Importance of vegetation analysis in the conservation management of the endangered butterfly *Aloeides dentatis dentatis* (Swierstra) (Lepidoptera, Lycaenidae)

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Deutschländer, M.S. and G.J. Bredenkamp. 1999. Importance of vegetation analysis in the conservation management of the endangered butterfly *Aloeides dentatis dentatis* (Swierstra) (Lepidoptera, Lycaenidae). *Koedoe* 42(2): 1–12. Pretoria. ISSN 0075–6458.

The study of the vegetation of the Ruimsig Entomological Reserve, Gauteng, South Africa revealed four plant communities one of which could be subdivided into two sub-communities and variants. The extensive climax stage of the vegetation represented by the *Themeda triandra - Trachypogon spicatus* grassland was found to be too dense and tall to support the butterfly *Aloeides dentatis dentatis* and the host ant *Lepisiota capensis* (Mayr). A degraded phase caused by succession in an area where pipes have been laid was found to be ideal habitat for both ant and butterfly. This vegetation also contained adequate numbers of the food plant *Hermannia depressa*. A seral community with tall-growing *Hyparrhenia hirta* was also found to be an unsuitable habitat for the butterfly. The identification of the preferred ideal habitat for the host ant and butterfly resulted in the compilation of a conservation management strategy that ensured the survival of the rare and endangered butterfly.

Keywords: disturbance, fire, grassland, habitat, phytosociology, *Aloeides dentatis dentatis*.

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Introduction

Aloeides dentatis dentatis (Swierstra) (Lepidoptera:Lycaenidae:Theclinae) (Pringle *et al.* 1994) is a small copper-coloured butterfly, living in association with the ant *Lepisiota capensis* (Formicidae) (Mayr) (Bolton 1995). The butterfly is orange on top and red with intricate black and silver markings on its underside. The female butterfly lays two eggs on the under surface (abaxial surface) of the leaves of the food plant *Hermannia depressa* N.E.Br (Sterculiaceae), after she has detected the host ant or its pheromones on the food plant (Henning *et al.* 1985).

The first to third larval instar of the butterfly feeds on the leaves of the food plant. During the third to the sixth instar the larvae are attended to by the ants, while sheltering in the ant nest during the day. *Aloeides dentatis dentatis* larvae secrete pheromones mimicking the smell of the ant brood (Henning 1983). However, they do not harm the ants or their brood, as they are entirely phytophagous (Pringle *et al.* 1994). The larvae leave the nest together at night to feed on *Hermannia depressa* under the attendance of the ants by mimicking certain pheromones. The pheromones excite and alert the host ant attracting them to the lycaenid larvae, which are protected by the ants on their journey to and from the food plant (Henning 1983).

In 1984 Ruimsig in the Roodepoort Municipal area was proclaimed a township. This area was the last known breeding habitat for the butterfly *Aloeides dentatis dentatis*. An area of twelve hectares was set aside in 1985 by the Roodepoort City Council for the conservation of the butterfly (Henning 1994). Evidence exists in Great

Britain that large populations of both common and scarce butterfly species can be supported in small, isolated areas (Munguira & Thomas 1992).

Besides *Aloeides dentatis dentatis*, about one hundred butterfly species are found on the reserve (Henning 1994). Fifteen of these species have not been recorded elsewhere on the Witwatersrand, four of which live and breed at Ruimsig including, *Aloena amazoula ochroma*, *Aloeides trimeni trimeni*, *Lepidochrysops ignota* and *Spialia asterodia* (Henning *et al.* 1983 unpubl.).

After the proclamation of the reserve, management prevented any disturbance. This led to an increase of the grass species *Themeda triandra* and a decrease in the number of *Aloeides dentatis dentatis* observed (Henning 1994). Fire breaks were made around the perimeter of the reserve to protect the vegetation from normal Highveld veld fires during the first winter. The following season *Aloeides dentatis dentatis* was not noted in the reserve, though a few individuals were observed on the firebreaks (Henning 1994). A total of 75 individual butterflies were counted by Henning when this study commenced in 1987. Optimal breeding habitat and conditions had to be identified, to enable the formulation of management strategies for the conservation of the butterfly in the reserve.

Study area

Ruimsig Entomological Reserve is situated on the northwestern outskirts of the city of Roodepoort, near the Witwatersrand National Botanical Gardens, between 27°51'E longitude and 28°00'S latitude. It is approximately 1579 m above sea level (Behr & Bredenkamp 1988), with a typical Highveld climate. The mean annual summer rainfall is 767 mm, occurring mostly between October and April. The mean temperature for January is 20 °C and for July 9.5 °C (Weather Bureau 1988). Frost during winter plays an important role in the distribution of woody plant species.

The reserve is situated in the Rocky Highveld Grassland (Bredenkamp & Van Rooyen 1996) and in Acocks's (1988) Bankenveld. This vegetation type is characterised by various grass species as well as an abundance of dicotyledonous forbs.

The soils of the reserve vary from distrophic to mesotrophic red soils of the Hutton Form to shallow, rocky soils of the Glenrosa soil Form (Soil Classification Workgroups1991). Mica schist ridges are found scattered in the reserve (Bredenkamp & Bezuidenhout 1986).

Methods

In order to compile a management strategy, it was necessary to classify the vegetation of the reserve, to enable the identification of different habitats. Furthermore, it was necessary to identify the optimal habitat for *Aloeides dentatis dentatis*, and to extend the existing optimal habitat. It was also necessary to create new optimal habitat situations through proper management.

A total of twenty 10 x 10 m sample plots were surveyed in the study area during the period January – May 1987. All plant species found were noted. The cover-abundance of each species was estimated by using the Braun-Blanquet cover-abundance scale described by Mueller-Dombois & Ellenberg (1974). The floristic data were classified by TWINSPAN (Hill 1979a) and refined by Braun-Blanquet procedures, using TURBOVEG (Hennekens 1996a) and MEGATAB (Hennekens 1996b) (Table 1). A possible vegetation gradient was determined by using DECORANA (Hill 1979b). Environmental information collected includes soil type, aspect and rockiness of the soil surface, as well as the presence or absence of the food plant and ant nests. During the entire survey period the presence of *Aloeides dentatis dentatis* and *Lepisiota capensis* were noted in the different sample plots and vicinity.

The distribution and density of the food plant *Hermannia depressa* was determined by using twenty random points in the major plant communities. The distances between consecutive food plants were measured.

Results

Classification

The vegetation of the reserve can be described as a *Themeda triandra - Ledebouria marginata* grassland. Four major vegetation communities were identified in the reserve, one with two sub-communities and two further variants. The communities are the following:

1. *Themeda triandra - Trachypogon spicatus* Grassland
 1.1 *Themeda triandra - Panicum natalense* Sub-community
 1.2 *Themeda triandra - Hypoxis rigidula* Sub-community
  1.2.1 *Acalypha angustata* Variant
  1.2.2 *Cymbopogon excavatus* Variant
2. *Eragrostis curvula - Eragrostis lehmanniana* Disturbed grassland
3. *Hyparrhenia hirta* Grassland
4. *Dombeya rotundifolia* Hillock

1. *Themeda triandra - Trachypogon spicatus* Grassland

This tall grassland community is dominated by the bunch grasses *Themeda triandra* (Species group J) and *Trachypogon spicatus* (Species group A) and comprises approximately 80 % of the study area (Fig. 1) on undulating plains and low ridges with sandy and stony soils. Other diagnostic grass species include *Diheteropogon amplectens*, *Elionurus muticus* and *Brachiaria serrata* (Species group A, Table 1). Two sub-communities can be distinguished in this grassland.

1.1 The *Themeda triandra - Panicum natalense* Sub-community

The sub-community is represented by relevés 17, 18 & 19 and is restricted to the limited mica schist ridges that extend in various directions in the reserve from the hillock. The soils are shallow and stony. Diagnostic species for this sub-community include the succulent *Euphorbia clavariodes* sub-species truncata, the shrub *Lightfootia denticulata* and the grass *Schizachyrium sanguineum*.

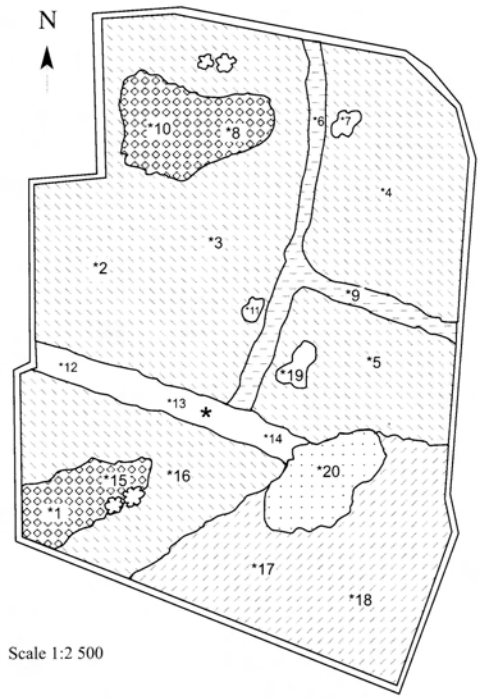


Fig. 1. Vegetation map of the Ruimsig Entomological Reserve Roodepoort, South Africa.

Table 1

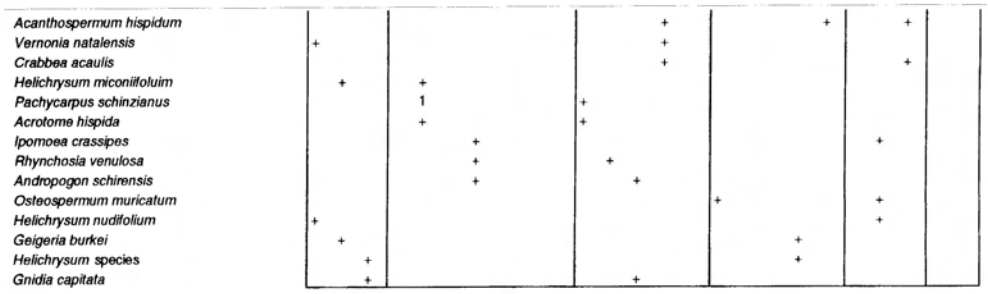
Phytosociological table of the vegetation of Ruimsig Entomological Reserve

Community				1								2					3		4
Sub.community	1 . 1					1 . 2			2										
Variant				1 . 2 . 1					1 . 2 . 2										
Relevé number	17	18	19	2	3	4	5	16	8	10	15	1	11	12	7	13	14	9	6	20
Species group A																				
Trachypogon spicatus	1	b	b	3	+	+	1	b	4	4	3			+					1	
Diheteropogon amplectens	+	+	+	+		+	+		+	+	+	+								
Elionurus muticus	+		+	+	+	+	+	+		+	+	+							+	
Brachiaria serrata	+	+			+		+	+		+	+	+				+				
Species group B																				
Panicum natalense	+	+	+																	
Euphorbia clavarioides sub-species *truncata*	+	+																		
Schizachyrium sanguineum		+	+																	
Urelytrum agropyroides		+	+																	
Wahlenbergia denticulata v. *denticulata*		+	+																	
Kohautia amatymbica	+																			
Tephrosia elongata		+																		
Acalypha species		+																		
Aristida diffusa		+																		
Digitaria eriantha		+																		
Species group C																				
Hypoxis rigidula				+	+	+	+	+	+		+	+								
Scabiosa columbaria				+	+	+	+	+	+	+	+						+		+	
Senecio isatidioides				+	+	+	+		+	+										
Species group D																				
Acalypha angustata				+	+	+	+								+				+	
Pentanisia angustifolia	+			+		+	+			+							+			
Ipomoea ommaneyi				+		+	+									+	+			
Vernonia galpinii				+			+													
Hypoxis multiceps				+	+						+									
Elephantorrhiza elephantina				+																
Cucumis hirsutus						+														
Anthericum species							+													
Justicia anagalloides							+													
Species group E																				
Cymbopogon excavatus		+			+				+	+	+						+		+	
Gazania krebsiana									+			+		+						
Striga elegans									+		+									
Eragrostis capensis									+											
Blepharis integrifolia									+											
Cucumis species										+										
Panicum maximum											+									
Dianthus mooiensis											+									
Senecio species											+									
Ipomoea obscura											+									
Setaria sphacelata										+										
Babiana hypogea											+									
Species group F																				
Eragrostis curvula				-									b	b	3		+			+
Eragrostis lehmanniana													+	1		b	b			

Table 1
(continued)

Aristida congesta sub-species *barbibicolis*													1	+		+				
Crabbea angustifolia												+		+	+			+			
Aristida stipitata														+		+				
Aristida canescens														+	+				+	
Aristida bipartita													+				1			
Tragus berteronianus		+											+	+						
Cynodon dactylon														b						
Solanum panduriforme															b					
Anthospermum species															+					
Setaria rigida															+					
Hibiscus trionum													+							
Teucrium trifidum													+							
Schkuhria pinnata														1						
Species group G																				
Vernonia oligocephala				+	+	+	+				+	+			+	+	+		+	
Ziziphus zeyheriana					+	+	+		+			+	+	+	b		+			
Setaria nigrirostris					+	+					+	+		+						
Species group H																				
Hermannia depressa	+			+	1	+	1	+		+	+	1	+	+	+	1	1			
Chaetacanthus costatus		+	+	+	+		+	+		+		1	+	+	+					
Dicoma zeyheri	+	+	+	+	+	+						+				+				
Acalypha capensis	+							+		+			+	+		+	+			
Senecio venosus		+		+			+				+	+				+				
Eragrostis racemosa	+		+						+	+		+		+						
Heteropogon contortus	1		+					+				+	+				+			
Senecio microspermus			+	+	+							+				+				
Indigofera costata sub-species *macra*	+						+				+						+			
Species group I																				
Hyparrhenia hirta	+							+		+								5	4	
Tephrosia semiglabra																			+	
Zornia milneana																		+		
Species group J																				
Themeda triandra	b	b	3	4	4	5	4	5	3	b	b	3	1	1	1	1	+	+		
Ledebouria marginata		+		+	+	+	+	+		+	+	+	+		+	+	+		+	
Species group K																				
Dombeya rotundifolia																				1
Melinis nerviglumis																				+
Diospyros lycioides																				+
Antizoma angustifolia																				+
Rhus rigida v. *rigida*																				+
Ehretia rigida																				+
Setaria lindenbergiana																				+
Crocosmia masonorum																				+
Pavetta gardeniifolia																				+
Tapiphyllum parvifolium																				+
Vangueria infausta																				+
Canthium gilfillanii																				+
Asparagus africanus																				+
Species group L																				
Sebaea grandis							+	+									+		+	
Indigofera hedyantha			+			+										+				
Sphenostylis angustifolia			+			+		+												
Melinis repens sub-species *repens*			+												+		+			
Nidorella species	+								+								+			

Table 1
(continued)



No individuals of *Aloeides dentatis dentatis* were noted.

The occurrence of *Hermannia depressa*, the food plant of the butterfly, is limited (<1%) in this sub-community, which renders it unsuitable as a habitat for the butterflies.

1.2 The *Themeda triandra - Hypoxis rigidula* Sub-community

This is the typical form of the *Themeda triandra - Trachypogon spicatus* grassland. It covers approximately 65% of the study area. The soils are moderately deep, red in colour and of the Hutton soil Form.

The density of the food plant is highest in this sub-community, with 220 plants/100 m². It is however not available to the butterflies due to the density of *Themeda triandra*. In spite of the availability of the food plant and the fact that this grassland was considered as suitable habitat for *Aloeides dentatis dentatis*, no individuals of the butterfly were noted.

The forbs *Scabiosa columbaria* and *Senecio isatidioides* (Species group C, Table 1) are diagnostic for this sub-community. Two variants are distinguished in this sub-community.

1.2.1. The *Acalypha angustata* Variant

This variant is represented by relevés 2,3,4,5 & 16 and is distinguished from the *Cymbopogon excavatus* Variant by the presence of species group D and the absence of species group E (Table 1). The soils are red, sandy, moderately deep and less stony than in the *Cymbopogon excavatus* Variant.

The grass species *Themeda triandra* is more dense and dominant in the *Acalypha angustata* Variant than in the *Cymbopogon excavatus* Variant hampering the flight of the butterflies and making it more difficult to locate the food plant and host ant. Diagnostic species for this variant are the forbs *Acalypha angustata*, *Pentanisia angustifolia*, *Ipomoea ommaneyi*, *Hypoxis multiceps* and *Vernonia galpinii* (Species group D, Table 1).

1.2.2 The *Cymbopogon excavatus* Variant (relevés 1,8,10 & 15)

This variant is situated in the northwestern and southwestern corners of the reserve (Fig. 1). The soils are sandy and well drained.

The grass species *Trachypogon spicatus* is more dominant in this variant, whereas *Themeda triandra* is more dominant in the *Acalypha angustata* Variant. This variant is further distinguished from the *Acalypha angustata* Variant due to the presence of species group E, including the forb *Gazania krebsiana* and the parasitic plant *Striga elegans*. The food plant *Hermannia depressa* is less abundant in this variant than in the *Acalypha angustata* Variant.

2. *Eragrostis curvula - Eragrostis lehmanniana* Disturbed Grassland

This grassland, represented by relevés 7,11,12,13 & 14, is limited to the areas previously disturbed by man. The two pioneer grasses *Eragrostis curvula* and *Eragrostis lehmanniana* are dominant, whereas *Themeda triandra* is less abundant than in community 1.

This community is characterised by species group F (Table 1), which includes the grasses *Eragrostis curvula*, *Eragrostis lehmanniana*, *Aristida congesta*, *Aristida bipartita*, *Aristida stipitata* and *Tragus berteronianus* as well as the forb *Crabbea angustifolia*, pioneer species indicating the degraded nature of the vegetation.

This community is the main breeding locality of *Aloeides dentatis dentatis* due to the presence of the host ant in these open areas. which can be ascribed to the low density of *Themeda triandra* . The density of the food plant is lower in this community (201 plants/ 100 m²), than in the *Themeda triandra - Trachypogon spicatus* community.

3. *Hyparrhenia hirta* Grassland

This grassland (relevés 6 & 9) is associated with drainage lines formed as a result of human disturbance, for instance old gravel roads and foot paths. This community is unsuitable as habitat for the butterflies due to the absence of the food plant *Hermannia depressa*. The tall grass *Hyparrhenia hirta* forms dense stands and is the dominant grass species (Species group I). Other species present are the grasses *Themeda triandra* (Species group J) and *Aristida canescens* (Species group F) and the forbs *Ledebouria marginata* (Species group J), *Vernonia oligocephala* (Species group G) and *Sebaea grandis* (Species group L). No individuals of *Aloeides dentatis dentatis* were noted.

4. *Dombeya rotundifolia* Hillock

The *Dombeya rotundifolia* community (relevé 20) is restricted to a small hillock situated in the southeastern corner of the reserve. The hillock consists of igneous rock boulders, and has shallow, rocky soils.

This community is characterised by the presence of woody species, which are absent in the rest of the reserve except for a few *Acacia karroo*. Tree species present include the dominant *Dombeya rotundifolia* as well as *Diospyros lycioides*, *Vangueria infausta*, *Tapiphyllum parvifolium*, *Ehretia rigida* and *Pavetta gardeniifolia*. Other species that occur are the grasses *Setaria lindenbergiana* and *Melinis nerviglumis* (Species group K, Table 1). No individuals of *Aloeides dentatis dentatis* were noted.

Ordination

Detrended correspondence analysis (DCA)(Hill 1979b) was applied to the floristic data set to determine possible environmental gradients and to facilitate the identification of management units. The scatter diagram of the entire data set displayed the four identified communities (Fig. 2), with the hillock situated to the left and the *Hyparrhenia hirta* community to the right of the diagram. Communities 1 and 2 are situated in the centre of the diagram. Relevés not suitable as butterfly habitat (relevés 6, 9 & 20) were omitted from the data set and a DCA was rerun.

The DCA ordination of relevés suitable as butterfly habitat (Fig. 3) revealed a distinct discontinuity between the undisturbed community 1, situated to the left of the scatter diagram, and the disturbed community 2, situated to the right of the scatter diagram. The distribution of relevés 7 and 11 in the right corner can be ascribed to a different disturbance factor. These two relevés are situated on old ant nests, but these differences do not show in the phytosociological table.

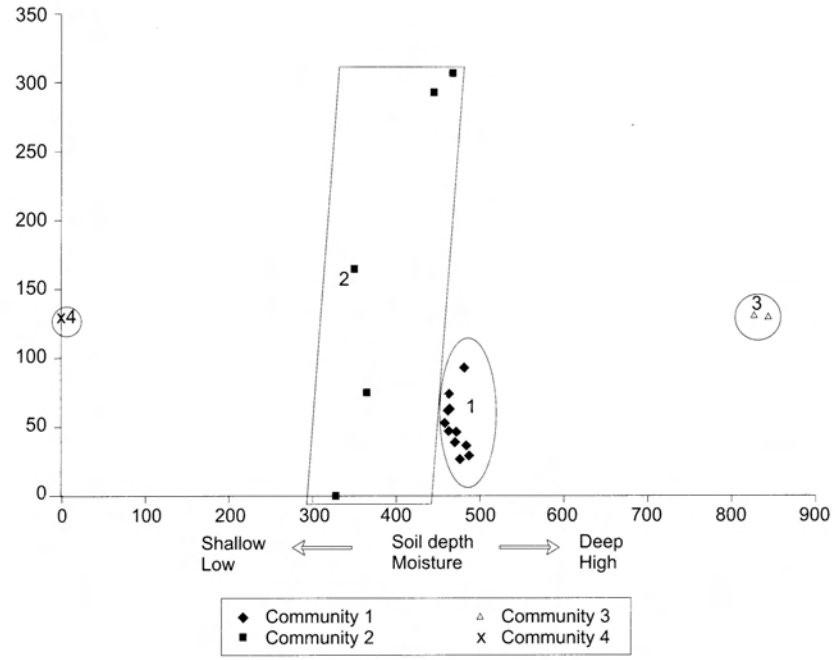


Fig. 2. Scatter diagram of a detrended correspondence analysis of the entire floristic data of the Ruimsig Entomological Reserve Roodepoort, South Africa.

Discussion

Distribution of ***Aloeides dentatis dentatis***

In the Ruimsig Entomological Reserve the distribution of *Aloeides dentatis dentatis* can be ascribed directly to the distribution of the host ant *Lepisiota capensis*. It was noted that the host ant preferred the open disturbed areas to the dense *Themeda* grassland. From the above it became clear that community 2 is the preferred habitat, although the *Themeda triandra* - *Hypoxis rigidula* grassland seemed to be ideal habitat for *Aloeides dentatis dentatis*, a relatively undisturbed *Themeda triandra* dominated grassland with an abundance of the food plant *Hermannia depressa*, the butterfly was however not observed to breed in this grassland. It seems as if the dense *Themeda triandra* hampers the butterfly to reach the food plant. The presence of the food plant alone will not ensure the presence of the butterfly.

Furthermore, it is clear that not all disturbed areas would qualify as habitat for the butterfly, as it was absent in community 4, also previously disturbed. Community 4 is now dominated by the dense tall-growing grass *Hyparrhenia hirta*, probably a seral phase between the pioneer and climax communities.

It was therefore concluded that the butterfly gave preference to a disturbed community in pioneer or early stage of succession, as exhibited by the pioneer plant species in community 2.

It is finally concluded that the vegetation controls the distribution of the host ant and

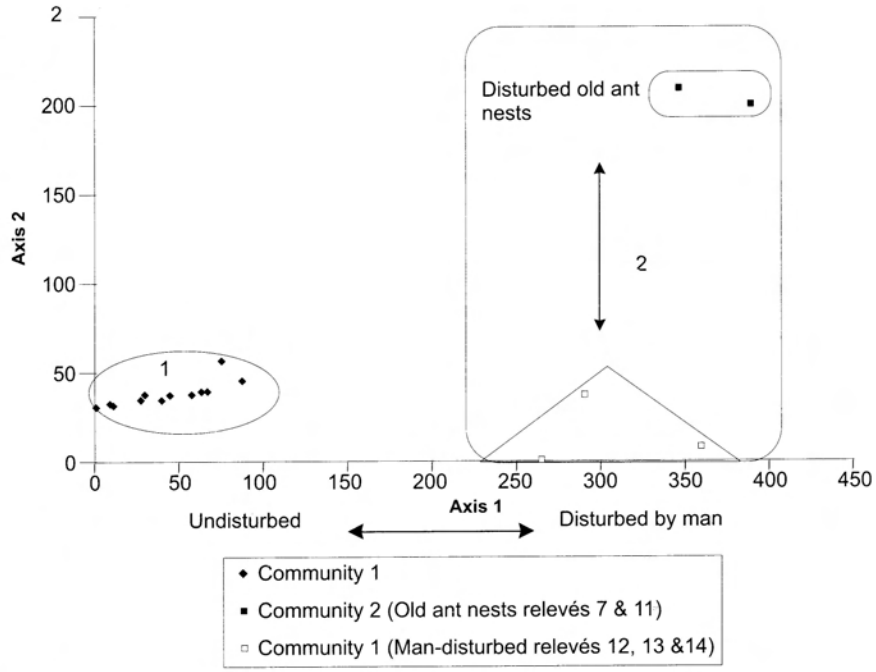


Fig. 3. Scatter diagram of a detrended correspondence analysis of the floristic data of the relevés suitable as butterfly habitat.

the presence of the ant is a prerequisite for the butterfly to be present.

The study of the vegetation (plant communities) enabled the identification of habitat preferences of the endangered and rare butterfly, and also provided knowledge which could be incorporated in a conservation management strategy to ensure the survival of the butterfly.

Management strategies

According to Morris *et al.* (1994) current efforts at conserving butterfly species are based on a number of principles. Firstly, the ecology of each species must be thoroughly understood, with emphasis on oviposition and the immature stages, which are often of greater significance than the adults. Secondly, there must be the ability to manipulate the habitat by management (Morris & Thomas 1989; Oates & Warren 1990). Thirdly, there is a need to monitor and evaluate the success or failure of novel procedures. The problem of maintaining populations under altering circumstances must also be addressed.

Most insects, including butterflies, normally have more exact requirements than their food plants. However, the latter must grow in the microhabitat preferred by the butterfly and in sufficient quantities to sustain viable butterfly populations (Morris *et al.* 1994). The management of grassland in reserves or protected areas for conservation consists of a series of subtle and finely-tuned processes (Morris 1991). It is necessary to extend existing optimal butterfly habitat as well as to create new habitats for the butterflies. The conservation of butterflies requires a reduc-

tion in distance between colonies as well as the creation of connecting corridors between colonies. Adult colonies can serve as sources for migration to other suitable breeding areas (Warren 1987).

Thomas (1993) suggested that the early-successional habitats of many butterfly species are unnatural and a direct consequence of the combination of changes in climate and land use during the Holocene. The preference of *Aloeides dentatis dentatis* for short, open pioneer grassland necessitates a management plan that will keep the vegetation short and open.

Various management strategies were formulated to ensure the survival of the butterfly. The following proposals were suggested:

Firstly the implementation of controlled burns during the winter months (July) in the reserve. This method is not harmful to the butterflies as they are adapted to fire and spend the winter months in the host ant nests. The vegetation is also considered as a fire climax (Acocks 1988).

Secondly, it was proposed that the surface-layer of vegetation be removed by applying surface scrapes or by cutting the grass in strips with a mower.

It was also recommended that 5 x 5 m blocks be cleared every alternative year (Fig. 4).

The resettlement of small game for instance *Raphicerus campestris* (steenbok), *Ourebia ourebu* (oorbietjie) and *Damaliscus dorcas phillipsi* (blesbok) was also considered. This would, however be costly and unpractical considering the size of the reserve (Kooij & Bredenkamp 1987).

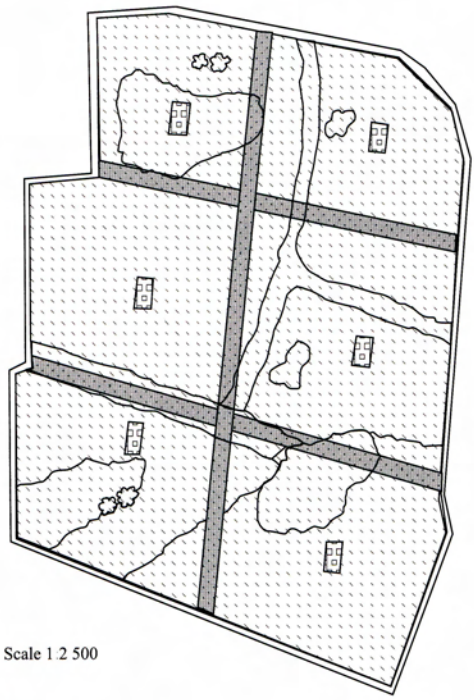


Fig. 4. Management strategies proposed for and implemented in the Ruimsig Entomological Reserve Roodepoort, South Africa

Management strategies applied since 1988 by the Roodepoort City Park Department

The reserve was divided into six management units by surface scrape strips, creating six burning blocks. Each burning block is burnt on a three year rotational basis during the winter months whereas the surface scrape strips are scraped each year. A fire break is burnt along the boundaries of the reserve every year. The surface scrapes, however, were terminated three years ago and replaced by mowing due to costs.

Monitoring

From mark-recapture data collected at the Ruimsig Entomology Reserve in 1989/1990 the population size of *Aloeides dentatis dentatis* was estimated at 400 specimens on the wing (Henning *et al.* 1993). Besides the

mark-recapture data collected in 1989/1990 the Hennings do monitor the presence of the butterfly yearly. This implies that the management strategies proposed by Kooij & Bredenkamp 1987 could be considered as successful in ensuring the survival of the butterfly, by providing mere habitat for the ants.

Conclusion

It has often been demonstrated that the delimitation of ecosystems based on plant communities forms the basis for the formulation of management strategies for wildlife (Bredenkamp & Van Rooyen 1998). It is concluded and evident from this study that it is even applicable for the conservation of an endangered butterfly.

Acknowledgements

The Roodepoort City Council is thanked for their financial support. A special word of thanks to Mr. Graham Henning for his enthusiasm for the conservation of *Aloeides dentatis dentatis*.

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