Seasonal activity patterns and habitats in Solifugae (Arachnida) in the southern Karoo, South Africa

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Received 9 March 1992; accepted 14 September 1992

Solifuges were caught with pitfall traps over a 29-month period in three different habitats at Tierberg, near Prince Albert. A total of 134 individuals of at least nine species of four families (Ceromidae, Daesiidae, Gylippidae and Solpugidae) were trapped in the three habitats. *Blossia karrooica, B. unquicornis* and *Hemiblossia idioceras* were caught only on plains, *Blossia* sp. nov. was caught only on 'heuweltjies', *Lipophaga trispinosa* was caught only on old fields, and *Hemiblossia oneili* and *Solpugiba lineata* were caught in all three habitats. Most species were active in the summer (October–March) but two species, *Blossia karrooica* and *Lipophaga trispinosa* were active throughout the year.

Jagspinnekoppe is in vanggate gedurende 'n tydperk van 29 maande in drie verskillende habitatte op Tierberg, naby Prince Albert, gevang. 'n Totaal van 134 individue van nege spesies van vier families (Ceromidae, Daesiidae, Gylippidae en Solpugidae) is in die drie habitatte gevang. *Blossia karrooica, B. unquicornis* en *Hemiblossia idioceras* is net op die vlaktes gevang, *Blossia* sp. nov. is net op heuweltjies gevang, *Lipophaga trispinosa* is net op ou landerye gevang, en *Hemiblossia oneili* en *Solpugiba lineata* is by al drie habitatte gevang. Die meeste van die spesies was aktief gedurende die somer (Oktober–Maart), maar twee spesies, *Blossia karrooica* en *Lipophaga trispinosa* was deur die hele jaar aktief.

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A large diversity of solifuges (Solifugae) occurs in the arid and semi-arid regions of southern Africa (Newlands 1978; Wharton 1981). The biology of solifuges in southern Africa is poorly known and few species have been studied intensively. Solifuge species diversity in small areas may be high and restricted to particular habitats (Wharton 1981; Griffin 1990). These authors have shown, for example, that most solifuges in the Namib Desert are habitat specific. Results of the present study indicate that many of the southern Karoo solifuge species are also habitat specific. Furthermore, the species composition of solifuge assemblages in this area apparently differs seasonally, suggesting that many species of solifuges are able to coexist in an area by partitioning activity periods through the year. We investigated habitat preferences and activity patterns of solifuges using pitfall traps at Tierberg Karoo Research Centre from March 1988 to July 1990.

Study area

Three different habitats in the Sandrivier Valley, near Prince Albert, southern Karoo, were sampled. Traps were set in open dwarf shrubland dominated by *Pteronia pallens* on plains, on 'heuweltjies' (nutrient-rich earth mounds) and on old cultivated lands on alluvial soils. The plains and 'heuweltjie' sites were on the 100 ha Tierberg Karoo Research Centre. This study site is fully described by Milton, Dean & Kerley (1992).

Plains

Deciduous and evergreen succulents, 10–40 cm tall, including *Ruschia spinosa, Rhinephyllum* spp., *Drosanthemum* spp. and *Brownanthus ciliatus* are common on the plains. There are few annual forbs and no grasses. The tallest plants (40–70 cm) are the abundant woody shrubs *Pteronia pallens* and *P.* cf. *empetrifolia* (Asteraceae).

Heuweltjies

These low, nutrient-rich mounds probably originate as soil and waste dumps of termites (Moore & Picker 1990). They are described by Lovegrove & Siegfried (1989) and Midgley & Musil (1990). The most abundant plants on 'heuweltjies' are succulent shrubs, particularly *Malephora lutea* and *Psilocaulon utile*. Other common species are *Augea capensis* and *Drosanthemum* cf. *hispidum*. Annuals, including *Tetragonia echinata*, are present on many 'heuweltjies' after good rains.

Old fields

Solifuges were trapped on three old fields on alluvial terraces along the Tierberg River. The alluvial terraces at Tierberg extend 50–200 m from the river banks, their outer edges usually being clearly defined by rock outcrops or a change in slope. The old fields had been fenced and ploughed from within 10 m of the river to the limits of the alluvium. Old fields on alluviums are conspicuous because of low plant cover during dry periods, dominance by a few species of succulents such as *Psilocaulon utile* and *Malephora lutea* and the presence of alien plants such as *Atriplex lindlevi* and *Salsola kali*.

The Prince Albert area is arid throughout the year, even in the relatively mesic autumn. Rainfall is highly variable (56–400 mm annually) and averages 169,6 ± *S.D.* 67,8 mm for the period 1878–1990 (95 complete data sets). Tempera-

tures in the area are extreme; mean monthly temperatures logged during 1990 at the Tierberg study site ranged from 8,8°C in June (range –2,3–25,6) to 24,4°C in January (range 9,8–39,2). Soil surface temperatures similarly range widely and may reach 70,0°C in summer (Figure 1).

Methods

Solifuges were caught using pitfall traps set once a month for 24 h. Griffin (1990) discusses the selectivity of pitfall traps for solifuges. Trapping periods differed between the three sites. On the plains and two of the 'heuweltjies', traps were first set in March 1988, and in July 1988 a further 18 traps were set on 'heuweltjies'. On the old fields, traps were set in August 1988 on two of the fields and in January 1989 on the third field. All trapping was terminated in July 1990. Total number of trap-days for each locality/habitat and for each month is given in Table 1. We laid out a grid of five pitfall traps in four rows, with the traps 5 m and the rows 20 m apart on the plains. On 'heuweltjies' we placed one trap roughly in the centre of each of the first 20 'heuweltjies' encountered on the study site. On old fields, we laid out a single line of five pitfall traps 5 m apart across the centre of each of the fields. The traps were tin cans with entrances 90 mm in diameter, sunk into the soil so that the top of the can was flush with the surrounding substrate. The method we used was exactly that described by Donnelly & Gilliomee (1985).

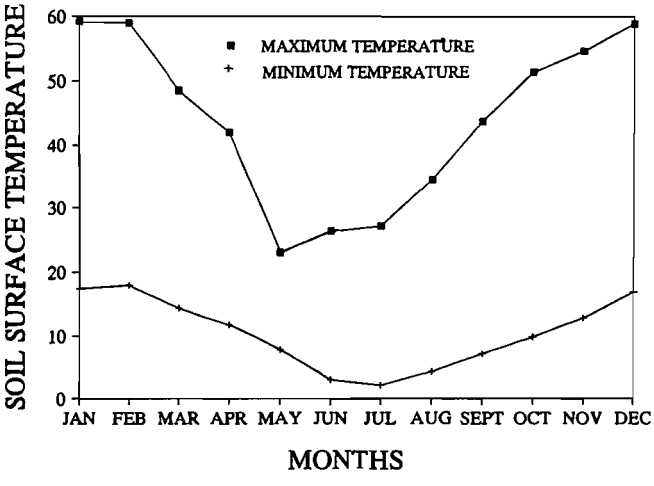

Figure 1 Mean monthly minimum and maximum soil surface temperatures logged at Tierberg, Prince Albert, during 1990.

Male solifuges were identified to species by EG, using published descriptions and type specimens. Females and juveniles were identified to genus where possible but in some cases only to family.

Results

A total of 134 individuals of at least nine species of solifuges of four families (Ceromidae, Daesiidae, Gylippidae and Solpugidae) was trapped in the three habitats (Table 2). The three habitats differed little in total solifuge diversity but more individuals were caught on the plains and on 'heuweltjies' than old fields. However, if the number of trap-days is taken into account, the probability of catching a solifuge was 0,086 on the plains, 0,090 on 'heuweltjies' and 0,11 on old fields, suggesting that both 'heuweltjies' and old fields were more frequently used by foraging solifuges, although not substantially more than plains. Most species were caught in the plains habitat and three species, *Blossia karrooica* Purcell, *B. unguicornis* Purcell and *Hemiblossia idioceras* Hewitt, were caught only on the plains. 'Heuweltjies' had the second highest diversity and only one species, *Blossia* sp. nov., appeared to be restricted to this habitat. One species, *Lipophaga trispinosa* Purcell was caught only on the old fields. Two species, *Hemiblossia oneili* Purcell and *Solpugiba lineata* C.L. Koch, were frequently caught in all three habitats (Table 2).

There were clear seasonal differences in the activity patterns of the various species. Most of the species were active only in the summer (October–March; Table 3) and most species and individual solifuges were active in January (Figure 2). However, adults of the two *Ceroma* species and *Hemiblossia idioceras* were active only in the autumn and winter. *Ceroma* sp. juveniles emerged during the winter. Two species, *Blossia karrooica* and *Lipophaga trispinosa*, appeared to be active throughout the year. *Solpugiba lineata* juveniles began to emerge in October and were active until March. Only *Solpuga chelicornis* was active for a similar period. At least two species common on the study site [Table 3: *Solpuga chelicornis* var. *rufescens* Lichtenstein and *Zeria venator* (Pocock), both Solpugidae] were not caught in pitfall traps and it is possible that other species present at the site avoided capture.

Discussion

Habitat preferences in southern African solifuges appear to be related to vegetation and rock cover, and substratum (Wharton 1981; Griffin 1990). The type of substratum may

Table 1 Trap-days and months in which trapping was done at each habitat type at Tierberg, Prince Albert

	Trap-days per month												
Habitat	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Tot.
Plains	40	40	60	60	60	60	60	40	40	40	40	40	580
Heuweltjies	40	40	42	42	42	42	60	40	40	40	40	40	508
Old fields	30	30	30	30	30	30	30	25	25	25	25	25	335
Totals	110	110	132	132	132	132	150	105	105	105	105	105	1423

Table 2 Number of individuals of each solifuge species trapped in each of three habitats at Tierberg, Prince Albert, from March 1988 to July 1990

Species	Plains	Heuweltjies	Old field
Ceromidae			
Ceroma sp nov	1	2	
Ceroma (F + juvs)	5	1	1
Daesiidae			
Biton schreineri		1	1
Blossia karrooica	3		
Blossia unquicornis	4		
Blossia sp nov		1	
Blossia (F + juvs)	9	8	2
Hemiblossia idioceras	3		
Hemiblossia oneili	3	8	5
Hemiblossia (F + juvs)	14	15	14
Gylippidae			
Lipophaga trispinosa			2
Lipophaga (F + juvs)			2
Solpugidae			
Solpugiba lineata	7	10	5
Solpugidae unidentified	1		6
Total species	6	5	4
Total individuals	50	46	38

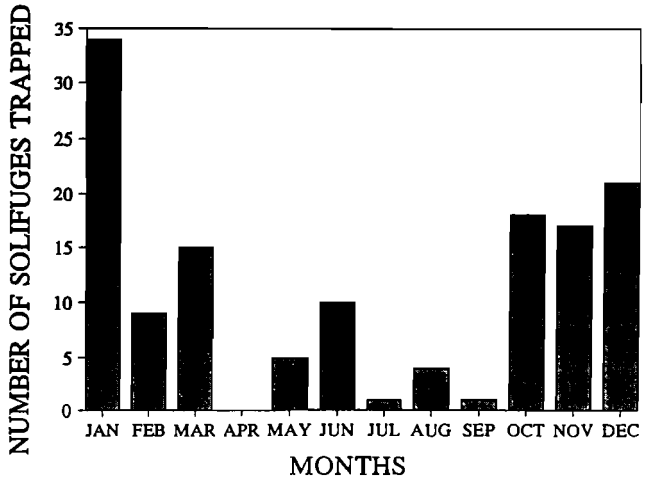

Figure 2 Numbers of solifuges trapped each month throughout the year at Tierberg, Prince Albert.

be the critical factor determining the distribution of some of the species. Plant cover was lowest on the old fields and highest on 'heuweltjies' (Milton *et al.* 1992; WRJD & S.J. Milton, unpublished data). Both old fields and 'heuweltjies' have similar sandy soils (WRJD, pers. obs). *Biton schreineri* was caught only on 'heuweltjies' and old fields, suggesting that it is the soil, rather than the cover, that determines the presence of this species. Many species of solifuges occur on sandy soils (*contra* Newlands 1978; supported by Wharton

Table 3 Months in which solifuges were trapped or observed actively foraging at Tierberg, Prince Albert

	Activity periods (months)											
Family and species	J	F	M	A	M	J	J	A	S	O	N	D
Ceromidae												
Ceroma sp nov.					–	–						
Ceroma (F + juvs)					–	–		–				
Daesiidae												
Biton schreineri	–									–		
Blossia karrooica	–							–		–		
B. unquicornis												–
Blossia sp nov.									–			
Hemiblossia idioceras						–						
H. oneili	–									–	–	
Hemiblossia (F + juvs)	–	–	–							–	–	–
Gylippidae												
Lipophaga trispinosa					–							
Lipophaga (F + juvs)											–	
Solpugidae												
Solpugiba lineata	–	–	–							–	–	–
*Solpuga chelicornis**	–	–	–							–	–	–
*Zeria venator**	–	–										–

* Direct observations only of these species

1981, 1987; Griffin 1990). Without information on the biology, including prey preferences of solifuges, it is not possible to speculate further on habitat preferences.

The activity data suggest that it is the smaller species (Ceromidae, Daesiidae and Gylippidae) that tend to be active in the winter, with the larger Solpugidae active in the summer. The largest solifuge present at the Tierberg site, *Zeria venator*, is a nocturnal species apparently active only during midsummer. Once again, without information on the biology of solifuges, it is not possible to determine the factors that decide why certain species are active at particular times. Surface-foraging termites (*Microhodotermes viator*) in the Tierberg area are active throughout the year at a wide range of soil-surface temperatures (WRJD, pers. obs.) so solifuges feeding on this prey would not be constrained by the seasonal activity patterns of the prey. *Hemiblossia* species are implied to feed on termites (Wharton 1981) and termites may provide an easily obtained, abundant prey for many of the other species of solifuge. This being the case, why then are certain solifuges active at certain times of the year and not at others? The possibility exists that those species of solifuge able to tolerate high soil-surface temperatures may feed on prey animals that succumb to thermal stress, as Marsh (1985) has suggested for the thermophilic ant *Ocymyrmex robustior* (formerly *barbiger*) and are thus able to exploit a resource not available to other species of solifuge. Since solifuges are unlikely to take an unmoving prey item, only those animals severely handicapped by thermal stress would be potential prey. *Solpuga chelicornis*, for example, has been frequently observed in the southern Karoo foraging during the hottest part of the day in summer, when soil-surface temperatures

attain >65°C (WRJD, pers. obs.). Wharton (1987) observed *Metasolpuga picta* foraging at soil-surface temperatures of 40–61°C in the Namib Desert and many other species of solifuge can apparently tolerate very high soil-surface temperatures. The smaller daesiids are apparently active at much lower soil-surface temperatures during the winter at Tierberg (Figure 1, Table 3). It is possible that soil-surface temperatures, competitive interactions and prey specialization may sort the activity patterns of different species of solifuges at Tierberg.

Acknowledgements

This research was supported by the Foundation for Research Development and the Percy FitzPatrick Institute of African Ornithology, University of Cape Town. We thank Harold Wright and Piet van Wyk for permission to carry out this study on old fields on Tierberg. We are grateful to Roy Siegfried for critical comments on a first draft of this paper.

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