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# Changes in the herb layer of the riverine woodland in the Sengwa Wildlife Research Area, Zimbabwe

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ABSTRACT

The changes in the dominant species of the herb layer, in particular *Blumea gariepina* DC., of riverine woodland in the Sengwa Wildlife Research Area in Zimbabwe, were monitored over a period of five years. Factors contributing to these changes appear to have been rainfall, utilization and interspecific competition.

*RÉSUMÉ*

*CHANGEMENTS DANS LA COUCHE D'HERBE DU WOODLAND RIVERAIN DANS LA RÉGION DE RECHERCHE SUR LA VIE SAUVAGE DE SENGWA EN ZIMBABWE*

*Les changements dans les espèces dominantes de la couche d'herbe, en particulier* Blumea gariepina *DC., du woodland riverain dans la région de Recherche sur la Vie Sauvage de Sengwa en Zimbabwe ont été observés pendant une période de cinq ans. Les facteurs contribuant à ces changements apparaissent avoir été les chutes de pluie, l'utilisation et la compétition interspécifique.*

## INTRODUCTION

Following a period of below average rainfall, a perennial, unpalatable, woody herb *Blumea gariepina* DC., dominated an area heavily utilized by a variety of game species. The three year period of low rainfall together with the heavy game pressure may have caused the death of other species through overutilization, allowing *B. gariepina,* an acknowledged pioneer of bare ground (Wild, 1969; Hilliard, 1977), to become established in the absence of competition (Goodman, 1975). As a result of its effect in decreasing the amount of palatable food in the herb layer, it was considered worthwhile to monitor the post invasion period of the riparian herbaceous layer by this unpalatable plant species.

## STUDY AREA

The work was carried out in the Sengwa Wildlife Research Area (18° 10* S; 28° 14* E), an area of 373 km² lying at the southern end of the Chirisa Safari Area, Zimbabwe. The average rainfall for the area for the past thirteen years is 662 mm. The mean annual temperature is 22,2°C (Torrance, 1965). The vegetation is generally described as deciduous miombo savanna woodland on the sandy soils, and dry early deciduous savanna woodland, which is dominated by *Colophospermum mopane* on the heavier lower lying clay soils (Wild & Grandvaux-Barbosa, 1965). The major rivers of the area, the Lutope, Manyoni and Sengwa, have well-developed fringes of riparian woodland dominated by *Acacia albida, A. tortilis* subsp. *heteracantha, Kigelia pinnata, Lonchocarpus capassa,* and *Trichila emetica.* The shrub layer is generally well developed being composed of, in particular *Combretum mossambicense, Diospyros senensis, Grewia flavescens* and *Securinega virosa* (Cumming, 1975). The establishment of *B. gariepina* occurred mainly in the riverine woodlands of the Sengwa and Lutope Rivers, areas heavily utilized by wildlife, but isolated groups of this species were found throughout the area in all vegetation types.

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## METHODS

Changes in the herb layer were recorded beginning in September 1974 using fifty quadrats each one metre square placed one metre apart along a randomly laid line in the central portion of the study area. The data collected from each species in the quadrats were density, maximum height to the nearest centimetre and above-ground biomass. The last-mentioned was measured by harvesting all the plants of each species at ground level within the quadrat. These plants were subsequently oven dried at 95°C for three days or longer immediately after harvesting. The recordings were made in September of each year along newly laid randomly placed lines.

The rate of colonization was studied by grading an open patch of about 1 000 m² free of all vegetation except for deeply rooted, small (<50 cm high), woody plants such as *Acacia tortilis* subsp. *heteracantha* and *Combretum mossambicense.* The grader blade was angled to remove the top 7,5 cm of soil to leave about 5,0 cm of the A horizon soil. In this way all seeds that may have been lying on the surface were also effectively removed. The frequency of the plants was determined in 40 permanently placed quadrats. The quadrat size used was 0,25 m². The quadrats were randomly placed within the graded area. These determinations were begun in January 1976 and continued each month for a year. The graded plot was allowed a 'settling down' period of three months before determinations were begun to allow the plants to grow to a size at which they could be identified with certainty. Determinations were discontinued after a year, because no differences between the frequency of plants within the plot and the same species outside of the plot could be detected.

In order to obtain an idea of the age to which *B. gariepina* will live, ten seedlings were tagged with aluminium labels in September 1974.

## RESULTS

The results from the first part of the study in which the changes in density, frequency and biomass were measured, are presented in Table 1 and Fig. 1. The monthly frequencies for the most important species in the graded study area are shown in Fig. 2.

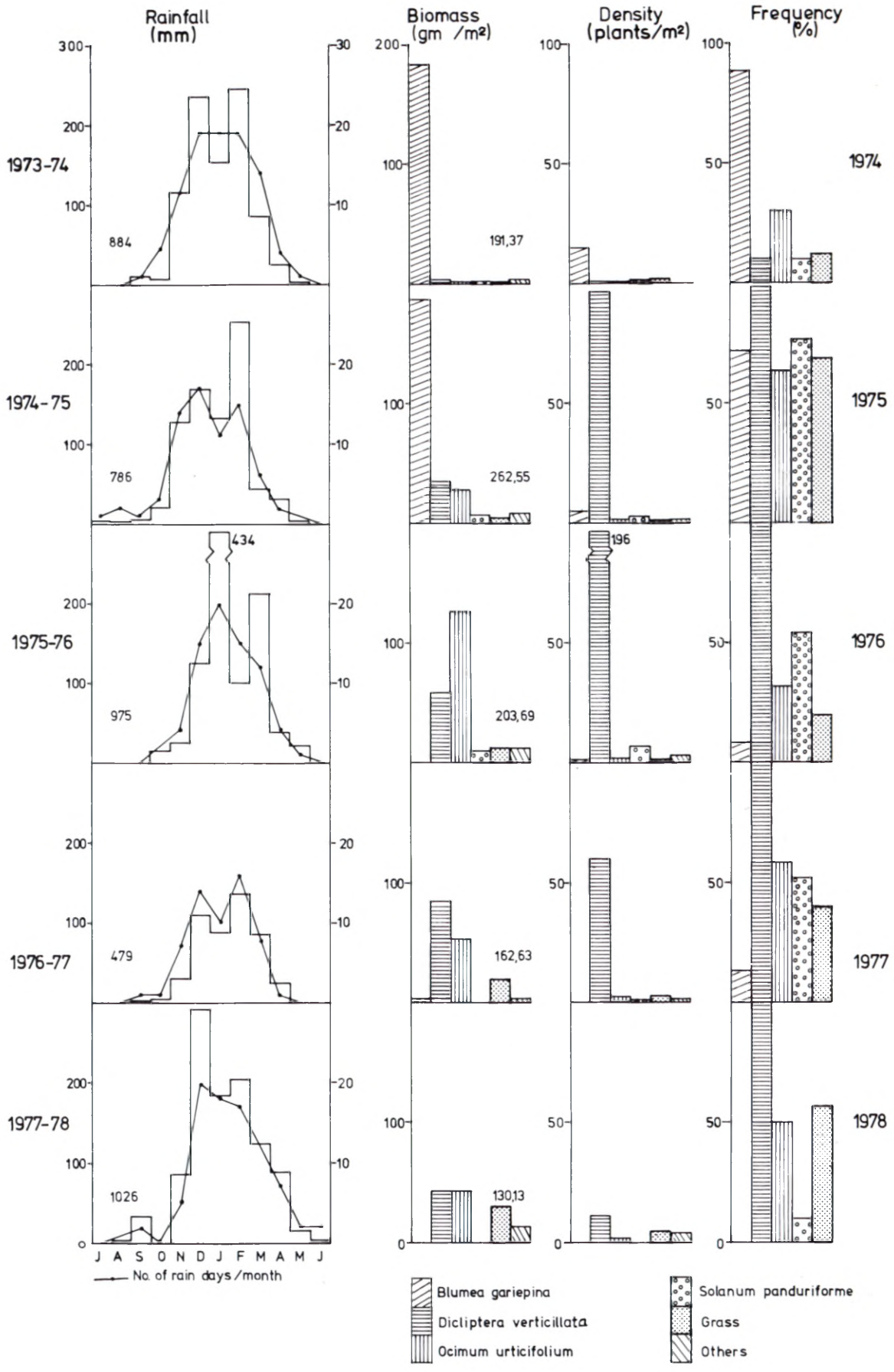


FIG. 1.—Changes in biomass, density and frequency of the most important species in the study area. The rainfall for the year preceding recording is given. The annual total rainfall and annual total biomass are indicated on each respective histogram.

TABLE 1.—The changes in average density, frequency, average maximum height and total above ground biomass of the most important species in the five years of recording

| | Average density (per $m^2$) | | | | | Frequency (%) | | | | | Average max. height (cm) | | | | | Total above ground biomass ($gm/m^2$) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year/Species | '74 | '75 | '76 | '77 | '78 | '74 | '75 | '76 | '77 | '78 | '74 | '75 | '76 | '77 | '78 | '74 | '75 | '76 | '77 | '78 |
| Aerva leucura | 0,05 | 0,6 | 0,6 | 0,34 | 0,12 | 2 | 24 | 8 | 16 | 12 | 10 | 12 | 32 | 14 | 2 | 0,06 | 1,18 | 0,8 | 0,07 | 0,03 |
| Achyranthes sicula | | | | 0,28 | 0,02 | | | | 2 | 2 | | | | 21 | 32 | | | | 0,02 | 0,08 |
| Blumea alata | | | 0,2 | | 0,06 | | | 2 | | 2 | | | 30 | | 25 | | | 0,7 | | 0,15 |
| B. gariepina | 15,0 | 4,9 | 0,4 | 0,14 | | 88 | 72 | 8 | 14 | | 68 | 67 | 12 | 12 | | 183,0 | 187,0 | 0,4 | 3,09 | |
| Boerhavia diffusa | 0,2 | 0,02 | | 0,04 | 0,06 | 6 | 2 | | 2 | 4 | 5 | 3 | | 4 | 4 | 0,6 | tr | | 0,18 | 0,02 |
| Cocculus hirsutus | 0,1 | 0,2 | tr | 0,02 | 0,04 | 4 | 6 | 2 | 2 | 2 | 10 | 9 | 15 | 9 | 2 | 0,01 | 0,24 | 0,5 | 0,5 | 0,02 |
| Dicliptera verticilliata | 0,5 | 96,0 | 196,0 | 60,0 | 10,5 | 10 | 98 | 100 | 100 | 100 | 42 | 24 | 27 | 31 | 29 | 3,2 | 34,9 | 52,4 | 84,1 | 42,96 |
| Indigofera praticola | | | | 0,04 | | | | | 2 | | | | | 2 | | | | | 0,01 | |
| Leonotis nepetifolia | | | | | 0,02 | | | | | 2 | | | | | 56 | | | | | 0,93 |
| Leucas martinaceus | | 0,1 | 0,16 | | 1,10 | | 8 | 4 | | 34 | | 22 | 20 | | 42 | | 0,15 | 0,02 | | 11,26 |
| Ocimum urticifolium | 0,7 | 1,4 | 1,8 | 2,1 | 1,82 | 30 | 64 | 32 | 58 | 50 | 19 | 41 | 52 | 37 | 47 | 1,4 | 27,9 | 123,0 | 53,0 | 43,23 |
| Plumbago zeylanica | | | | 0,02 | | | | | 2 | | | | | 5 | | | | | 0,08 | |
| Pterocaulon decurrens | | | 0,64 | | | | | 14 | | | | | 11 | | | | | 0,4 | | |
| Rhinacanthus gracilis | | 0,2 | | | | | 4 | | | | | 40 | | | | | 0,4 | | | |
| Sida alba | | | 0,24 | 0,58 | 0,24 | | | 6 | 16 | 12 | | | 18 | 14 | 10 | | | 0,06 | 0,08 | 0,55 |
| S. cordifolia | 0,5 | 0,5 | | 0,58 | 0,10 | 22 | 26 | | 24 | 6 | 18 | 10 | | 15 | 17 | 1,4 | 0,13 | | 2,1 | 0,02 |
| Solanum panduriforme | 0,8 | 2,8 | 6,9 | 0,48 | 0,26 | 10 | 60 | 54 | 18 | 10 | 9 | 17 | 23 | 17 | 11 | 0,4 | 6,4 | 9,7 | 0,5 | 0,11 |
| Vernonia cinerea | | | 0,4 | | | | | 6 | | | | | 15 | | | | | 0,01 | | |
| V. poskeana | | 0,1 | | | 0,10 | | 8 | | | 6 | | 9 | | | 4 | | 0,04 | | | 0,17 |
| Grass (various species) | 0,07 | 0,9 | 1,9 | 2,4 | 4,3 | 12 | 18 | 20 | 38 | 56 | 14 | 15 | 12 | 18 | 20 | 1,3 | 4,2 | 10,7 | 18,9 | 30,6 |

tr = trace (< 0,01)

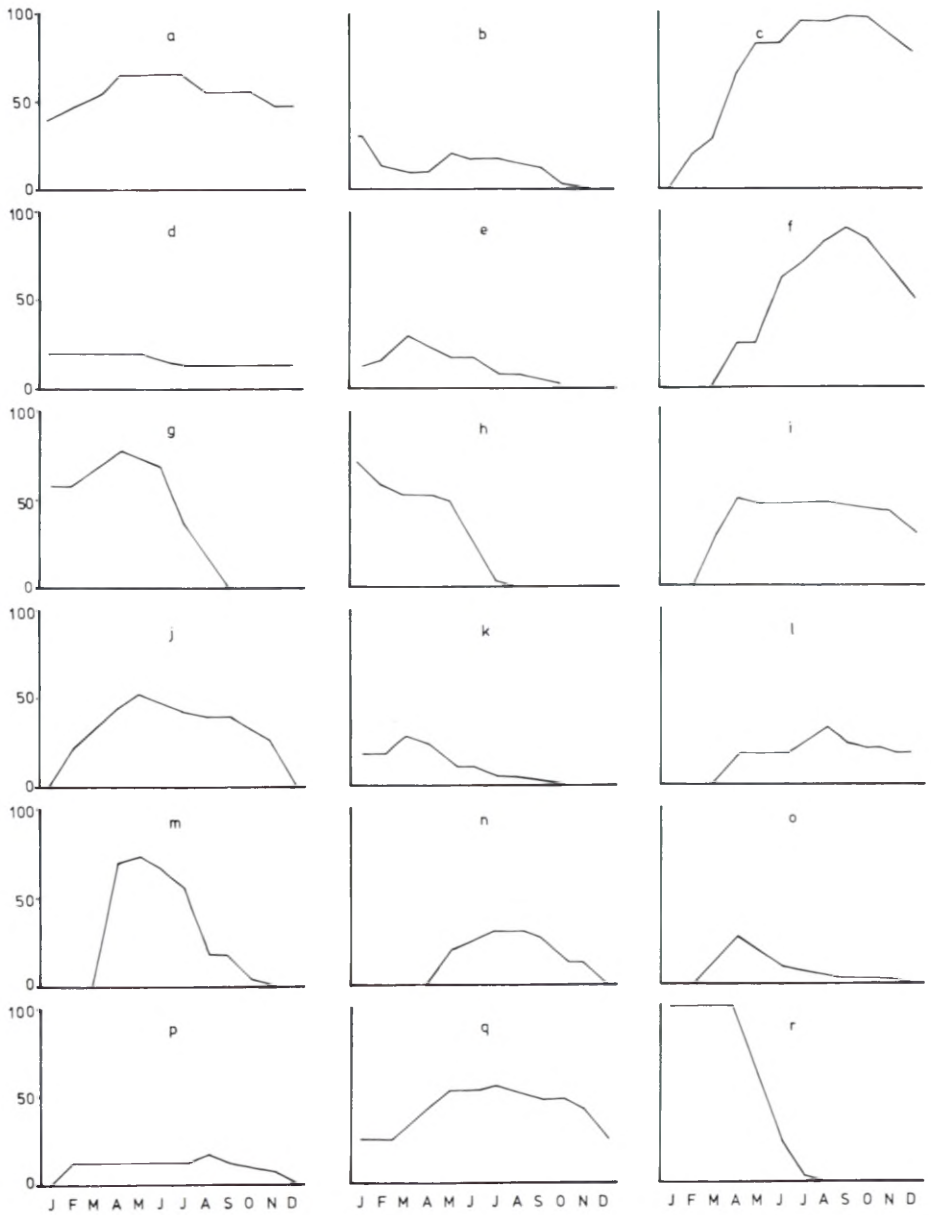


FIG. 2.—Changes in the frequency of *Acacia tortilis* subsp. *heteracantha* and herbs by month in the graded study area in 1976. a, *Acacia tortilis* subsp. *heteracantha*; b, *Amyranthus hybridus*; c, *Blumea gariepina*; d, *Boerhavia diffusa*; e, *Cassia* sp.; f, *Conyza aegyptiaca*; g, *Corchorus tridens*; h, *Dactyloctenium giganteum*; i, *Dicliptera verticillata*; j, *Eragrostis cilianensis*; k, *Indigofera* spp.; l, *Ocimum urticifolium*; m, *Oldenlandia herbacea*; n, *Pterocaulon decurrens*; o, *Sida alba*; p. *Sida cordifolia;* q, *Solanum panduriforme*; r, *Urochloa trichopus*.

In 1974, immediately following the establishment of *Blumea gariepina,* neither *Dicliptera verticillata* nor *Ocimum urticifolium* were well represented in the herb layer (Table 1, Fig. 1). *Blumea gariepina* was well established as the dominant species. In 1975, although there were large numbers of *Dicliptera verticillata, Blumea gariepina* was still the most important species, but by 1976 some three years after its establishment, *B. gariepina* had declined in dominance and only represented 0,2% of the total biomass (Table 1). At this time *Oci urticifolium* contributed the most to the total biomass and *Dicliptera verticillata* contributed the most to density. In the following year, *D. verticillata* was the dominant species in terms of both density and biomass. In 1977, the individuals of *D. verticillata* consisted of well formed plants in contrast to the numerous spindly seedlings of the previous year. This would account for its increase in biomass despite the considerable decrease in density (Table 1, Fig. 1). No single species was dominant in 1978, as both *Dicliptera verticillata* and *Ocimum urticifolium* had biomass figures of about 43 gm $m^{-2}$ (Table 1). The increasing importance of perennial grasses is of interest.

There appears to be a definite successional process taking place in the herb layer. All four important species show the same phenomenon. *Blumea gariepina* was observed on the downward part of the process, *Ocimum urticifolium* and *Dicliptera verticillata* through the full process with peaks in 1976 and 1977 respectively, and it appears that the perennial grasses are on the upward part of the succession. Of the 19 species (except grasses) recorded in the study area only five were present in all five years of study (Table 1).

The effectiveness of *Blumea gariepina* as a colonizer is clearly illustrated in Fig. 2. It rapidly increased in frequency and having reached a high frequency remained at that level. Other species reacted differently. The annual grasses *Urochloa trichopus* and *Dactyloctenium giganteum* decreased in frequency in May, at the end of the rainy season. Other species, *Boerhavia diffusa* and *Dicliptera verticillata* maintained their frequency albeit at a lower level, and some species, *Oldenlandia herbacea* and *Pterocaulon decurrens,* were present for only part of the year. Most species, however, had specific patterns of colonization, some were late colonizers particularly *Conyza aegyptiaca* and *Ocimum urticifolium,* and others *Corchorus tridens* and *Sida alba* increased in frequency only to decrease rapidly thereafter.

## DISCUSSION AND CONCLUSIONS

Some of the success of *Blumea gariepina* as a pioneer can be attributed to its production of large amounts of wind dispersed seeds and its tolerance of wide soil and moisture conditions (Wild, 1969; Hilliard, 1977). In areas of high animal concentrations such as the study area, it success may be further attributed to its unpalatability. The leaf of *B. gariepina* on steam distillation yields a volatile oil which consists of 66% of cineol, 10% of d-fenchone and about 6% of citral (Watt & Breyer-Brandwijk, 1962). Cineol, the major constituent of oil of eucalyptus, is poisonous to man, and citral is the major constituent of lemon grass oil (Watt & Breyer-Brandwijk, 1962). No animals have been observed to feed on *B. gariepina* despite its abundance. This may be related to the presence of cineol and citral making the plant unpleasant smelling. It may afford some protection to other species growing in its vicinity as Muller, Muller & Haines (1964) observed that dew caused deposition of volatile oils to take place on plants growing near aromatic shrubs. A sheen was observed on some herbs and grasses not normally glossy, growing at the base of *B. gariepina* plants. Perhaps the protection afforded to the grasses by these oils has encouraged their growth despite the continued heavy utilization of the area by game.

It is apparent that the initial fears that the area would become dominated by the unpalatable *B. gariepina* to the exclusion of the other species were unfounded. Seedlings of *B. gariepina* tagged in 1974 survived for three years, indicating that the normal life of the plant is probably not more than about four years. High densities of *B. gariepina* can be expected to be maintained for three or four years and possibly longer if conditions are ideal. The periods of higher rainfall may have caused the decline of *B. gariepina,* but this may have also been affected by the superior competitive abilities of the other species.

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## *UITTREKSEL*

*Die veranderinge in die oorheersende spesies van die kruidlaag, veral van* Blumea gariepina *DC., in rivieroewerboomveld in die Sengwa Wildnavorsingsgebied, Zimbabwe, is waargeneem gedurende 'n periode wat oor vyf jaar gestrek het. Faktore wat bygedra het tot hierdie veranderinge is veral die reënval, verbruik en wedywering tussen die verskillende soorte plante.*

## REFERENCES

CUMMING, D. H. M., 1975. *A field study of the ecology and behaviour of warthog.* Museum Memoir No. 7. Salisbury: The Trustees of the National Museums and Monuments of Rhodesia.

GOODMAN, P. S., 1975. *The relation between vegetation structure and its use by wild herbivores in a riverine habitat.* M.Sc. thesis, University of Rhodesia (unpublished).

HILLIARD, O. M., 1977. *Compositae of Natal.* Pietermaritzburg: University of Natal Press.

MULLER, C. H., MULLER, W. H. & HAINES, B. C., 1964. Volatile growth inhibitors produced by aromatic shrubs. *Science* 143: 471–473.

TORRANCE, J. D., 1965. The temperature of Rhodesia. In M. O. Collins, *Rhodesia: its natural resources and economic development.* 28–29. Salisbury: M. O. Collins.

WATT, J. M. & BREYER-BRANDWIJK, MARIA, 1962. *Medicinal and poisonous plants of southern and eastern Africa.* 2nd edition, London: E. & S. Livingstone.

WILD, H., 1969. The compositae of the Flora Zambesiaca Area, 2. *Kirkia* 7: 121–135.

WILD, H. & GRANDVAUX-BARBOSA, L.A., 1967. Vegetation map of the Flora Zambesiaca Area. Supplement to *Flora Zambesiaca.* In H. Wild & A. Fernandes. *Flora Zambesiaca.* Salisbury: M. O. Collins & Government Printer.