



Ecology of Invading Plants

SESSION CHAIR: P HANNO (J) KILIAN

Tuesday, 20 July 2010, 14:00-15:30

Platform & Poster Presentations

PLATFORM PRESENTATION: THE RESPECTIVE ROLES OF COMPETITION, FIRE AND BROWSING IN ACACIA MELLIFERA ESTABLISHMENT EVENTS IN NAMIBIA

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Bush encroachment is largely a result of an inadequate understanding of the dynamics of encroaching species. Yet research in Namibia still focuses on symptom treatment, rather than on the underlying dynamics of encroaching species. Preliminary findings on *Acacia mellifera* subsp. *detinens* recruitment dynamics were used to develop a conceptual model. More rigorous field experiments investigating the roles of competition, fire and browsing in *A. mellifera* establishment events are being conducted at Neudamm Agricultural College in the semiarid Highland Savanna, to test this model. The soils are shallow lithic leptosols and MAR is approximately 361 mm, but is variable (CV = 40%).

In 2008, *A. mellifera* seeds were planted in the field in 288 0.81 m² exclosures and unfenced plots in four areas to test the roles of **1.** competition, **2.** fire and **3.** browsing on seedling establishment. **1.** Approximately half the seeds were planted next to climax grass tufts and the other half > 20 cm away. Half the grasses were clipped to reduce potential competition. Soil water potential was measured next to, and away from, grasses at 10 cm depth using gypsum blocks, following rainfall at regular intervals. Survival and above-ground growth rate were determined in 2008 and 2009. **2.** Fire was applied in 2008 to one of the four areas and in 2009 to two of the remaining areas (all with unburnt controls). Survival and resprouting of seedlings, saplings and mature shrubs were measured in burnt areas and controls. Fire temperature was measured at each monitored plant. **3.** Seedling survival in exclosures and unfenced plots was compared using χ^2 analysis to determine the impact of browsing. Mortality due to browsing by hares was also determined.

1. Correlations and LSD *post hoc* comparisons revealed that *Schmidtia pappophoroides* showed competitive effects, but *Antheophora pubescens* did not. In both cases, Seedlings were healthy in grass tufts, discounting competition as a factor in reducing establishment. Factors other than transpiration by grasses may be more important in determining soil water. **2.** 97% of seedlings died in the 2008 burnt area and 51% in the control (P<0.001; chi square) after one season of growth. Survival of saplings and mature shrubs > 10 mm in stem diameter was high (94%), most saplings resprouting after topkill. **3.** Survival in controls was significantly lower (60%) than in exclosures (83%) (P<0.001; chi square). In the dry season browsing by hares of survived seedlings increased from 13% to 31% in the 2009 dry season. 54% of seedlings browsed by hares did not resprout, and it is likely that these have died.

It is concluded that competition is unlikely to significantly affect woody recruitment dynamics in the semiarid Highland Savanna. Fire, applied during rare establishment events (approximately every 20 years) is effective in inhibiting transitions to bush thickets (bush encroachment). Hares reduce establishment densities by thinning out seedlings, particularly in dry seasons when graze loses quality.

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PLATFORM PRESENTATION: DYNAMICS OF ARID SAVANNA ECOSYSTEMS

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Arid savanna ecosystems are characterised by spatially distributed woody vegetation, grasses and shrub communities. It is found that it also dominates regions of low rainfall. Understanding the dynamics of arid savanna ecosystems is of great importance because it leads to further research in ecosystem patterns and processes. How woody plants interact with shrubs and grasses in this ecosystems is of global interest. In South Africa it has been estimated that 13 million hectares of savanna have been subjected to thorn bush encroachment. Despite the wide extent of this occurrence, little is known about the dynamics, patterns, processes and causes of bush encroachment. While it has been shown that encroachment in some areas is successional and takes place over centuries, reports from other areas indicate event-driven pulses of shrub recruitment. The factors considered as main causes of encroachment are grazing, fire, browsing and rainfall. The encroachment of shrubs into grassland and savanna can alter soil moisture, nutrient and microclimate conditions, and can suppress grass productivity. Woody vegetation and grasses compete for water in the surface layers of the soil, but woody vegetation has exclusive access to a source of water relatively deep underground. Where there is only a small biomass of grass the soil surface tends to become impermeable. Comparison of the dynamics of various savanna and other natural systems leads to the conclusion that the resilience of the systems decreases as their stability (usually induced) increases.

Non-equilibrium ecological theories are founded on the identification of the inherent dynamism of dryland ecosystems, where rainfall plays a greater role in plant growth than variations in grazing regimes. Vegetation changes are often not all, reversible, such that even systems classified as severely degraded demonstrate rapid recovery characteristics, especially following the return of good rainfall after drought years. This suggests that dryland ecosystem dynamics can be described by a set of discrete states of the vegetation community, and a series of distinct transitions between states. State and transition models imply that environmental changes can occur very rapidly and may be triggered by management actions such as increased grazing pressure or managed burning regime, and/or by natural events including rainfall variability and fire. None equilibrium concepts emphasise on understanding the interrelated effects of rainfall, grazing, and fire regimes in affecting the ecological and soil-resource bases.

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POSTER PRESENTATION: THE EFFECTS OF DIET, ANIMAL SPECIES AND SEED CHARACTERISTICS ON GERMINATION POTENTIAL OF *DICHRISTACHYS CINEREA* AND *ACACIA NILOTICA* SEEDS

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Dense woody rangelands provide a limited amount of forage to grazing animals because they are difficult to penetrate and have a reduced grass layer compared to open structures. The causes of woody plant encroachment have been attributed to several factors including heavy grazing by livestock, patchy rainfall, climate change, and fire suppression. These studies have not yielded a broad understanding of the problem and an integrated approach to manage increasing woody plant encroachment. However, it is generally believed that recruitment of tree seedlings is the



limiting step in the encroachment of woody plants. The objective of this study is to determine the effect of diet (low versus high quality), plant seed characteristics and animal species on passage rate, effectiveness of animal seed dispersal and germination rate of *D. cinerea* and *A. nilotica* seeds.

We ran two trials, where the first trial consisted of two parts. In the first part of trial 1, we investigated seed recovery from dung where goats, sheep and cattle were fed grass hay with *Acacia nilotica* seeds and lucerne hay with *Dichrostachys cinerea* seeds. In the second part of trial 1, we investigated seed recovery from dung where goats, sheep and cattle were fed grass hay with *D. cinerea* seeds and lucerne hay with *A. nilotica* seeds. Each animal in all animal species received 1000 *A. nilotica* seeds and 1000 *D. cinerea* seeds. Seeds were recovered from the dung for 9 days and they were germinated separately per day of recovery.

The second trial investigated germination rates subjected to the following treatments: 1) control (no scarification), 2) mechanically scarified, 3) goats fed grass hay with *A. nilotica* seeds and lucerne hay with *D. cinerea* seeds, 4) sheep fed grass hay with *A. nilotica* seeds and lucerne hay with *D. cinerea* seeds, 5) cattle fed grass hay with *A. nilotica* and lucerne hay with *D. cinerea* seeds. The germination trial will be monitored daily for a period of 28 days and all germinated seeds will be counted and removed.

In the first part of trial 1, more *A. nilotica* seeds fed with grass hay were recovered from goats (48.7%), sheep (26.5%) and cattle (23.0%) than *D. cinerea* seeds fed with lucerne hay from goats (23.9%), sheep (26.1%) and cattle (12.1%). In the second part of trial 1, more *A. nilotica* seeds fed with lucerne hay were recovered from goats (23.5%) and cattle (29.5%) than *D. cinerea* fed with grass hay from goats (19.1%) and cattle (11.6%). More *D. cinerea* seeds fed with grass hay were recovered from sheep (27.5%) than *A. nilotica* seeds fed with lucerne hay from sheep (23.7%).

Recovered seeds from feces will be used for germination test. The findings of this study will be used in an integrated approach towards management of woody plant encroachment.

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**PLATFORM PRESENTATION: PHYTOMASS AND ECOLOGICAL SIGNIFICANCE OF
CHRYSOCOMA CILIATA WITHIN THE LETS'ENG-LA-LETSIE CATCHMENT AREA OF
LESOTHO, SOUTHERN AFRICA**

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The study was conducted in the Lets'eng-la-Letsie catchment area, located in the Kingdom of Lesotho, southern Africa. It is an official Ramsar site, but suffers from overgrazing and erosion. The karroid shrub *Chrysocoma ciliata* is common on the drier slopes and is often associated with rangeland degradation. The area is an important grazing resource for local herdsmen, and they also use the *C. ciliata* shrubs as fuel for heating and cooking. The objectives of the study were to: (i) develop a phytomass quantification technique for Karroid shrubs; (ii) quantify the phytomass of *C. ciliata* and herbaceous plants on the upland slopes, and (iii) evaluate the ecological significance of *C. ciliata* in the study area.

The study area is located in the Highland Basalt Grassland of Lesotho (30°19'S, 28°10'E) at altitudes of 2400 - 2600 m asl. Twenty five *C. ciliata* plants were randomly selected for harvesting. The height and canopy diameter were measured and the leaves, flowers and twigs <2.0 mm (possible fodder for herbivores) separated from the twigs and stems >2.0 mm (fuel for cooking and heating). Material was dried (70°C) and weighed. Regression analyses were applied with plant phytomass as dependent variable and canopy volume, plant height and canopy diameter as independent variables. The canopy diameter of all rooted *C. ciliata* plants were measured in a belt transect (0.5 m x 200 m) and the phytomass calculated from the developed regression equations. Phytomass of herbaceous plants was determined with a harvest technique.



Positive relations between plant phytomass and plant height, plant volume and plant canopy diameter were found. Highly significant regressions ($P < 0.001$) were achieved with canopy diameter and the multiplicative regression model that yielded the highest correlation coefficients (Table 1). The upland slopes supported a high density of 35333 *C. ciliata* plants.ha⁻¹ with a phytomass of 3666 kg.DM.ha⁻¹. The edible parts of the plants were estimated at 1198 kg.DM.ha⁻¹. Herbaceous phytomass was very low and estimated at 446 kg.DM.ha⁻¹.

Table 1 Results of the regression analyses of the relation between canopy diameter and the different phytomass fractions of *C. ciliata*. (y=estimated phytomass (dry mass), x=canopy diameter.* a=log a)

Plant fraction	Regres model	n	r	r ²	P	a (intercept)	b (slope)
Phytomass < 2.0 mm	$y = ax^b$	25	0.96	0.93	<0.001	-2.75945*	1.72722
Phytomass > 2.0 mm	$y = ax^b$	25	0.96	0.92	<0.001	-2.8596*	1.92878
Total plant Phytomass	$y = ax^b$	25	0.97	0.94	<0.001	-2.12475*	1.8481

The development of a phytomass quantification technique for *C. ciliata* was very successful and the measurement of canopy diameter provided an accurate means of estimating the phytomass of these shrubs. Despite the reputation of *C. ciliata* as being unpalatable, there are indications that it is browsed by livestock. It is also considered valuable for its use as fuel in an area without trees. The low herbaceous phytomass is likely the result of both heavy continuous grazing, as well as negative competition interactions between the shrubs and the herbaceous plants. Due to a lack of reference sites, it was not possible to conclude if the high density of *C. ciliata* represents a natural state or one induced by overgrazing. It does, however, appear that *C. ciliata* is intolerant of wet conditions and degradation of the area will result in drier soil profiles, which will favour *C. ciliata*. Restoration of this ecological sensitive area will have to take cognisance of both the benefits and detriments of *C. ciliata*, but any restoration measure is likely to fail without reducing the stocking density of livestock, notably sheep.

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PLATFORM PRESENTATION: ECOLOGICAL NICHE SEPARATION OF *DICHAPETALUM CYMOSUM* (GIFBLAAR) ON SOUTH AFRICAN RANGELAND COMMUNITIES

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The aim of this study was to investigate mechanisms of species interaction and coexistence within *Dichapetalum cymosum* (gifblaar) communities in South African rangelands. Emphasis was on the balance competition model and niche separation by phenology amongst coexisting species. Our interest was to understand factors influencing the relative abundance of gifblaar in rangeland communities.

The study was conducted at Kwa-Mhlanga and Klipfontein, which are situated in Mpumalanga and Gauteng provinces of South Africa respectively. We used five 100 x 100 m plots in each province and nearest neighbour distance to investigate the spatial distribution of shrubs and trees within gifblaar communities. The dispersion analysis in both provinces revealed an aggregated population for all species (i.e. values approached 0) when the standard normal variate and Clark and Evans (1954) dispersion index was used.

These suggest that members of one species or both occur in familial clumps owing to the fact that they reproduce vegetatively and/or by seeds within small radius of dispersion. Further, this population may be aggregated because of heterogeneity of the habitat. There was no competition found among species in both provinces when a correlation analysis was done between nearest neighbour distance and combined canopy sizes of the nearest neighbour pair. The shrub species



(i.e. *Dichapetalum cymosum* - *Perinary capensis* and *D. cymosum* - *Pygmaothumnus zeyheri*) were found to be segregated, with interspecific nearest-neighbour pairs occurring less often than expected. In contrast, the shrub species (i.e. *P. capensis* - *P. zeyheri*) were found to be negatively segregated, with interspecific nearest neighbour pair occurring more often than expected.

Lack of competition among species within gifblaar communities suggests further research is needed to understand other mechanisms of species interaction and coexistence. Niche separation will be discussed in light with the data from the differences in the optima among coexisting species within gifblaar communities.

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A large rectangular area consisting of alternating light and dark grey horizontal bands, serving as a template for notes.