas the distribution of herbivores was mainly governed by the time elapsed since burning, the

amount of dead stems in the grass sward, the cover of grass, and the distance to the Bénoué River which is the main source of water in the park. Regrowth age (or the time elapsed since burning) was by far the most important factor governing the habitat selection by herbivores. Antelopes mostly selected areas that were recently burned, most probably because of the higher nutrient levels in young regrowth compared to older regrowth.

Several studies have shown that the body mass of a herbivore is related to the quality of the food it selects, and hence also to the competition between species. Theoretical studies predict that smaller species need higher food quality than larger species. However, analyses of dung samples of antelopes in Bénoué National Park showed that the levels of nitrogen and phosphorus in the diet of small species were not related to the body mass of ruminants. In addition, there was no relation between body mass and the digestibility of the food or the composition of the food (the species of grass in the diet). This indicates that grazing herbivores do not segregate in food quality along a body mass axis. Species-specific differences in digestive physiology are probably more important, as shown by the aberrant nutrient concentrations in the faeces of hippopotamus.

The question whether herbivores in Bénoué N.P. compete for food is difficult to answer with certainty. Some observations from the park such as a high dietary overlap and a regularity in body mass distribution are often quoted as indications for competition. However, the presence of competition between herbivores in Bénoué N.P. is seriously challenged by other results presented in this thesis. Herbivore species in the park differ in patterns of habitat use and spatial distribution in the burned landscape during the dry season. Thus even when diets are similar, differential habitat use can preclude competition!

Fires can affect diversity patterns of ungulates at both local and regional scales. At the local scale, herbivores were not randomly distributed over burned and unburned areas. Burned areas supported higher numbers of ungulates than unburned areas, although species richness was not different. In addition, grazers reached higher numbers and species richness than browsers on burned areas. The effects of fire on regional diversity patterns are even more prominent. Previous studies have argued that diversity patterns of large mammalian herbivores are governed by gradients of plant abundance and quality, which in turn depend on moisture and nutrient availability. However, the

results described in this thesis show that the diversity of grazers in West Africa is governed mainly by the occurrence of fire. Fires affect both the species richness and species composition of grazers. In many savannas the dry season grass quality is generally not sufficient for herbivores to survive. By improving the quality and structure of the grass sward, fires have become the main reason of the high diversity of antelopes in the moist savannas of West Africa.