Assessment of plant species richness within and outside *Androstachys johnsonii* and *Colophospermum mopane* woodlands of Makuya Nature Reserve, Limpopo Province

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Introduction

Androstachys johnsonii (Lebombo ironwood) and *Colophospermum mopane* (mopani) are indigenous tree species found dominant in the poorly drained soil and rocky outcrops of the north-eastern part of the Limpopo Province of South Africa (Schmidt *et al.* 2002). Under the canopies of *A. johnsonii* and *C. mopane*, there are generally few shrubs and grasses growing, but species richness (defined as number of different species in a given area) of shrubs and grasses increases as one moves away from both *A. johnsonii* and *C. mopane* dominated stands (Chudnoff 1984).

According to Scholes and Walker (1993) and Scholes and Archer (1997), mature trees use deep soil water, and grasses use surface soil water. It is commonly believed that trees have a suppressive effect on grass production, whilst grasses have little direct competitive effect on mature trees. Both *A. johnsonii* and *C. mopane* secrete secondary or allelopathic compounds that suppress the establishment and hence growth and development of other species under their canopies (Munonde 1992, Rambau 1995, Molotja 2001, Lukhele and van Ryssen 2003). These allelochemicals are also known to play an important role in determining species distribution and abundance within plant communities (Einhellig 2002). Molotja (2005) investigated the effects of soils collected under *C. mopane* and *A. johnsonii* on the growth of *Zea mays* (maize), and reported that *Zea mays* grown on soils collected under *C. mopane* were healthier and greener than the ones grown on soils collected under *A. johnsonii*. Molotja (2005) concluded that there are toxic chemicals under *A. johnsonii* causing the death and establishment failure of other plants.

This paper focuses on the assessment and comparison of species richness within and outside both *A. johnsonii* and *C. mopane* woodlands on sandy and loamy soils. We

hypothesized that species richness would be higher on open habitats than within *A. johnsonii* and *C. mopane* stands, on both soil types. Besides casting shade, *A. johnsonii* and *C. mopane* are known to release secondary compounds that suppress the establishment of other plant species under them and as such limit plant diversity.

Method

The study was conducted at Makuya Nature Reserve, north-eastern part of the Limpopo Province, South Africa. It lies between 30° 50´E, 31° 05´E and 22° 25´S, 22° 35´S, along the Luvuvhu and Mutale Rivers. The soil type of the study site varies from loamy-sand to clayey in the undulating granitic landscape of the northern Kruger National Park. Annual summer rainfall varies between 250 to 500 mm per year, with a mean rainfall of 300 mm. The vegetation was described as Mopane Bushveld by Low and Rebelo (1996) and presently classified as Makuleke Sandy Bushveld by Mucina and Rutherford (2006). It is characterized by a fairly dense growth of *C. mopane* and mixtures of *Combretum apiculatum*, associated with *Acacia nigrescens, Adansonia digitata, Commiphora* spp*, Terminalia pruniodes* and *Androstachys johnsonii* while the ground layer includes *Panicum* spp, *Fimbrostylus hispidula* and *Indigofera* spp. The sandy-loam soil, low rainfall, high temperatures and lack of frost influence the distribution of

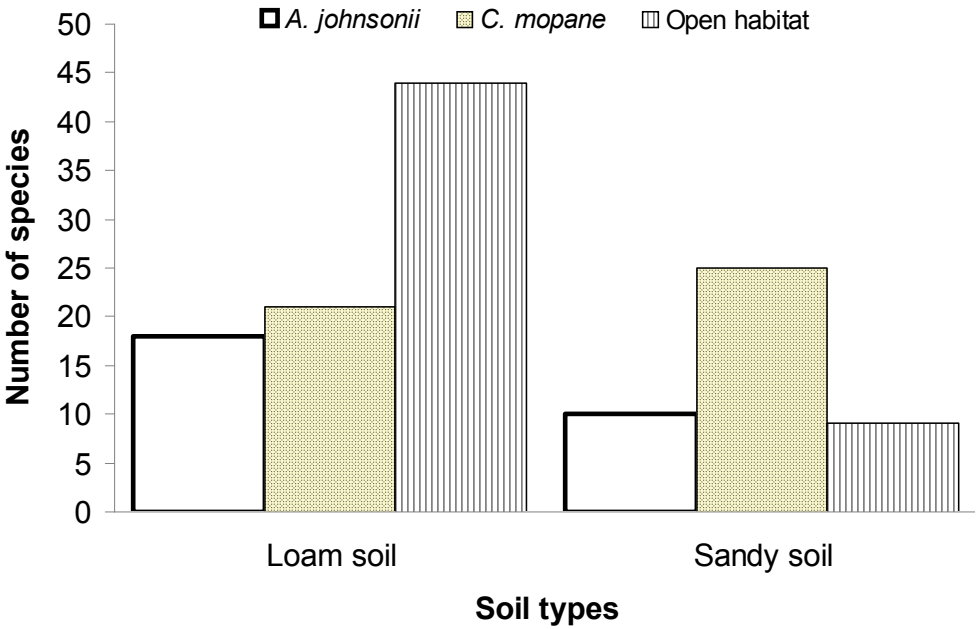

Figure 1. Comparison of species richness within and outside *A. johnsonii* and *C. mopane* woodlands on sandy and loamy soils.

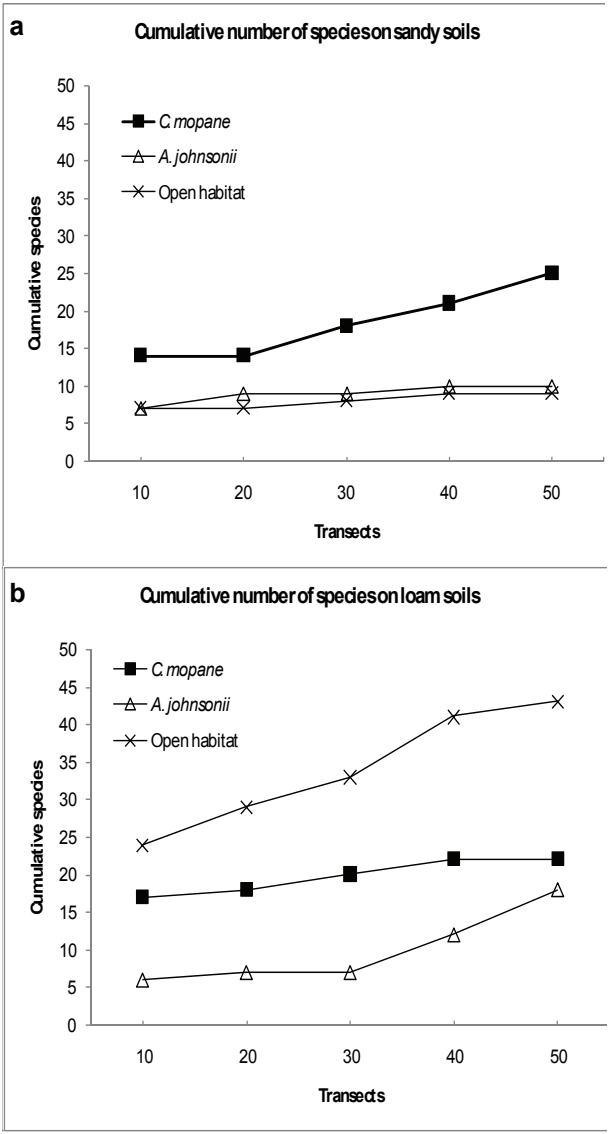

Figure 2. Cumulative number of species encountered within and outside *A. johnsonii* and *C. mopane* woodlands on (a) sandy and (b) loam soils.

this vegetation type (Rathogwa *et al.* 1999).

The belt transects and quadrat methods (Smith 1974) were laid out to sample within and outside *A. johnsonii* and *C. mopane* stands. Open habitats sites were recognised as areas without canopy effect on any large tree. Four plots, each of 20 m × 10 m in size, with 50 quadrats each of 2 m × 2 m, were placed within *A. johnsonii* and *C. mopane* stands on both loamy and sandy soils, with another pair of plots in the open on loamy and sandy soils. Species quantification included counting of individuals of all species present per 4 m^2 quadrat on each of the six plots. Differences in number of species and abundance within and outside both *A. johnsonii* and *C. mopane* stands were established. No statistical tests were performed as the study was pseudoreplicated.

Results

On loamy soils, species richness was highest on open habitats, low within *C. mopane* stands and lowest within *A. johnsonii* stands. On sandy soils, there was high species richness within *C. mopane* stands, and low on both *A. johnsonii* and open habitats (Figure 1). Cumulative number of species encountered on sandy soils was high within *C. mopane* stands (r^2= 0.94, y= 2.9x +

9.7), low on open habitats (r^2= 0.9, y= 0.6x + 6.2), and lower within *A. johnsonii* stands (r^2= 0.82, y= 0.7x + 6.9) (Figure 2a). Cumulative number of species encountered on loam soils was highest on open habitats (r^2= 0.98, y= 5x + 19), low within *C. mopane* stands (r^2= 0.94, y= 1.4x + 15.6), and lower within *A. johnsonii* stands (r^2= 0.82, y= 2.9x + 1.3) (Figure 2b).

Discussion and Conclusion

The results of this study suggest that *A. johnsonii* woodlands at Makuya Nature Reserve sustain few species within their woodlands and could probably cause an enormous decline in both species richness. Low species richness under *A. johnsonii* might be a strong indication that there are indeed toxic substances released by this species, and that such substances are remarkably suppressive to the wellbeing of the understory vegetation. *C. mopane* can interact positively with other species since it demonstrates that by high species richness found within its woodlands on sandy soils. Although *C. mopane* is believed to release secondary compounds, its effect seems to be less intense than that found under *A. johnsonii* stands. It was also thought *C. mopane* may act as a refuge for plant species that cannot tolerate direct exposure to high light intensities and allelochemicals. Several plant species tended to grow and establish themselves successfully well within *C. mopane* stands. On open habitats, low species richness is probably caused by exposure of plant species to direct sunlight which is surely scorching on sandy soil. Sandy soil is known for its high infiltration and low water holding capacity, hence less moisture and fewer nutrients are available to support variety of plant life. Accordingly, such soil type would generally support less number of species.

High species density on open habitats on loam soil may have been the result of no canopy effect, soil type and space availability to support shade intolerant species. The canopy cover effect, on loam soil may have a considerably high effect on species richness, within *A. johnsonii* and *C. mopane* stands. This probably might be as a result of intense competition between understory species for moisture and nutrients, resulting in only few species surviving under canopy environments. This results also show that different canopy habitats have different effects on the vegetation through canopy-induced factors such as competition, shading and allelopathic effects. Loam soil holds more water and is known of being rich in nutrients content. It should therefore be unsurprising to observe open habitats supporting highest species abundance and density than under canopy environments.

The cumulative number of species shows that there is a potential of finding more new species within *C. mopane* woodlands on sandy soils than within *A. johnsonii* and open habitats, whilst the same cannot be said for species on loam soil. Open habitat had the highest cumulative number of species becoming a preferred habitat for new species on loam soils, then C. mopane woodlands and *A. johnsonii* woodlands.

Overall this study shows that shading by both *A. johnsonii* and *C.*

mopane and probably other woodland species is a factor that needs to be borne in minds when overstorey-understorey interactions are looked at. Expansion of *A. johnsonii* woodland stands in Makuya Nature Reserve could probably cause an enormous decline in species richness, whereas *C. mopane* woodlands and open habitats may increase species richness on this area. Thorough understanding of this interaction has to be considered when looking at plants interaction and allelochemicals in conservation areas.

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