Guild composition and seasonal distribution of insects on *Protea magnifica* and *P. laurifolia* (Proteaceae)

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Insects were collected over a period of 12 months from *Protea magnifica* and *P. laurifolia* by beating. Analysis of guild composition showed remarkable uniformity in proportion of species in different guilds on the two plants. Proportions of individuals in different guilds were not uniform, owing to a larger proportion of phytophages being collected on *P. magnifica*. A distinct seasonal distribution in insect numbers was observed in four out of six study sites, with peak numbers being collected in summer.

Insekte is oor 'n periode van 12 maande vanaf *Protea magnifica* en *P. laurifolia* deur middel van uitklop versamel. Ontleding van gildestruktuur het noemenswaardige uniformiteit in verhoudings van spesies in verskillende gildes op die twee plante getoon. Verhoudings van individue in verskillende gildes was nie uniform nie, weens 'n groter proporsie fitofage insekte op *P. magnifica*. 'n Duidelike seisoenale verspreiding in insekgetalle is in vier uit die ses studiepersele waargeneem, met piekgetalle in die somer.

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Very few insect community studies have been undertaken in the fynbos (the Capensis flora, *sensu* Taylor 1978), and they have concentrated either on specific taxa (e.g. Formicidae, Donnelly & Giliomee 1985, Koen & Breytenbach 1988), or a limited range of taxa (e.g. Orthoptera & Hemiptera, Schlettwein & Giliomee 1987). The first study which attempts to consider all the arthropods associated with selected fynbos plants is that of Coetzee (1989), who followed the 'knock-down' approach of Moran & Southwood (1982). A major problem encountered in this study was identifying species collected as the insects of the fynbos are poorly known (Coetzee 1989).

The present study forms the basis for a comprehensive investigation of insect–plant interactions (viz. herbivory, seed predation and pollination, all reported separately), on *Protea magnifica* Link and *P. laurifolia* Thunb., two fynbos species which are also used commercially for their flowers.

The two host plants have similar overall distribution patterns in the south-western Cape, though *P. magnifica* has a discontinuous distribution pattern within its overall range, occurring only on mountain peaks above 1200 m (Rourke 1980). *Protea laurifolia* occurs below 1200 m (Rourke 1980). Also, the architecture of the plants differs in that *P. magnifica* seldom grows higher than 2 m, while *P. laurifolia* may reach 8 m (Vogts 1982). This difference should allow a test of Lawton's (1983) hypothesis that plant height is of significance in determining how many insect species utilize it. Unfortunately, certain factors complicate this test, as *P. magnifica* has a relatively disjointed distribution, and is subject to a more variable climate than *P. laurifolia* (Vogts 1982).

The leaves of *P. magnifica* are broader than those of *P. laurifolia* and occur in a more dense concentration on branches. Both plants are evergreen.

The aim of this study was to establish the guild structure of insects on the two plants in question and their seasonal distribution, and to discuss factors possibly influencing these aspects.

Materials and Methods

Study sites were located in Du Toits Kloof (DTK) (33° 38′S/ 19°05′E, both plants), the Cedarberg (CB) (32°25′S/ 19°10′E, both plants), Groenlandberg (GB) (34°07′S/ 19°08′E, *P. magnifica*) and Mont Rochelle (MR) (33°54′S/ 19°09″E, *P. laurifolia*). Population sizes of *P. magnifica* ranged from 50–250 plants, and *P. laurifolia* from several hundred to thousands of individuals. Populations of the two species never overlapped.

Insects were collected on a monthly basis from DTK, MR and GB and bimonthly from CB. Collections were made from January 1988 to December 1988, except for MR, where collecting commenced in February 1988 and ended in January 1989. Collecting was done by beating (Smithers 1981), rather than by the knock-down method, because of the frequently windy conditions under which collecting was done. It was decided to sample 24 branches as a species-sampling area analysis at DTK indicated that no new species were collected with further effort. Each of 24 randomly selected branches of both species were sampled each month by beating until insects no longer fell onto the 50 × 50-cm sheet. Insects thus collected were stored in 70% alcohol and later sorted into morphospecies (hereafter referred to as 'species'). In the case of phytophagous species, specialists on taxa were consulted to obtain reliable identifications. Specimens were allocated to the following guilds: phytophages [divided into chewers (PC) and suckers (PS)], predators + parasitoids (P), ants (A), 'detritivores' (D, all non-detrimental feeders on the plant, viz., fungivores, detritus feeders), flower visitors (FLO) and tourists (T). These guilds were decided on after consulting Moran & Southwood (1982) and Coetzee (1989). Guild allocations were made by

Table 1 Insect taxa, and guild allocations of insects collected on *Protea magnifica* (Pm) and *P. laurifolia* (Pl). Species are grouped by guild, then taxon. (PS = phytophagous sucker, PC = phytophagous chewer, FLO = flower visitor, P = predator/parasite, A = ant, T = tourist, D = detritivore)

Taxon	AcHRP	Guild	Pm	Pl
Hemiptera				
Miridae (Gen. et sp. indet.)	764	PS	*	*
Lygaeidae				
Oxycarenus maculatus	624	PS	*	*
Machiademus diplopterus	208	PS	*	*
Caprhobia similis	262	PS	*	*
Poeanthus velox	237	PS	*	*
Gen. et sp. indet.	1963	PS	*	*
Aradidae	1965	PS	–	*
Pentatomidae				
Antestiopsis variegata	545	PS	*	*
Gen. et sp. indet.	680	PS	*	*
Cydnidae				
Dimegistus fimbriatus	373	PS	*	*
Membracidae				
Gargaza sp.	529	PS	*	*
Psyllidae (Gen. et sp. indet.)	1990	PS	*	*
Diaspididae				
Ledaspis distincta	926	PS	*	*
Gen. et sp. indet.	1937	PS	*	–
Gen. et sp. indet.	926	PS	*	*
Thysanoptera	1953	PS	*	*
Phasmotodea (Gen. et sp. indet.)	1959	PC	*	–
Orthoptera				
Tettigonidae	1956	PC	–	*
Coleoptera				
Phalacridae				
Olibrus aerolatus	717	PC	*	*
Discolomidae				
Notiophygus sp.	1952	PC	–	*
Chrysomelidae				
Prasoidea sericea	521	PC	*	*
Xenoomorphus sp.	603	PC	*	*
Rhabdocneorane sp.	708	PC	*	*
Gen. et sp. indet.	1987	PC	*	–
Buprestidae				
Sphenoptera sp. A	1938	PC	*	–
Sphenontera sp. B	1951	PC	–	*
Anthribidae				
Holophloeus nigellus	1992	PC	–	*
Gen. et sp. indet.	1993	PC	–	*
Cerambycidae				
Gen. et sp. indet.	1744	PC	*	*
Cryptophagidae				
Micrambe tenuicormis	760	PC	*	–
Curculionidae				
Afroleptops coetzeei	664	PC	*	*
Eremnus nr. *atratus*	735	PC	*	*
Stenotypus sp.	1949	PC	–	*
Hipporhinus sp.A	1961	PC	*	–
Hipporhinus sp.B	1941	PC	*	–
Euderes lineicollis	1912	PC	–	*

Table 1 Continued

Taxon	AcHRP	Guild	Pm	Pl
Sibinia sp.	1989	PC	*	–
Smicronyx sp.	1946	PC	*	*
Gen. et sp. indet.	1945	PC	*	–
Cryptorhynchinae (Gen. indet.)	1948	PC	–	*
Apionidae (Gen. et sp. indet.)	1954	PC	–	*
Lepidoptera				
Geometridae (Gen. et sp. indet.)	1947	PC	*	*
Psychidae (Gen. et sp. indet.)	1942	PC	*	*
Limacodidae (Gen. et sp. indet.)	10	PC	*	*
Sphingidae (Gen. et sp. indet.)	1960	PC	*	–
Pyralidae (Gen. et sp. indet.)	1954	PC	–	*
Bostra conspicualis	329	PC	–	*
Phyllocnistidae				
Phyllocnistis sp.	698	PC	*	*
Family indet. (Larvae)	1937	PC	*	–
Family indet. (Larvae)	1939	PC	*	*
Family indet. (Larvae)	1981	PC	*	–
Family indet. (Larvae)	1983	PC	*	–
Coleoptera				
Scarabaeidae				
Tricostetha capensis	61	FLO	–	*
Platychelus sp.	1132	FLO	*	*
Chrysomelidae				
Chirodica calcoptera	706	FLO	*	*
Staphylinidae				
Phloeonomus sp.	725	FLO	*	*
Nitidulidae				
Pria cinerascens	713	FLO	*	*
Helodidae				
Helodes sp.	1950	FLO	–	*
Mantodea (Gen. et sp. indet.)	663	P	–	*
Hemiptera				
Anthocoridae	134	P	*	–
Reduviidae	1994	P	–	*
Neuroptera				
Chrysopidae	1196	P	*	–
Coleoptera				
Cleridae	258	P	*	*
Melyridae	720	P	*	–
Melyridae	1159	P	*	*
Carabidae				
Xenitenus tessalatus	625	P	*	*
Cucujidae				
Phyconomus tricolor	721	P	*	*
Phyconomus palidus	722	P	–	*
Nitidulidae				
Cybocephalus sp.	825	P	*	*
Coccinellidae				
Rhyzobius javeti	766	P	*	*
Telsimia tetrastricta	863	P	*	*
Rhyzobius sp.	1995	P	*	*
Scymnus morreleti	617	P	*	*
Adonia variegata	613	P	–	*
Cheilomenes lunata	792	P	*	*
Hymenoptera				
Chalcididae				
Hockeria sp.	1970	P	*	–

Table 1 Continued

Taxon	AcHRP	Guild	Pm	Pl
Dirhinus sp.	972	P	*	–
Gen. et sp. indet.	280	P	*	–
Ichneumonidae				
Gen. et sp. indet.	1304	P	*	–
Vespidae				
Polistes sp.	1985	P	*	–
Eupelmidae				
Gen. et sp. indet.	740	P	–	*
Family indet.	1969	P	*	–
Family indet.	1968	P	*	*
Family indet.	379	P	–	*
Family indet.	1986	P	*	–
Formicidae				
Camponotus maculatus	1976	A	*	–
Camponotus niveosetosus	1150	A	*	*
Camponotus fulvopilosus	1979	A	–	*
Camponotus sp.1	1974	A	*	*
Camponotus sp.2	1977	A	*	–
Camponotus sp.3	1996	A	*	–
Camponotus sp.4	1980	A	*	–
Crematogaster peringueyi	653	A	*	*
Crematogaster lingmei	694	A	*	*
Crematogaster sp.1	1972	A	–	*
Crematogaster sp.2	1973	A	–	*
Anoplolepis custodiens	1810	A	*	*
Acantholepis capensis	1809	A	*	*
Pheidole prob. *capensis*	1820	A	*	*
Plagiolepis sp.	1975	A	*	*
Myrmecaria nigra	1819	A	–	*
Iridomyrmex humilis	656	A	–	*
Microcoryphia				
Family indet.	1940	D	*	–
Collembola				
Arthropleona	1970	D	–	*
Thysanura				
Lepismatidae	1971	D	*	*
Psocoptera				
Family indet.	935	D	*	*
Blattaria				
Blattidae	751	D	*	*
Blaberidae	1988	D	*	*
Coleoptera				
Tenebrionidae	1991	D	*	–
Lathridiidae	1610	D	*	*
Lathridiidae	899	D	–	*
Hemiptera				
Cercopidae (Gen. indet.)	1966	T	–	*
Fulgoroidea (Var. spp.)	1967	T	*	*
Cicadellidae (Var. spp.)	1962	T	*	*
Aphididae (Gen. indet.)	844	T	*	–
Plecoptera				
Nemouridae (Gen. indet.)	1964	T	–	*
Diptera (Var. fams)	Various	T	*	*

consulting literature, or by personal observations of feeding habits. In the case of many taxa, no identification to species

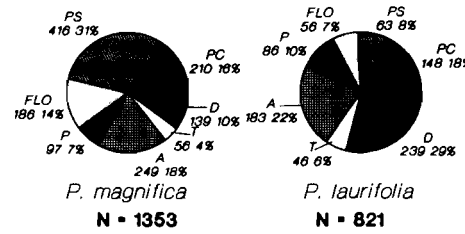

Figure 1 Guild composition of insects (number of individuals) on two *Protea* species. (A = ants; PC = phytophagous chewers; FLO = flower visitors; D = detritivores; P = predators & parasitoids; T = tourists; PS = phytophagous suckers.)

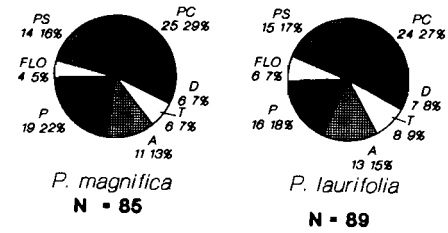

Figure 2 Guild composition of insects (number of species) on two *Protea* species. (PC = phytophagous chewers; PS = phytophagous suckers; FLO = flower visitors; P = predators & parasitoids; A = ants; T = tourists; D = detritivores.)

Table 2 Tests for uniformity of proportion of guilds between *Protea magnifica* and *P. laurifolia* using 2×2 contingency tables with Yates correction. Data analysed are for number of species and number of individuals from Figure 1 and Figure 2. (Phy. = Phytophages; P = Predators & parasitoids; All = all guilds except phy.)

Comparison	χ^2	P (df = 1)	Conclusion
No. spp.: Phy.: P	0,05	NS	Uniform
: Phy.: All	0,01	NS	Uniform
No. inds.: Phy.: P	33,48	< 0,001	Non-uniform
: Phy.: All	90,42	< 0,001	Non-uniform

level was possible, so morphospecies were allocated accession numbers only (AcHRP = Accession number, Horticultural Research, Proteas). All insects collected were deposited in the collection of fynbos insects of the VOPRI at Elsenburg (near Stellenbosch), or with the National Collection of Insects (PPRI), Pretoria.

An analysis (according to Moran & Southwood 1982), was done to establish whether the phytophage guild was uniformly represented on both plants with respect to predators + parasitoids and all other guilds collectively.

Results

All taxa collected are listed in Table 1, with their guild allocations and host plant.

The proportions of individuals and species in different guilds are given in Figures 1 and 2 respectively. The number

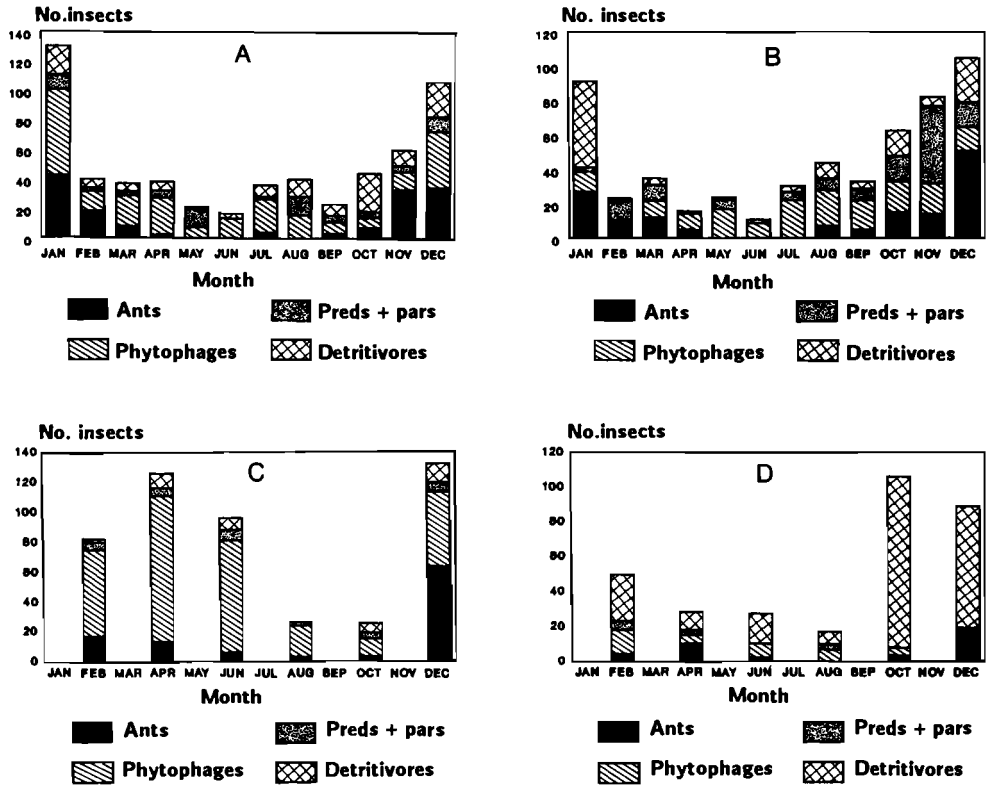

Figure 3 Seasonal distribution of insects on two *Protea* species. A: *P. magnifica*, DTK & GB; B: *P. laurifolia*, MR & DTK; C: *P. magnifica*, CB; D: *P. laurifolia*, CB.

of species collected in each guild for the two plants studied, showed remarkable uniformity.

Number of species of phytophages relative to other guilds was uniform for the two plants, but not the number of individuals (Table 2).

A distinct seasonal distribution was apparent for both plants at DTK, MR and GB but appeared to be different at CB (Figure 3). Proportions of predators + parasitoids : phytophages appeared to be lower for the *P. magnifica* site at CB than for the other sites and *P.laurifolia* (Figure 3). More phytophagous insects were also collected from the CB *P. magnifica* than in other sites (Figure 3).

Discussion

The observed similarity in the number of insect species on the two plants is to be expected in terms of the similar distribution of the two plant species (Lawton & Schroder 1977), though one might have expected a lower species richness for *P. magnifica*, in view of the higher altitudes where it occurs, as was found by Wolda (1987). The differences in architecture (e.g. height) of the two plants also provide grounds to expect a difference in the number of species utilizing each (Moran 1980; Lawton 1983). The broad-leaved nature of *P. magnifica* might cause it to host more species than one might expect of a plant with its lower height and disjointed distribution, considering that Moran & Southwood (1982) have shown that broad-leaved trees harbour more species than narrow-leaved ones. Furthermore, it has been shown by Lawton & Strong (1981), that small, local clumps of plants support less species than larger clumps, but in the present study it is possible that the inclusion of a number of isolated clumps of *P. magnifica*, with possibly dissimilar insect faunas, may have led to the plant having as many species as the more evenly distributed *P. laurifolia*. Even interplant distance has been found to influence similarity of insect faunas in Bornean forests (Stork 1987b), and a similar phenomenon may occur with *P. magnifica*, with its widely separated patches. This aspect deserves further scrutiny.

The similarity (uniformity) of proportions of phytophages to other guilds is in accordance with findings of Moran & Southwood (1982). Non-uniformity of numbers of individuals might be attributable to climate or incorrect guild allocations. For example, the Phalacridae are placed in different guilds by Moran & Southwood (1982); Stork (1987a); Louw (1988) and Coetzee (1989), and the possibility thus exists that they are incorrectly placed in the present study.

The number of species and individuals collected (particularly tourists, detritivores and flower visitors) were considerably lower than the numbers recorded on five Proteaceae by Coetzee (1989). This can probably be attributed to the different collecting method used in the present study, viz. beating, as well as the often inclement weather conditions (hot/cold, wind) under which collecting was done. Beating will tend to collect large, slow-moving insects better than small flying ones, whereas the knock-down method used by Coetzee (1989) may collect more equable proportions of both types of insects. The cup-shaped form of the inflorescences of the two study plants probably led to few hymenopteran flower visitors being collected.

The seasonal distribution of insects at DTK, GB and MR appeared to be strongly correlated with winter (cold) and

summer conditions. This is in contrast with Coetzee's (1989) findings that no seasonal distribution of insects (except for ants and flower visitors) occurred on his five Proteaceae. The sites used in his study were, however, all located at lower altitudes than the sites used in the present study, and all have a less harsh winter than the sites in the present study. The importance of climate to insects has been emphasized by Caughley & Lawton (1981).

In conclusion, results obtained in this study show that the proportion of phytophagous insects to other guilds is uniform on *P. magnifica* and *P. laurifolia*, as is the case on other plants (Moran & Southwood 1982). Distinct seasonal changes in insect abundance occurred in most study sites, probably owing to climatic variability associated with high altitudes.

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