SUMMARY

Habitat fragmentation of the afromontane grassland of the escarpment region of

Mpumalanga, South Africa

by

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MAGISTER SCIENTIAE

The biological diversity of the planet is at great risk as a direct result of an ever-expanding human population and its associated activities. Landscape transformation to accommodate such activities leads to habitat loss and habitat fragmentation, often creating patches of relatively undisturbed habitat within a matrix of transformed areas that are often too small too support most species previously occupying the area and as a result loses its ecological integrity. A century ago the escarpment region of Mpumalanga consisted of large open plains covered with montane grassland dissected by montane forests and riparian vegetation alongside mountain streams. Today the grasslands and forests have almost disappeared from the area, the remaining patches mostly small fragments within a matrix of exotic tree plantations which have also dried up many of the rivers and streams in the area. The natural grassland areas persisting in the region are unique in habitat characteristics and floral species composition. It is also high in plant species richness, diversity and endemicity. The high degree of isolation experienced by

these floral communities poses serious threats to both the floral and faunal species that currently exits within these isolated 'islands', many of which are endemic to the area and at great risk of extinction. These risks call for serious collaboration between the land owners (mostly forestry companies) and conservationists to assure the practical and necessary preservation and management of this unique and crucially valuable natural resource.

This study aims to provide the first step into understanding the ecological principles associated with habitat fragmentation related specifically to the mountain grassland fragments within the afforestation matrix of the escarpment region of Mpumalanga, and to create a platform for the process of collaboration between land owners and conservation agencies to assess and manage these grassland patches.

The aims of Chapter 2 included:

1 To determine if any marked human-induced disturbance to the plant communities in the grassland fragments has occurred. I do this in three ways:

    a) To compare the plant community composition of eighteen fragments with those of six control plots outside of the plantations where no marked disturbance to the grassland can be observed.

    b) To determine whether the plant assemblages in the fragments can be assigned to any of the natural and intact plant communities that Matthews (1993) described from a large-scale survey of undisturbed mountain areas.

c) To determine the presence of any known intruder plant species within the fragments.

2 To assign conservation priorities to the remaining grassland fragments.

The results obtained from the TWINSPAN analysis revealed six alliances of plant communities grouped hierarchically into four orders and two major classes of montane grassland. The DECORANA supported these results, indicating clear differences between communities 1.1 (Eriosema salignum – Loudetia simplex grassland of the wetter North region), 1.2 (Lobelia erinus – Panicum natalense grassland of the Transitional region), 2.1 (Parinari capensis – Eragrostis racemosa grassland) and 2.2 (Helichrysum rugulosum – Eragrostis racemosa grassland). Different plant communities revealed different combinations of geological characteristics, slope, aspect and elevation. The sample plots of isolated grassland fragments and those of large unfragmented areas compare well with each other - the species richness of experimental and control plots do not differ significantly. Also, the species composition of plots from the Wetter North, Transitional and Drier South regions show more variation than is evident between experimental and control plots. There was also good qualitative comparisons (quantitative comparisons were not possible as a results of sampling and analytic discrepancies) between the sample plots used in this study and the plant communities described by Graham Deall and Wayne Matthews. Some evidence of exotic invader plants was found within the sample plots, notably *Pteridium aquilinum*. Fortunately such species were localized in their distribution and restricted to community 1.1.2.2.

The aims of Chapter 3 included the following:

1. To compare the faunal biodiversity in grassland fragments within afforested areas to that of control plots in large, relatively undisturbed grassland areas.
2. To determine to which degree the Coleoptera, Orthoptera, Lepidoptera and bird communities reflect recognized plant communities, and are restricted to specific plant communities.
3. To compare the habitat specificity (degree of stenotopy) of the different taxonomic groups and trophic levels of animals.
4. To make recommendations for the conservation of the Afromontane grassland fauna in the remaining grassland fragments in afforested areas.

The sampling of 15602 beetles, grasshoppers and crickets were collected, with an average of 3900 per sampling period, revealed unique combinations of animal species linked to the different plant communities mentioned above. Significant differences were evident from the one-way analyses of similarity (ANOSIM) used to compare the faunal community structures of sample plots of the Wetter North, Transitional and Dryer South regions. The faunal community structures of the experimental and control plots of the Wetter North and Transitional regions did not differ significantly. The indexes of habitat specificity (fractions of species constricted to certain plant communities) indicated that the plants and butterflies were more habitat-specific than the Coleoptera, Orthoptera and Birds. The carnivorous insects showed a surprisingly high level of habitat specificity compared to the relatively low level of the phytophagous insects. This surprising trend was also evident in various insect families – Acrididae, Scarabaeidae and Nymphalidae had relatively high levels of habitat specificity compared to that of the Curculionidae and the Chrysomelidae.

Chapter 4 has the following aims:

1. To quantify the effect of several environmental characteristics (slope, rainfall, geology, etc) on the faunal community structure of the grassland fragments.
2. To quantify the effects of degree of isolation on species richness, species diversity and assemblage structure of plants, insects and birds in grassland remnants.
3. To test for the effects of edges on the extant insect biodiversity in the grassland fragments inside plantations.
4. To quantify the effects of fragment size on species richness, species diversity and assemblage structure of plants, insects and birds.
5. To rank the grassland fragments in an order of conservation importance using factors such as biodiversity and uniqueness of the floral community.

No clear relationship between fragment size and area sampled and species richness and/or – diversity was evident from the results. Indeed, the smallest area sampled had the fourth highest species richness and the largest area sampled had the fourth lowest species richness and species diversity. Regressions results did not show any significant effects of the geographical area sampled on the biodiversity estimates of the fragments. Therefore I assume that the estimates arrived at for the area sampled within each fragment is representative of that of the complete fragment.

The Detrended correspondence analysis (DCA - using square root transformed abundance data) used, indicated the need to perform a gradient analysis using a redundancy analysis (RDA). The permutation test resulting from this analysis revealed a non-significant value for the first canonical axis, but a significant value for the first four canonical axes together. The ten species contributing the most to above-mentioned result include two Scarabs (Scarabaeidae – Aphodius sp 1 and Melolonthinae sp 2), two weevils (Curculionidae – Eudraces sp 1 and Curculionidae sp 42), one leaf beetle (Chrysomelidae – Asbecesta near capensis), one darkling beetle (Tenebrionidae – Lagria sp 1), one longhorn beetle (Cerambycidae – Anubis scalaris), one jewel beetle (Buprestidae – Buprestidae sp 1), one ladybird (Coccinellidae – Coccinellidae sp 4) and one Dor beetle (Bolboceratidae – Mimobolbus maculicollis). Of these ten beetles only three are not restricted to the Drier South Region (Anubis scalaris – Wetter North and Drier South, Lagria sp 1 – throughout and Eudraces sp 1 – throughout). The associated stepwise multivariate regression showed distance to the nearest grassland to be the only environmental characteristic to significantly influence the faunal community structure of the fragments. Slope was the environmental characteristic with the smallest effect. In contrast with the results from redundancy analysis, the analysis of similarity (ANOSIM) and t-tests did not reveal significant differences in the faunal community structure of fragments closer to – and further than one kilometre from the nearest grassland neighbour. This trend was the most evident for fragments of the Transitional region and the least obvious for the fragments of the study area as a whole. The SIMPER analysis showed that of the ten species contributing most to the dissimilarity between insect communities of fragments closer/further than one kilometre from the nearest grassland neighbour, eight were also in the group of ten species characterizing the faunal communities of either/both groups (contributing towards similarity).

The insect communities found at 10, 20 and 50 metres from the edge of the grassland fragments did not differ significantly, nor did an ANOSIM performed separately for each of the three major plant communities reveal any significant edge-related differences. The ANOVA results for the individual species revealed only one (of 57 - in the Transitional region) having a distribution that differs significantly with respect to distance from the habitat edge: *Eremnus* sp. 2 was only found at 10 metres from the edge of the fragment, close to the plantations. Of all the groups, only bird diversity, bird richness and general faunal diversity showed significant relationships with fragment size. There was a non-significant trend for insects to biodiversity to be reduced in very small fragments. Most of the botanical data exhibited no significant relationship with fragment size. The species composition of control sites were not found to be significantly different from that of experimental fragments for all the faunal groups pooled together or for the fragments of the Transitional Region and the Wetter North Region. Using the four separate scores for birds, butterflies, beetles and grasshoppers, each fragment was assigned a total conservation score. The twenty-four fragments were then ranked in order of conservation importance. Fragments of the Wetter North had an average score of 65.3, fragments of The Transitional Region 66.6 and fragments of the Drier South 52.3.

The results relating to this study has lead to the following conclusions:

- It is concluded that afforestation and habitat fragmentation have not significantly impacted on the flora of the montane grassland of the study area since many of the grassland fragments surrounded by plantations are still easily identifiable as natural communities, described by Matthews and Deall in broader-scale surveys in the past. Also, no obvious invader – or disturbed plant communities are discernible even though some of them have been isolated for as long as 40 years.
- The plant communities of conservation importance described by Matthews coincide with the important communities recognized in this study. Rare and endangered plant species, as well as species endemic to the region, are more often than not found on the scarce Black Reef quartzite of the region, which is more evident to the Northern part of the study area. Communities 1.1 and 1.2.2 are therefore of particular conservation importance, not only as a result of their scare geological base, but also because of the high risk associated with the few grassland examples left of these communities.
- The high levels of habitat specificity of many of the taxonomic and trophic faunal groups indicate that many of the invertebrate taxa are probably endemic to the region, and that the plant endemicity encountered in the Afromontane grasslands is reflected by a similar degree of animal endemicity.
- The similarity in faunal assemblages and diversity between isolated fragments and large areas of grassland emphasizes the conservation importance of the fragments, even when smaller than 5 Ha in extent.

- Appropriate management of the grassland fragments within the plantations is therefore important for the conservation of the plant and animal taxa encountered there. Experimental management involving grazing, mechanical cutting, grazing and burning is needed to decide on an efficient management regime, so that the grassland biodiversity can be conserved in a planned way. Such work will also allow empirical testing the efficiency of the indicator species suggested above.

- Isolated grassland fragments in this study represent largely unaffected natural plant and insect communities, differing little from large unfragmented grasslands in the study area.
- Fragments found within afforested areas therefore have a high conservation importance, since they represent 'natural' grassland areas and are often the only representative of a particular plant community left in the area.
- No significant edge effects on the faunal communities 10, 20 and 50 metres from the fragments' edges exist as a result of afforestation in the area.
- Birds (and probably other vertebrates in these grasslands) are affected by fragment size, while invertebrates are much less affected and plants do not show any measurable effect of fragment size.

- Fragments in the wetter northern part of the study area, characterized by high levels of plant endemicity, have a higher conservation importance as judged by faunal biodiversity.

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