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Geographical distribution of dung beetles (Coleoptera: Scarabaeidae) and their seasonal activity in south-western Cape Province

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A total of 30 species of dung beetles was recorded in indigenous shrubland near Langebaan and a pasture of Kikuyu grass near Paarl over a period of 13 months. These species were divided into 2 groups according to their distribution between the rainfall regions of southern Africa. Group 1, which was numerically dominant at Langebaan, was largely endemic to the winter and bimodal rainfall regions and was principally active during the winter rainy season in the south-western Cape. Group 2, which was numerically dominant at Paarl, was widespread in the winter, bimodal and summer rainfall regions and was principally active during the summer dry season and beginning of the rainy season in the south-western Cape. The potential of these beetles as control agents of the dung-breeding bush fly in south-western Australia is discussed.

INTRODUCTION

Bornemissza (1960) recommended that exotic, dung-burying beetles (Scarabaeidae: Scarabaeinae) should be introduced into Australia to remove cattle pads which foul pastures and act as breeding sites for the fly pests, *Haematobia irritans exigua* (de Meijere) (buffalo fly) and *Musca vetustissima* Walker (bush fly). Dung beetles with potential as control agents of the bush fly in the mediterranean climatic region of south-western Australia are being sought in roughly homoclimatic areas of southern Europe and south-western Cape Province in South Africa. Those species selected must show peaks in abundance which coincide with the increase in numbers of the bush fly during spring in south-western Australia (Ridsdill Smith & Matthiessen 1984).

The seasonal distribution of dung beetle fauna in regions with mediterranean-type climate has been previously studied in both southern Europe (Krausse 1907a, b, Lumaret 1983) and south-western Australia (Ridsdill Smith & Hall 1984a, b). The present study examines the seasonal activity of dung beetles in the south-western Cape. As much of the native vegetation has been cleared from this region, traps were placed in both indigenous shrubland and in a pasture of introduced Kikuyu grass *(Pennisetum clandestinum)*. The geographical distribution of the species recorded was plotted on maps of southern Africa and compared with their seasonal activity patterns in the south-western Cape.

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METHODS

Study sites and trapping method

The study site in indigenous shrubland was situated on deep sand on the farm, 'Geelbek' (33° 10′ S 18° 08′ E), near Langebaan. This shrubland was described as dense strandveld scrub by Acocks (1975) and is characterised by a vegetative profile of up to 3 m and a vegetative cover of approximately 40%.

The study site in Kikuyu grass was situated on sandy loam on the farm, 'Nantes Herd' (33° 40′ S 18° 48′ E), near Paarl in an area totally cleared of native vegetation. Kikuyu grass differs from the shrubland it replaces not only in its low vegetative profile of a few centimetres but also in its 100% vegetative cover. A small part of this study site retained green grass throughout the dry season due to seepage from a pumphouse. Pipe irrigation of this study site was observed on a single occasion.

There were climatic differences between the two sites. The farm, 'Geelbek', is situated at sea level on the west coast which results in a less extreme annual range in mean monthly temperatures (max. 28°C, min. 7°C at Langebaanweg) than at Paarl (max. 30°C, min. 6°C) which lies inland at an altitude of *c.* 140m a.s.l. The average annual rainfall also differs between sites with *c.* 300 mm at Langebaan and *c.* 600 mm at Paarl.

Seasonal distribution of dung beetles at Langebaan and Paarl was studied for 13 months between April 1979 and April 1980. At each study site, 10 pitfall traps were placed 2–3 m apart and baited with *c.* 1L of fresh cattle dung for 24 h each week. Because the study sites were 120 km apart, the traps at each were baited on different days of the week.

Distribution of dung beetles in relation to climatic zones

Over the last 16 years a large reference collection of scarabaeine dung beetles has been amassed by the Dung Beetle Research Unit. This collection currently contains *c.* 850 species from over 2500 localities, mostly in southern Africa. The distribution of the dung beetle species trapped during the present study was plotted in relation to the major climatic regions of southern Africa. These regions were derived by reducing the 19 temperature/rainfall zones proposed for the area by Walter & Lieth (1964), to four regions based solely on the seasonal occurrence of rainfall.

The seasonal distribution of rainfall at one site in each of the four regions is shown by Figure 1. In the winter rainfall region (WR) of the western Cape, peak rainfall is during mid-winter (usually June or July) whereas in the bimodal rainfall region (BR) in the southern and eastern Cape, peaks in rainfall occur during spring (usually September-November) and in late summer or autumn (usually March-May). In summer rainfall region one (SR1), which comprises southern South West Africa and central South Africa, peak rainfall occurs during late summer (usually in March). In summer rainfall region two (SR2), which comprises Botswana, northern South Africa and northern South West Africa, rainfall is fairly evenly distributed throughout the rainy season with a peak in mid-summer (usually December or January).

RESULTS

A total of 30 species of Scarabaeinae was trapped (Table 1). These were divided into two groups on the basis of their distribution between the four rainfall regions

TABLE 1. Distribution of 30 species of dung beetles in southern Africa and total numbers recorded in indigenous shrubland at Langebaan and in a pasture of Kikuyu grass at Paarl over a period of 13 months.

GROUP 1. Species restricted or largely restricted to the winter rainfall (WR) and bimodal rainfall (BR) regions

Species	Total numbers	
	LANGEBAAN Indigenous shrubland	PAARL Kikuyu grass
Pachysoma hippocrates MacLeay	3	
Kheper bonellii (MacLeay)	15	
Scarabaeus rugosus (Hausman)	1948	
S. intricatus Fabricius	44	
S. suri (Hausman)	2	
Sceliages brittoni zur Strassen	6	
Sisyphus quadricollis Peringuey	1	
Epirinus aeneas Weideman	82	
E. bentoi Ferreira	47	
E. flagellatus (Fabricius)	1	
Odontoloma dentinum (Harold)	3	24
O. pusillum Howden & Scholtz	86	
Odontoloma sp.	1	
Copris anceus Olivier	442	
C. capensis Waterhouse	4	
Macroderes sp.	6	
Sarophorus tuberculatus (Castelnau)	20	
Onthophagus cameloides d'Orbigny	3	12
O. giraffa Hausman	36	
O. immundus Boheman		4
O. minutus Boheman	1366	
Total	4107	40
Number of traps x number of trapping occasions	552	543

GROUP 2. Species of the winter; bimodal and summer rainfall (SR1, SR2) regions

Species	Total numbers	
	LANGEBAAN Indigenous shrubland	PAARL Kikuyu grass
Onitis aygulus (Fabricius)	52	28
O. caffer Boheman	7	27
O. confusus Boheman	11	
Chironitis scabrosus (Fabricius)	22	1
Onthophagus binodis Thunberg		90
O. gazella Fabricius		69
Euoniticellus africanus (Harold)		7
E. intermedius (Reiche)	80	569
E. triangulatus (Harold)		368
Total	172	1159
Number of traps x number of trapping occasions	552	543

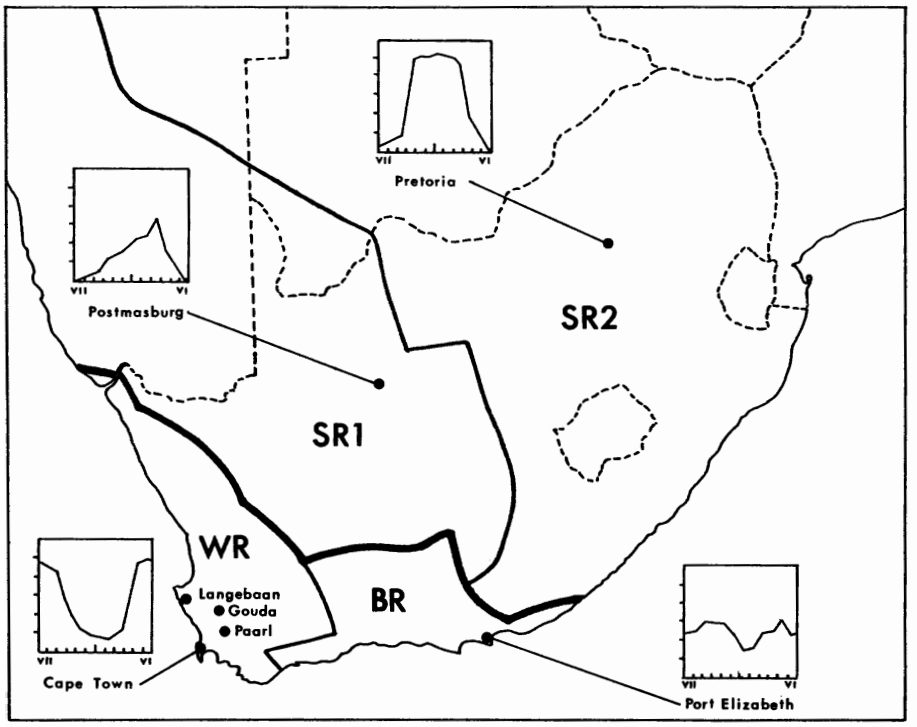

Fig. 1. The four rainfall regions of southern Africa (derived from Walter & Lieth 1964) with examples of seasonal rainfall from each region and the location of trapping sites in south-western Cape Province. WR = winter rainfall. BR = bimodal rainfall. SR = summer rainfall (areas 1 and 2).

of southern Africa (Figs 1–4). Group 1 comprises 18 species restricted to the winter (WR) and bimodal rainfall (BR) regions (Fig. 2) plus three species with a marginal distribution in the southern parts of the summer rainfall (SR1, SR2) region in addition to their occurrence in the winter and bimodal rainfall regions (Fig. 3). Group 2 comprises nine species with a wide distribution in the winter, bimodal and summer rainfall regions (Fig. 4).

Group 1 comprised 96% of the total numbers recorded in indigenous shrubland at Langebaan (Table 1) and was predominantly active during the winter rainy season (Fig. 5). At the beginning of the rainy season in autumn (April-May) there was an increase in abundance which reached a maximum during spring (August-October). Activity declined rapidly at the beginning of the dry season (November-December) and remained low until the beginning of the following rainy season (April). This seasonal distribution reflects the August, September or October peaks in activity of all the more abundant ($n > 20$) Group 1 species except *Epirinus aeneas* which shows a peak in activity during May (Table 2). Group 1 comprised only 3% of the total numbers recorded

TABLE 2. Seasonal occurrence of the most abundant species (n > 20) of Group 1 dung beetles in the south-western Cape and the size of each species expressed as mean dry mass.

Species	Mean/trap × 100			Month of maximum activity	*Mean dry mass (g) per specimen
	Early rainy season Apr.-Jul.	Late rainy season Aug.-Nov.	Dry season Dec.-Mar.		
LANGEBAAN					
Epirinus aeneas	32	18	0	May	0,019
Copris anceus	87	169	7	Aug.	0,253
Onthophagus minutus	234	523	41	Aug.	0,007
O. giraffa	6	13	1	Sept.	0,032
Odontoloma pusillum	15	30	0	Sept.	0,002
Sarophorus tuberculatus	0	11	0	Sept.	0,020
Epirinus bentoi	0	28	3	Sept.	0,014
Scarabaeus rugosus	279	802	4	Oct.	0,339
S. intricatus	1	18	6	Oct.	0,043
PAARL					
Odontoloma dentinum	1	11	0	Oct.	0,002

*Derived from 10 specimens for each species.
Mass indicates potential usefulness for dung removal.

TABLE 3. Seasonal occurrence of the most abundant species (n > 20) of Group 2 dung beetles in the south-western Cape and the size of each species expressed as mean dry mass.

Species	Mean/trap × 100			Month of max. (or 2nd to max.) activity	* Mean dry mass (g) per specimen
	Early rainy season Apr.-Jul.	Late rainy season Aug.-Nov.	Dry season Dec.-Mar.		
LANGEBAAN					
Euoniticellus intermedius	25	6	10	April	0,010
Chironitis scabrosus	0	1	13	Dec.	0,063
Onitis aygulus	4	1	28	Feb.	0,256
PAARL					
Onthophagus gazella	25	0	14	April	0,039
Euoniticellus intermedius	26	19	23	May	
Onitis caffer	15	3	0	May	0,223
Euoniticellus triangulatus	62	69	90	April (Nov.)	0,009
Onthophagus binodis	14	12	30	April (Dec.)	0,027
Onitis aygulus	1	1	16	Dec.	

*Derived from 10 specimens for each species.
Mass indicates potential usefulness for dung removal.

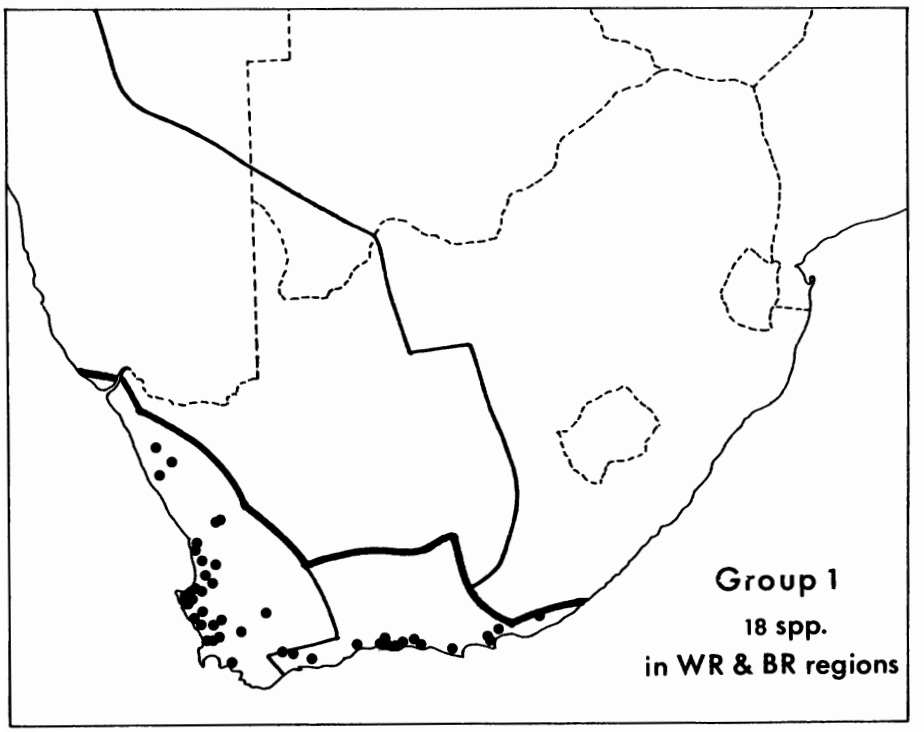

Fig. 2. The combined distribution of 18 species of dung beetles in Group 1 (all those listed in Table 1 minus those cited in Fig. 3) in the winter and bimodal rainfall regions of South Africa.

in Kikuyu grass at Paarl. These numbers were too low to assess seasonal distribution (Fig. 6).

Group 2 comprised 97% of the total numbers recorded at Paarl (Table 1) and showed bimodal seasonal activity (Fig. 6). The greatest peak in abundance was at the beginning of the rainy season in 1979 (April-May). This was followed by a decline in activity during the latter half of the rainy season (June-October). A second and smaller peak in abundance occurred at the beginning of the dry season (November-December) followed by decline in activity during the latter half of the dry season. No increase in activity was recorded in April 1980. Group 2 comprised only 4% of the total numbers recorded at Langebaan. The activity period from December to May was similar to that of Group 2 at Paarl (Figs 5, 6).

The seasonal distributions recorded for the more abundant ($n > 20$) species of Group 2 are summarized in Table 3. Activity by *Onitis caffer* was restricted to the rainy season. *Onthophagus gazella, O. binodis, Euoniticellus intermedius* and *E. triangulatus*, were relatively abundant in both the rainy and the dry season whereas activity by *Onitis aygulus* and *Chironitis scabrosus* was largely restricted to the dry season.

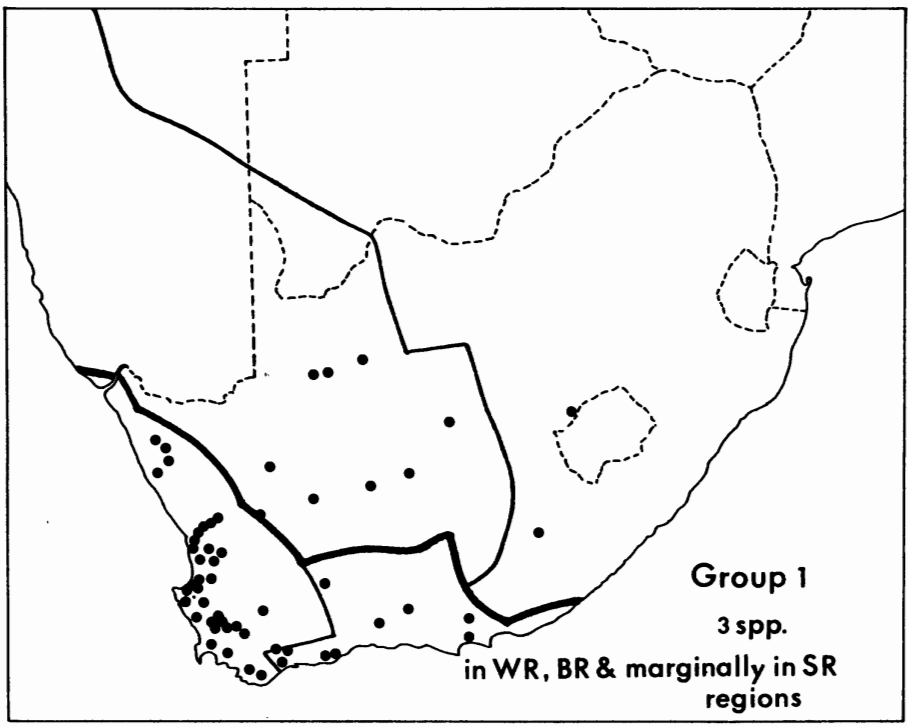

Fig. 3. The combined distribution of three Group 1 species of dung beetles, *Epirinus aeneas*, *E. flagellatus* and *Onthophagus cameloides*, between the four rainfall regions of southern Africa.

DISCUSSION

Two faunal groups of dung beetles have been shown to occur in the mediterranean climatic region of the south-western Cape. A relationship has been shown between their geographical and seasonal distributions. It is suggested that in addition to seasonal activity, the vegetation associations of these groups will strongly influence their potential as control agents of the bushfly in south-western Australia.

Geographical and seasonal distribution

The virtual restriction of Group 1 species to the winter and bimodal rainfall regions is reflected by their seasonal activity which is largely during the winter rainy season in the south-western Cape. The minor peak in activity by Group 1 species at the beginning of the rainy season (autumn) and the major peak late in the rainy season (spring) is similar to that of the dung beetles of southern Europe (Krausse 1907a, b, Lumaret 1983). However, the overall seasonal pattern of activity in southern France differs from that in the south-western Cape, presumably due to the lower mean annual temperature, much shorter dry season and correspondingly longer rainy season. In south-western Australia, seasonal peaks in abundance of dung beetles were variable be-

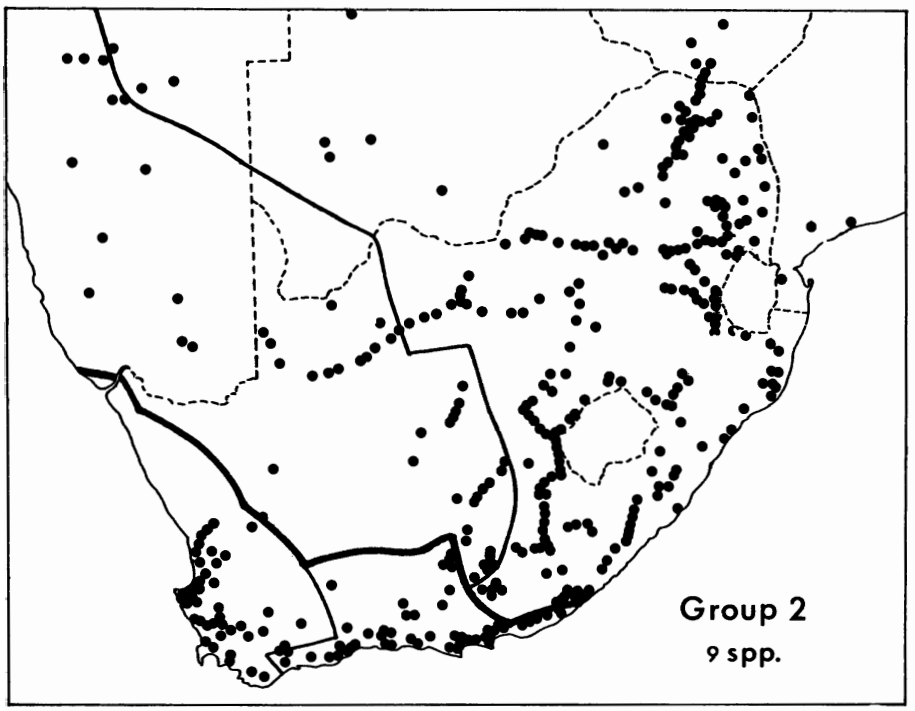

Fig. 4. The combined distribution of the nine species of dung beetles in Group 2 (see Table 1) between the four rainfall regions of southern Africa.

tween localities with either a single peak in spring, a single peak in autumn or a major peak in autumn and a minor peak in spring (Ridsdill Smith & Hall 1984a, b).

Group 2 shows a wider geographical range (Figs 2, 3, 4) and a broader seasonal distribution (Tables 2, 3) than Group 1 but overall abundance was much lower (Table 1). This may be because greatest activity by dung beetles is during rainy periods (Krausse 1907a, b, Halffter & Matthews 1966, Kingston 1977, Cambefort 1982, Lumaret 1983) whereas, in the south-western Cape, the main activity period of Group 2 species is during the warmer, predominantly dry months (Fig. 6). Furthermore, the present study was conducted in virtually non-irrigated situations so that there was little dry-season soil moisture. The occurrence of Group 2 at Langebaan and Paarl may be associated with the moderate to high rainfall coastal belt of the southern Cape which connects the south-western Cape to the moist summer rainfall region. In contrast, no naturally-occurring dung beetles with Group 2 activity patterns have been recorded in south-western Australia (Ridsdill Smith and Hall 1984a, b) which is isolated from moist summer rainfall regions by the arid centre of the continent.

Effects of habitat and farming practice on distribution of dung beetles

Much of the shrubland indigenous to the south-western Cape has been cleared. In perennial cattle pastures it is often replaced either by a sparse cover of natural

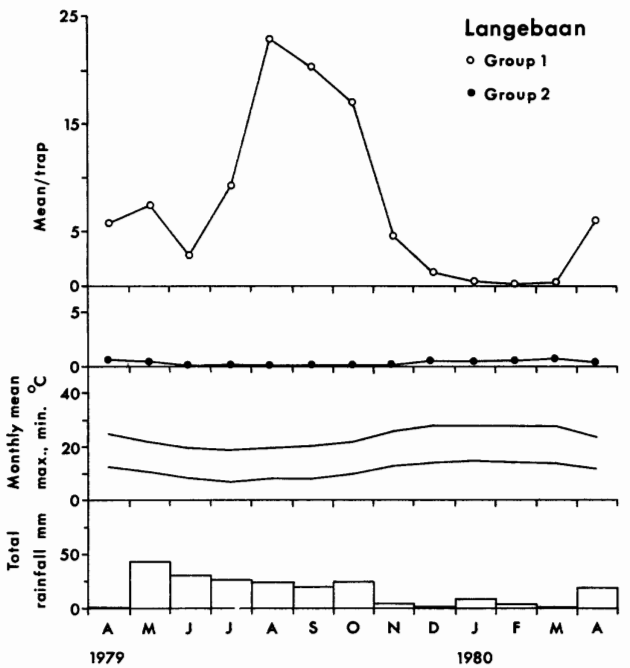

Fig. 5. Seasonal distribution of Group 1 and Group 2 dung beetles in indigenous shrubland near Langebaan with seasonal temperature and rainfall data from Langebaanweg (climatic data courtesy of the Weather Bureau of South Africa).

herbs and grasses or by a dense cover of Kikuyu grass usually under irrigation during the dry season. In herbs and grasses at Langebaan and at Gouda (33° 16′ S 19° 02′ E), numerical balance of Group 1 (*c.* 60%) and Group 2 (*c.* 40%) (Davis, unpubl. data) was intermediate to the extreme distributions of the groups in indigenous shrubland and Kikuyu grass. These differences in faunal composition parallel increasing modification of the native habitat. As vegetation type, soil type and climate differed between trapping sites in the present study, further work is necessary to determine the causes of these differences.

Selection of dung beetle species for introduction into Australia

Of the seven species of dung beetles that have been introduced into south-western Australia and become established (Ridsdill Smith & Matthiessen 1984), *Onitis aygulus, Onthophagus binodis* and *Euoniticellus intermedius* were recorded during the present study. These three species belong to Group 2 which shows summer and autumn activity in the south-western Cape. A similar activity period is shown by the entire group of exotic species introduced into south-western Australia. This postdates the spring increase in the abundance of the bushfly (Ridsdill Smith & Matthiessen 1984) which these species were introduced to control. The present study has identified spring-active species belonging to Group 1 in the south-western Cape but they may be associated

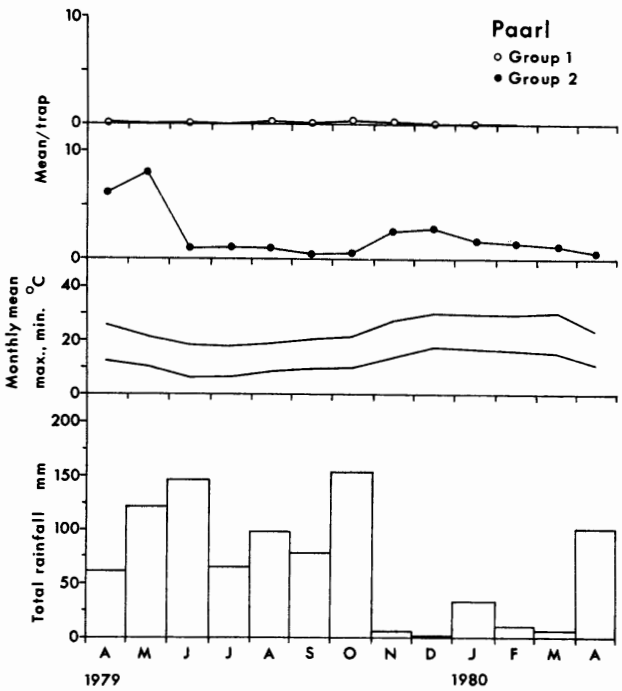

Fig. 6. Seasonal distribution of Group 1 and Group 2 dung beetles in Kikuyu grass near Paarl with temperature and rainfall data for Paarl (climatic data courtesy of the Weather Bureau of South Africa).

with indigenous shrubland which would make them unsuitable for introduction into pasture habitats in Australia.

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