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Ecology and population biology of *Euphorbia perangusta* (Euphorbiaceae) in the Transvaal, South Africa

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ABSTRACT

The conservation status of *Euphorbia perangusta* R. A. Dyer, an endangered plant restricted to the Marico District of the Transvaal, South Africa, and adjoining parts of Bophuthatswana was determined. The distribution, habitat and population dynamics of *E. perangusta* are discussed.

The monitoring of the largest known population has revealed that this population has declined rapidly since the onset of a drought in 1983. The major cause of this decline appears to be the destruction of the plants by porcupines which feed on *E. perangusta* during droughts.

It appears that, during droughts, *E. perangusta* is restricted to rocky ridges because there is an increase in porcupine damage on more accessible populations. The species is also subjected to other factors which reduce flower formation in a large proportion of plants. If these factors continue to operate, the species could become extinct in the near future. Conservation recommendations are discussed.

UITTREKSEL

Euphorbia perangusta R. A. Dyer, 'n bedreigde plant wat in sy verspreiding beperk is tot die Maricodistrik van die Transvaal, Suid-Afrika, en 'n aangrensende gebied in Bophuthatswana, se bewaringstatus is bepaal. Die verspreiding, habitat en populasiedinamika van *E. perangusta* word bespreek.

Moniteringsresultate het getoon dat die grootste bekende populasie se getalle drasties verminder het sedert die aanvang van die droogte in 1983. Die primêre oorsaak van hierdie afname in getalle kan toegeskryf word aan die voedingsgewoontes van ystervarke tydens droogte-periodes.

Dit wil voorkom asof *E. perangusta*-plante gedurende droogteperiodes, tot rotsagtige rante beperk word as gevolg van 'n toename in ystervarkskade aan meer toeganklike populasies. Die spesie word ook blootgestel aan ander faktore wat 'n afname in blomvorming by baie van die plante tot gevolg het. Indien hierdie oorsaaklike faktore ongehinderd voortduur, kan die spesies in die nabye toekoms uitsterf. Bewaringsriglyne word bespreek.

INTRODUCTION

Euphorbia perangusta R. A. Dyer was first described (Dyer 1938) from material collected in the Marico District of the western Transvaal. The plants are distinctive in that the primary branches rarely re-branch and that they have very thin wing-like angles (Figure 1). The species is threatened by collecting, small mammal damage and trampling by cattle (White *et al.* 1941; Fourie 1982). This has resulted in a serious decline in the number of plants, causing it to be listed as an endangered species (Fourie 1986).

Fourie (1982) briefly described the habitat of *E. perangusta* Dyer (1938) and White *et al.* (1941) state from notes made by the discoverer of the species that *E. perangusta* appeared not to set seed even though large numbers of flowers were formed.

FIGURE 1.—*Euphorbia perangusta* R. A. Dyer in its natural habitat.

METHODS

Distribution

All distribution records for *E. perangusta* were extracted from the literature and the National Herbarium in Pretoria, using the method proposed by Hall *et al.* (1984). The recorded localities were visited and the species searched for and positively identified in the field. New populations in the Transvaal (excluding Bophuthatswana) were searched for in the manner described by Fourie (1986) in June 1985. Populations were defined as stands further than two kilometres apart.

Habitat

The physiognomy of the vegetation associated with each population was recorded. The vegetation structure was classified according to Edwards (1983). Average annual precipitation was obtained from a local land-

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owner and tested for reliability against Weather Bureau records (Weather Bureau 1986) of rainfall stations in the District. Altitude to the nearest 20 m above sea level and aspect for each new population found was recorded from South Africa 1:50 000 topocadastral maps. Soil texture was recorded on site for each population using the sausage method (National Working Group For Vegetation Ecology 1986). The geology associated with each population was determined using a recent 1:250 000 geological map (Visser 1984).

In addition to the above, presence of all trees, shrubs and herbs growing within 3 m of twenty randomly selected *E. perangusta* plants were recorded, i.e. plants directly associated with *E. perangusta*. The species at each population were recorded. The Czekanowski coefficient (Bray & Curtis 1957), was used to show the percentage similarity between sets of these species. The formula used was

$$\frac{2w}{A + B} \times 100$$

where W = number of associate species in common; A = number of associates for one population, and B = number of associates for another population.

Monitoring

In June 1979 the largest population (no. 1) of *E. perangusta* was first visited and a total count of all plants done. The state of each plant, i.e. whether vegetative or flowering, was recorded.

In June 1985 a total count of all plants in all populations found was done and the state of each plant, i.e. whether vegetative or flowering, was recorded.

A permanent monitor plot measuring 30 m × 50 m was established centrally within the largest known *E. perangusta* (no. 1) population so that changes over time in the population and the vegetation associated with the population could be recorded. The four corners of the plot were permanently marked by piles of white painted rocks. Monitoring was carried out during the last week of June 1985 and 1986.

The monitor plot was subdivided into sixty 5 × 5 m blocks and the exact locality of each individual *E. perangusta* plant within these blocks was mapped. This procedure allows for individual plants to be easily relocated in successive years and facilitates the recording of information for each plant in the plot. This procedure is essential if a full life-table analysis is to be made as an aid to understanding the population biology of *E. perangusta*. It is possible that short-lived seedlings that were recruited into the population may have been missed by monitoring only once a year.

The following information was recorded for each *E. perangusta* plant within the monitor plot: a, plant dead or alive; b, state of plant—vegetative or flowering; and c, factors affecting the plant. Additional information recorded included (a) precipitation for year of monitoring; (b) land use practice; (c) vegetation structure; (d) dominant associated vegetation; and (e) disturbances to the habitat of the population.

The classes of factors affecting the plant, land use practices and disturbances to the habitat were determined by the percentage of *E. perangusta* plants affected and divided into the following: (i) modifies but does not destroy habitat or affects but does not kill plant and (ii) destroys habitat and/or plant or has potential to do so.

Photographs of the monitor plot from a fixed photo point were taken in June 1985 and June 1986 to visually record change in the vegetation over time.

RESULTS

Distribution

Prior to this study *E. perangusta* was known from only two populations (White *et al.* 1941); one of which is in Bophuthatswana. During this study four additional populations were found in South Africa. Figure 2 shows the known distribution of *E. perangusta* in the Transvaal. In South Africa the species is restricted to the Marico District of western Transvaal.

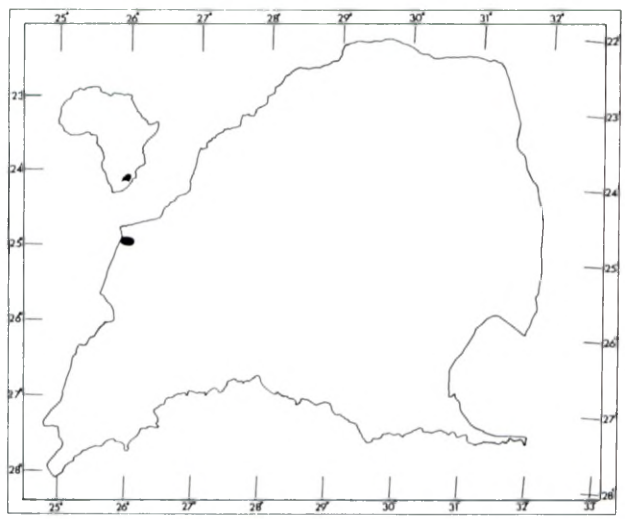

FIGURE 2.—The known distribution of *Euphorbia perangusta* R. A. Dyer in the Transvaal.

Habitat

All populations occur within Acocks (1975) Veld Type No. 13—Other Turf Thornveld, are at altitudes of 1 050–1 150 m and receive an annual average precipitation of 450 mm. Four of the five known Transvaal populations are found on the southern or south-eastern slopes of quartzite ridges. Table 1 shows the approximate distances between the five known *E. perangusta* populations in the Transvaal. The plants grow in partial to full sunlight, are wedged between rocks in well drained, gritty sand and vary in height from 50–900 mm. The vegetation associated with *E. perangusta* populations on the ridges is a *Croton gratissimus* var. *gratissimus* dominated woodland with a tall (3–5 m), open structure (Edwards 1983).

The fifth population of plants was found growing approximately 40 m from a quartzite hill on a flat, sandy plain. No surface rocks were present. The plants grow in the shade of trees in deep (>1 m) alluvium soil and vary in height from 0,2–1,2 m. The vegetation associated with this population is a *Peltophorum africanum* and *Terminalia sericea* dominated woodland with a tall (5–10 m), closed structure (Edwards 1983).

TABLE 1.—Approximate distances (km) between the five known populations of *Euphorbia perangusta* R.A. Dyer in the Transvaal

	Populations				
	1	2	3	4	5
Population 1					
Population 2	11				
Population 3	12	4,5			
Population 4	10	4	2,5		
Population 5	10	2	5	3,5	

TABLE 2.—Plants associated with *Euphorbia perangusta* populations

Species	Occurrence within *E. perangusta* populations				
	1	2	3	4	5
Trees and shrubs:					
Croton gratissimus var. *gratissimus*	•	•	•	•	–
Euclea natalensis	•	–	–	•	–
Boscia albitrunca	•	•	–	•	–
Combretum zeyheri	•	•	•	•	–
Ficus abutilifolia	•	•	•	•	–
Mundulea sericea	•	•	–	–	–
Pappea capensis	•	•	–	•	–
Ochna inermis	•	–	•	•	–
Combretum molle	•	•	•	•	–
Pavetta zeyheri	•	–	•	•	–
Dombeya rotundifolia	•	–	–	–	–
Bridelia mollis	•	–	•	•	–
Gardenia volkensii	•	•	–	•	•
Ximenia americana	•	•	•	•	–
Peltophorum africanum	•	•	–	–	•
Vangueria infausta	•	–	–	–	–
Bequaertiodendron magalismontanum	•	–	•	•	–
Dichrostachys cinerea	•	–	•	–	–
Canthium sp.	•	–	–	–	–
Mimusops zeyheri	–	•	•	•	–
Terminalia sericea	–	•	–	–	•
Ficus ingens	–	•	•	•	–
Grewia flavescens	–	–	•	–	•
Ziziphus mucronata	–	–	•	–	•
Maytenus heterophylla	–	–	–	–	•
Grewia bicolor	–	–	–	–	•
Combretum apiculatum	–	–	–	–	•
Euclea undulata	–	–	–	–	•
Acacia robusta	–	–	–	–	•
Acacia tortilis subsp. *heteracantha*	–	–	–	–	•
Grewia flava	–	–	–	–	•
Landolphia capensis	•	•	•	•	–
Xerophyta retinervis	•	•	•	•	–
Herbs:					
Dodonaea angustifolia	•	•	•	•	–
Indigofera sp.	–	•	•	–	–
Hibiscus sp.	–	–	–	–	•
Huernia sp.	–	–	–	–	•
Selaginella dregei	•	•	•	•	–
Pellaea sp.	•	•	•	•	–

• species present; – species absent.

Table 2 presents the floristic composition of the vegetation associated with the five *E. perangusta* populations.

Population similarity

Table 3 shows the percentage similarity between the five populations based on associated vegetation using the Czekanowski coefficient.

TABLE 3.—Percentage similarity between sets of associates for five *Euphorbia perangusta* populations, using between-population frequency data on tree, shrub and herb associates (Table 1) to calculate the Czekanowski co-efficient

	Populations				
	1	2	3	4	5
Population 1		69,76	68,18	81,81	9,10
Population 2			66,66	76,90	18,18
Population 3				80,00	11,76
Population 4					5,88

The habitat of *E. perangusta* is similar in all populations except for the population growing on the flat, sandy plain. Similarity values between sets of associates (Table 3) were high for the four populations occurring on the rocky ridges. Population no. 5 showed a low similarity between sets of associates with each of the other four populations.

The difference in the species composition of the associated vegetation of the population growing on the flat, sandy plain may be due to the deeper, alluvial soil in that area. The occurrence of *Terminalia sericea*, a tree species associated with deep, sandy soils (Coates Palgrave 1983; Palmer & Pitman 1972), the taller, more closed structure of the associated vegetation and the taller *E. perangusta* plants within this population, support this view.

Number of plants in each population

Table 4 presents the number of plants for each population of *E. perangusta* as determined in June 1985. It shows that the populations on the rocky ridges (nos 1–4) comprise more plants than the population (no. 5) on the flat, sandy plain.

TABLE 4.—Numbers of plants in the five known populations of *Euphorbia perangusta* in the Transvaal as determined in June 1985

	Flowering plants	Non-flowering plants	Total live plants	Plants killed by porcupines
Population 1	50	78	128	13
Population 2	27	25	52	7
Population 3	8	10	18	3
Population 4	40	11	51	9
Population 5	2	2	4	6
Total			253	38

Population biology

Figure 3 shows the population dynamics of the largest known *E. perangusta* population (no. 1) as determined from a survey undertaken in June 1979 and monitoring over the period 1985–1986. Figure 3 shows that this population is declining dramatically and could soon become extinct.

Mortality

Figure 3 shows that the total population (no. 1) declined from 135 plants in 1979 to 108 in 1986. 5,18 % of the plants in the monitor plot died between June 1979 and June 1985, while 15,26 % died between June 1985

and June 1986. All mortalities recorded in the monitor plot were due to the physical destruction of plants by porcupines (*Hystrix africaeaustralis* Peters) which exposed and ate the subterranean stems and roots (Figure 4). Porcupines are predominantly vegetarian, eating bulbs, tubers and roots which they dig up (Smithers 1983).

Table 4 shows the numbers of plants in each population killed by porcupines (class ii factor) in 1985.

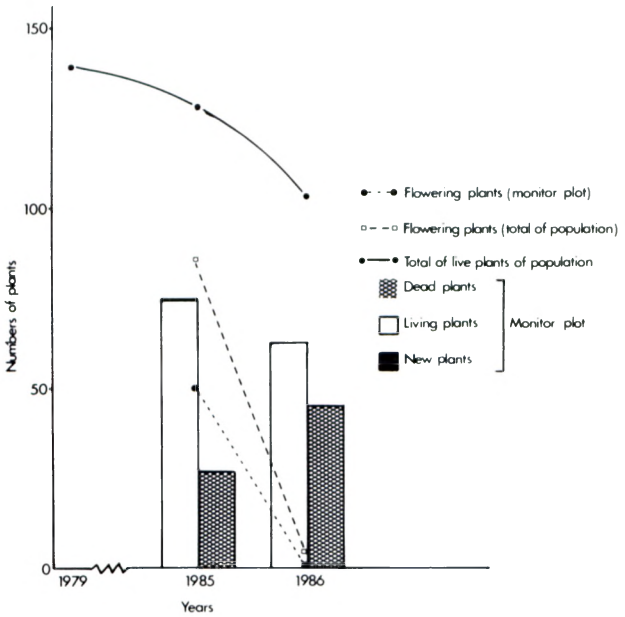

FIGURE 3.—The population dynamics of *Euphorbia perangusta* R. A. Dyer in population No 1.

Number of plants

Figure 3 shows the numbers of living and dead plants present in the monitor plot in both 1985 and 1986. One new seedling was noted in the monitor plot in 1985 and none in 1986.

Flower formation

Figure 3 shows that the proportion of plants that flowered in the population declined from 66,6 % in 1985 to 3,17 % in 1986. The proportion of plants that flowered in the monitor plot declined from 69,44 % in 1985 to 3,27 % in 1986.

FIGURE 4.—The physical destruction of *Euphorbia perangusta* R. A. Dyer plants by porcupines (*Hystrix africaeaustralis* Peters).

Factors affecting the taxon

Besides porcupines, other class i factors affecting *E. perangusta* are: destruction of emergent branches by trampling (Fourie 1982) (Figure 5); and the destruction of emergent branches by insect larvae (Figure 6). These factors, although obvious, are difficult to quantify.

Fixed photo point

No obvious change in the vegetation in the monitor plot was recorded between June 1985 and June 1986.

FIGURE 5.—The destruction of emergent branches of *Euphorbia perangusta* by trampling.

FIGURE 6.—The destruction of emergent branches of *Euphorbia perangusta* by an unidentified moth species.

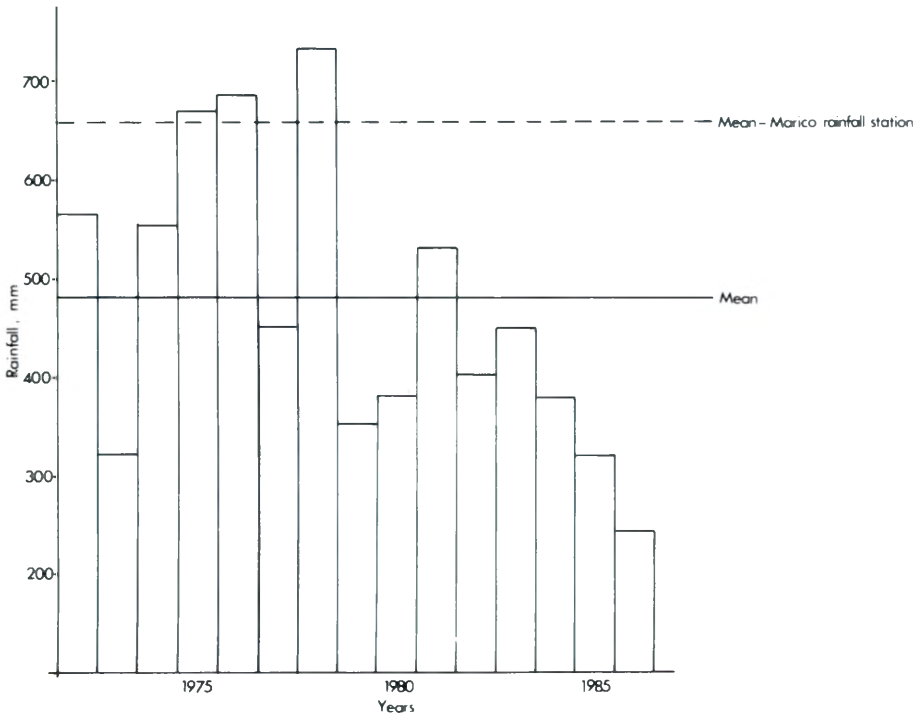

FIGURE 7.—Annual rainfall figures for the Marico District.

Rainfall

Figure 7 shows the annual rainfall figures for the Marico District for the past 15 years as recorded by a local landowner. The histogram shows that the species has been experiencing drought conditions in 1984, 1985 and 1986.

The mean annual rainfall figures for the Marico rainfall station for the years 1951–1984 (Weather Bureau 1986) is shown on Figure 7. The Marico rainfall station is situated approximately 80 kilometres south of the *E. perangusta* populations.

DISCUSSION

Distribution

From this study it appears that *E. perangusta* is endemic to the Marico District of the western Transvaal in South Africa and western Bophuthatswana. The highly localized distribution range of the species within the Transvaal was intensively and repeatedly searched and it is unlikely that any additional populations remain undiscovered in the Province.

The distribution of *E. perangusta* extends marginally into Bophuthatswana; with one population (White *et al.* 1941) being recorded for that region. It is possible that a few small populations remain undiscovered in Bophuthatswana and adjacent parts of Botswana.

Population biology

Mortality

E. perangusta numbers confirm that it is an endangered species and is in danger of becoming extinct if the factors causing its decline are allowed to continue operating. The results show that plant mortalities have increased dramatically since the start of a drought in June 1983.

The greatest factor causing the death of *E. perangusta* plants are porcupines which expose and eat the subterranean stems and roots (White *et al.* 1941; Fourie 1982; this study). The shortage of available food since the start of the drought has forced the porcupines to utilize alternative sources; one source being the roots and stems of *E. perangusta* plants. Porcupine damage has increased since the start of the drought and has resulted in a rapid decline in the number of plants in the population being monitored.

Porcupine damage was most evident in population no. 5 located on the deep, sandy plain. It is obviously easier for the porcupines to expose the roots and stems of plants growing in deep sand than those growing wedged between rocks. The majority of plants on the rocky ridges that were damaged by porcupines grew in relatively large pockets of soil.

Flower formation

The sudden decline in flowering from 1985 to 1986 may be due to reduced rainfall in 1986. Flower formation appears to be suppressed when there is a shortage of water during the period of active growth (October–June) of the plants.

The fewer flowers formed in 1986 resulted in a lower potential for seed set and consequently, the number of seedlings that could be recruited into the population.

Factors affecting the taxon

(i) Trampling: the five Transvaal populations were subjected to trampling by cattle. Although normally non-fatal, trampling has the effect of breaking off emergent branches and exposing the subterranean stems. The drought has forced cattle to wander onto the rocky ridges in search of food. This increased exposure of *E. perangusta* plants to trampling, and the subsequent breaking