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Biotic processes in a coastal dunefield: An assessment of seed removal, with non-native seed removal experiments

Castley, J. Guy[1,2*]; Kerley, Graham I.H.[1] & McLachlan, Anton[1,3]

[1]*Terrestrial Ecology Research Unit, Department of Zoology, University of Port Elizabeth, P.O. Box 1600, Port Elizabeth 6000, South Africa;* [2]*Present address South African National Parks, P.O. Box 20419, Humewood 6013, Port Elizabeth, South Africa;* [3]*Present address Dean, College of Science, Sultan Qaboos University, Al Khod 123, Sultanate of Oman;* [*]*Corresponding author; Fax +27415085415; E-mail gcastley@upe.ac.za*

Abstract. The impact of granivores on coastal dune seed reserves may be high, increasing along a landward gradient from the littoral zone as the structural complexity of the habitat increases. Seasonal removal rates of non-native seeds by nocturnal and diurnal vertebrates and ants from experimental seed trays in two habitats within the Alexandria Coastal Dunefield, South Africa, were determined. Overall, seed removal was higher in the dune-field bush-pocket habitat than the landward thicket habitat. Nocturnal vertebrates were the most important seed removers within bush-pockets. The importance of nocturnal vertebrates decreased in the thicket and there was a shift in the dominant seed removers to diurnal vertebrates. Seed removal by ants and diurnal vertebrates did not differ significantly between the bush-pockets and thicket while that of nocturnal vertebrates showed a significant change. This can be ascribed to the abundance of the omnivorous murid rodent *Gerbillurus paeba exilis* in the bush-pockets which is absent from thicket vegetation.

Keywords: Alexandria Coastal Dunefield; Ant; Bird; Granivore; Rodent.

Nomenclature: Arnold & De Wet (1993) for plants; Skinner & Smithers (1990) for mammals.

Abbreviations: ACD = Alexandria Coastal Dunefield.

Introduction

Abiotic factors often drive ecosystem processes in physically extreme environments, such as deserts (Noy-Meir 1980). Coastal dune environments are often largely controlled by abiotic factors, dominated by the marine influence. However, McLachlan (1991) suggested that the influence of abiotic factors decreases landward of the shoreline while the reverse is true for biotic factors. This hypothesis was supported by Gaylard et al. (1995) who showed that well structured faunal communities were associated with increased vegetation structure and reduced physical stress along this landward gradient.

However, the importance of biotic processes (e.g. herbivory, dispersal, granivory) in the near-shore environment of coastal dune fields is poorly known. This study aimed to address this aspect by investigating the importance of one of these ecological processes, seed removal, in the near-shore bush-pocket environment of the Alexandria Coastal Dunefield (ACD) which has been described as a physically driven system (Illenberger 1986; McLachlan 1991), as well as in the landward evergreen broad-leaved sclerophyllous subtropical thicket habitat which is less influenced by abiotic factors (Gaylard et al. 1995; Kerley et al. 1996).

Seed removal of non-native seed banks can be viewed as an index of an important ecological process, granivory, which influences seed fate and hence establishment of plant communities. Experimental seed removal manipulations have previously been used to highlight the importance of granivorous taxa (rodents, ants and birds) and their capacity to harvest seed resources, largely within desert landscapes (Brown et al. 1975; Mares & Rosenzweig 1978; Brown et al. 1979; Abramsky 1983; Morton 1985; Kerley 1991), while also being used to monitor such effects across ecotonal boundaries (Burkey 1993). Granivorous effects are far-reaching, affecting not only plant communities directly, but also co-existing granivore populations (Brown & Heske 1990; Reichman 1979). Given the importance of seed dynamics in plant colonization and hence sand stabilization, and ultimately conservation and management of coastal dune fields, this process is particularly relevant but so far poorly understood.

The impact of granivores on dune seed reserves is unknown; it may be high. Based on McLachlan (1991) and Gaylard et al. (1995) we hypothesized that the patterns of granivory would follow similar trends, being more pronounced in the landward thicket habitats than in the bush-pocket habitats within a coastal dune field. We used non-native seed removal as in index of granivory and relate these findings to the importance of the various granivorous guilds in these coastal habitats.

Methods

Study area

The study was conducted in the Woody Cape Nature Reserve, Algoa Bay, South Africa (Fig. 1). Shifting sand dunes (the ACD) constitute the majority of the reserve, with thicket vegetation landward of the dunes. Rainfall is ca. 400 mm/yr at the Sundays River mouth and is bimodal, with peaks in winter and spring (McLachlan et al. 1982).

The thicket vegetation is an evergreen broad-leaved sclerophyllous subtropical thicket, dominated by woody plant species such as *Schotia afra*, *Cassine aethiopica*, *Sideroxylon inerme*, *Euclea undulata*, *Pterocelastrus tricuspidatus*, *Azima tetracantha*, *Olea exasperata*, *Rhus longispina*, *Zygophyllum morgsana*, *Lycium afrum* and *Carissa bispinosa*, with a large component of lianas and climbers (Pierce & Cowling 1984; Everard 1987).

The ACD (Fig. 1) is an active transgressive coastal dune sheet dating back to 6500 yr BP and covers 120 km^2 with an average width of 2.1 km (McLachlan et al. 1982). The dune field stretches from the Sundays River mouth (33° 44' S; 25° 51' E) to Cape Padrone ca. 50 km to the east, with dunes rising in height from the beach inland to a maximum height of 150 m (Brown 1990).

Shifting sands make up 81 % of the dune field, the remainder comprising a series of distinct habitat types. Bush-pockets make up 3 % of the area and occur as isolated patches of bush interspersed in the inter-dune hollows of the dune field, often being associated with calcite outcrops (aeolianite formations) or simply occurring as elevated knolls of vegetation (Talbot & Bate 1991). There are 277 bush-pockets occurring in the landward half of the dune field, having an average size of 0.012 km^2 (McLachlan et al. 1982; Brown et al. 1995). Bush-pockets remain fairly constant in size and shape over long periods (Young 1987). The bush-pocket flora are dominated by *Myrica cordifolia*, *Stoebe plumosa*, *Metalasia muricata*, *Rhus crenata*, *Passerina rigida*, *Chrysanthemoides monilifera*, *Helichrysum cymosum*, *Anthospermum littoreum* and *Brachylaena discolor*. However, Talbot & Bate (1991) highlight variations in the vegetation communities of the bush-pockets, with the knoll pockets having a greater thicket affinity.

Faunal communities

Small mammal community structure is closely linked to habitat structure and is reflected in the increasing species richness away from the shoreline (Gaylard et al. 1995). Small mammal communities in the thicket and bush-pockets are dominated by *Rhabdomys pumilio* (striped field mouse), and include *Mastomys natalensis* (multimammate mouse), *Mus minutoides* (pygmy mouse), *Aethomys namaquensis* (Namaqua rock mouse), and *Otomys irroratus* (vlei rat). *Graphiurus murinus* (woodland dormouse), and *Myosorex varius* (forest shrew) are found in the thicket but are not recorded from the bush-pockets. In addition, the bush-pockets support a dune-field endemic, *Gerbillurus paeba exilis* (pygmy hairy-footed gerbil) (McLachlan et al. 1982; Ascaray et al. 1991; Brazzale 1992). Additional small mammal

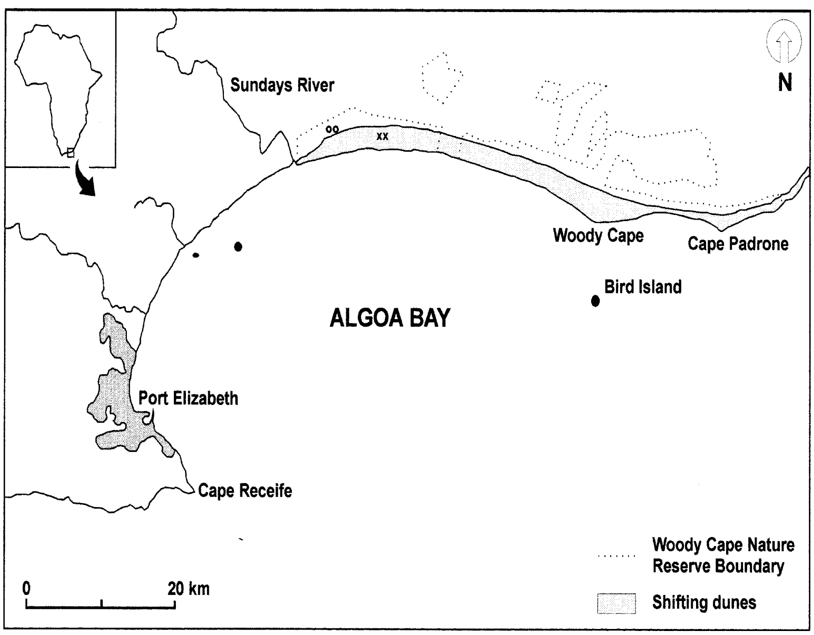

Fig. 1. The Woody Cape Nature Reserve, Algoa Bay, South Africa. x = location of bush-pocket seed removal experiments; o = location of thicket seeds removal experiments.

species which are recorded infrequently from the dune field and adjacent thicket habitats include *Otomys saundersiae* (woodland mouse), *Grammomys dolichurus* (grey climbing mouse), *Dendromus melanotis* (Saunders' vlei rat), and *Saccostomus campestris* (pouched mouse) (McLachlan et al. 1982).

The avifaunal communities of the ACD have been extensively described (Brown 1990; Brown et al. 1995; Bruton 1992; Gaylard et al. 1995). Species richness of the bush-pockets and thicket range from 53 - 63 species respectively with species richness increasing along the landward gradient. Bush-pocket bird communities are dominated by transient visitors with only a few residents and the composition of the communities is largely determined by vegetation structure (Brown 1990). Although dominated by insectivores, the bush-pockets support a higher proportion of granivores than the thicket. Frugivores are restricted to those areas with suitable vegetation structure and resource availability (Brown 1990; Bruton 1992; Gaylard et al. 1995).

Invertebrate communities are poorly studied from these areas although preliminary findings indicate that communities from both the bush-pocket and thicket habitats are dominated by Hymenoptera and Coleoptera. The thickets however have a higher diversity of invertebrate Orders (Gaylard et al. 1995).

Species composition

Small mammal communities from the thicket and bush-pockets were assessed from previous surveys (Brazzale 1992; Gaylard et al. 1995), supplemented by further trapping (App. 1). Trapping was conducted using Sherman live traps (7.5 × 9 × 23 cm). Traps were laid 10 m apart and baited with a mixture of rolled oats and peanut butter. Brazzale (1992) trapped in 20 bush-pockets of varying size with trap effort ranging from 150 trap nights to 12 trap nights depending on pocket size. A further 400 trap nights were included from the bush-pocket habitat during the present study. Trapping effort totalling 500 trap nights was included from the thicket during undergraduate training programmes (Gaylard et al. 1995).

Bird communities from the thicket and bush-pockets were assumed to be similar to those obtained from previous studies within these habitats (Brown 1990; Bruton 1992; Gaylard et al. 1995) (App. 1).

Ants were collected opportunistically from nest sites encountered (App. 1), and seed trays in the bush-pocket and thicket habitats and preserved in 70% alcohol for later identification. No determination of nest densities was undertaken in either the bush-pockets or thicket habitats.

Seed removal

Seed removal rates were quantified using a seed dish technique in the landward thicket, as well as the bush-pocket habitat (Fig. 1). Three treatments which assessed the removal of seed by diurnal and nocturnal vertebrates and invertebrate granivorous guilds were deployed and monitored over four seasons: February 1991 (austral summer), May 1991 (autumn), August 1991 (winter) and November 1991 (spring). 30 stations were erected within each habitat to measure the extent of seed removal by the various guilds. Each station comprised three feeding trays, which were plastic petri dishes 9 cm in diameter, baited with non-native seeds, differentially available to the different guilds. The experimental design allowed the analysis of interactions between guilds, seasons and sites (habitats).

Ant trays were placed flush with the soil surface, equipped with cardboard ramps to allow easy access and covered with inverted, slatted, pot plant holders. The 6-mm slits in the holders allowed access to invertebrates while excluding vertebrates. Vertebrate trays were elevated 2 cm off the ground on small platforms supported by large nails. The upper cm of each nail was treated with ant barrier to prevent access by ants. Nocturnal vertebrate trays were open at night and covered during the day and diurnal vertebrate trays were open during the day and covered at night. Seed removal was recorded over 72 h for the nocturnal and ant trays while the diurnal trays were monitored over 120 h (Mares & Rosenzweig 1978; Kerley 1991). Diurnal trays were run over a longer period to allow for use by birds, as birds rely on predictable, high quality food patches and spend little time searching for ‘new’ seed patches (Mares & Rosenzweig 1978) and therefore take longer to find new resources.

Each tray was baited with 10 g (to the nearest 0.01 g) of commercial white millet *Panicum miliaceum* (mean seed mass = 0.0052 g) while the ant trays had an additional 10 g of the smaller *Eragrostis curvula* seed (mean seed mass = 0.0003 g). Trays were checked at dawn and dusk, and preweighed amounts of additional seed were added as required to maintain high levels of seed availability. Seed trays which were disturbed by larger mammals were excluded from the analysis. After each seasonal session, remaining seeds were weighed to the nearest 0.01 g and the amount of seed removed calculated. Removal rates, standardized to g/tray/12h, were compared for seasonal and habitat differences among the various granivorous guilds. Data were log transformed (Zar 1984) prior to analysis using ANOVA (Anon. 1995).

Table 1. Mean seeds (g / tray / 12h ± standard error) removed by the three granivorous guilds (sites and seasons combined), by habitat (taxon and season combined) and by season (taxon and habitat combined). *n* represents the number of useable (undisturbed by bush-pigs etc.) seed trays for each treatment.

Grouping	*n*	Seeds removed ± SD
Bush-pockets	356	4.69 ± 8.97
Nocturnal	120	13.17 ±11.35
Diurnal	118	0.70 ± 1.25
Ants	118	0.05 ± 0.07
Intact thicket	344	0.39 ± 0.99
Nocturnal	114	0.25 ± 0.45
Diurnal	120	0.84 ± 1.52
Ants	110	0.04 ± 0.04
Spring (November)	180	1.99 ± 5.93
Summer (February)	179	2.54 ± 5.3
Autumn (May)	163	3.96 ± 8.98
Winter (August)	178	1.93 ± 6.42

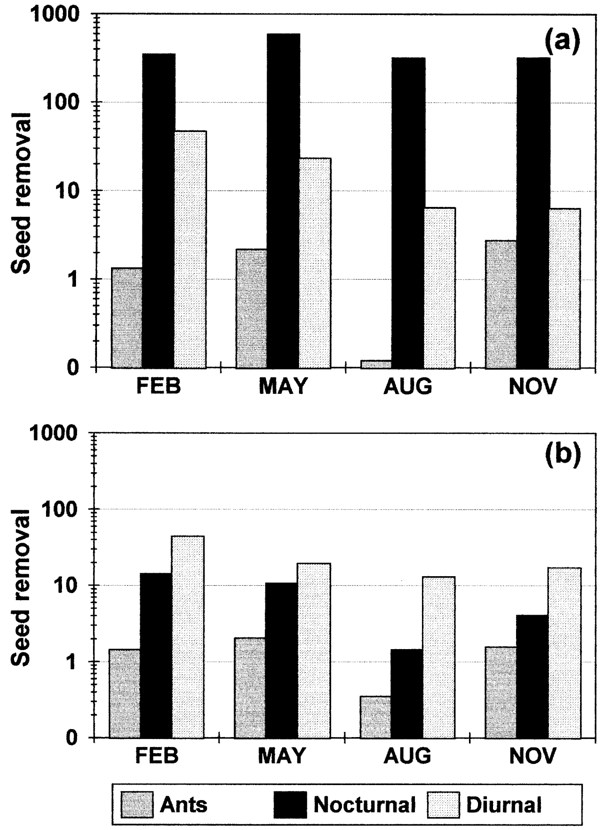

Fig. 2. Seed removal by granivorous guilds of the Alexandria Coastal Dunefield from (**a**) bush-pocket and (**b**) thicket habitats expressed as g / 30 trays / 12 h. Note the non-linear Y-axis.

Results

Species composition

Small mammal captures recorded from the bush-pockets (Brazzale 1992, this study) included five rodent species, *G. paeba exilis, A. namaquensis, R. pumilio, M. natalensis and M. minutoides. A. namaquensis, G. paeba exilis, M. natalensis* and *M. minutoides* were only caught at night, while *R. pumilio* was caught only during the day. Activity characteristic of the diurnal, herbivorous vlei rat *Otomys irroratus* was noted in one bush-pocket, although none were captured. Small mammals recorded from the thicket include *A. namaquensis, O. irroratus, Graphiurus murinus, M. natalensis, M. minutoides, Myosorex varius* and *R. pumilio*. Both *A. namaquensis* and *R. pumilio* were active both diurnally and nocturnally, all other captures were made at night. However, Gaylard et al. (1995) indicated that *M. minutoides* and *M. natalensis* were also active during the day in thicket habitats. Small mammal communities from the bush-pockets and thicket were relatively depauperate and estimates of density were not determined.

The small mammal species composition of the thicket and bush-pockets show little variation, the only differences being (1) the presence of the insectivorous species (*M. varius* and *G. murinus*) in the thicket, these being absent from the bush-pockets; (2) the presence in the bush-pockets of the omnivorous *G. paeba exilis* which is absent from the thicket.

Ants recorded in the bush-pockets comprised a single seed dispersing species, *Anoplolepis steingroeveri*, and four others, the widely distributed *Pheidole megacephala*, a granivore (Scholtz & Holm 1985), two species of the genus *Crematogaster* from the *liengmei* and *peruingyi* groups, and *Camponotus* spp. of the *maculatus* group (H. Robertson pers comm.)[1]. Ants were common in the bush-pockets, nesting in aeolianite mounds, sand and grass, but were rarely noted in the thicket where only *A. steingroeveri* was recorded.

Seed removal – overall effects

A comparison of seed removal between the bush-pockets and thicket, granivorous guilds and seasonal activity (Table 1) show that seed removal was highest in the bush-pockets where nocturnal vertebrates removed more seeds. In contrast, diurnal vertebrates removed the bulk of the seed in the thicket. Seed removal peaked during autumn and was lowest during winter. Seed removal by all guilds was an order of magnitude higher (three-way ANOVA: $F = 290.57$; $df = 1{,}676$; $p < 0.0001$) within the bush-pockets (mean = 4.69 ± 8.97 g/tray/12h; n = 356) than the nearby thicket habitat (mean = 0.39 ± 0.99 g/tray/12h; n = 344). Seasonal variation in seed

[1]Dr. H.G. Robertson, Department of Entomology, South African Museum, P.O. Box 61, Cape Town 8000, South Africa.

Table 2. Seasonal removal of seeds by the three granivorous guilds in the different habitats, expressed as g/ 30 trays / 12 h (for comparison with similar published studies). Comparisons are made using Tukey's highest significant difference range tests, a + in the same column indicates homogeneous removal rates at the 95 % level.

Site	Season	Taxon	Seed removal rate (g/30 trays/12 h)	Significance							
Pocket	Winter	Ants	0.10	+							
Thicket	Winter	Ants	0.40	+							
Pocket	Summer	Ants	1.30		+						
Thicket	Summer	Ants	1.40		+	+					
Thicket	Winter	Nocturnal	1.40			+					
Thicket	Spring	Ants	1.60			+					
Thicket	Autumn	Ants	2.00			+					
Pocket	Autumn	Ants	2.20			+					
Pocket	Spring	Ants	2.80			+					
Thicket	Spring	Nocturnal	4.10				+				
Pocket	Spring	Diurnal	6.40				+				
Pocket	Winter	Diurnal	6.50				+				
Thicket	Autumn	Nocturnal	10.70				+	+			
Thicket	Winter	Diurnal	12.80				+	+			
Thicket	Summer	Nocturnal	14.30				+	+			
Thicket	Spring	Diurnal	17.20					+	+		
Thicket	Autumn	Diurnal	19.40					+	+		
Pocket	Autumn	Diurnal	23.30						+		
Thicket	Summer	Diurnal	43.90						+		
Pocket	Summer	Diurnal	46.80						+		
Pocket	Winter	Nocturnal	318.50							+	
Pocket	Spring	Nocturnal	322.80							+	
Pocket	Summer	Nocturnal	347.20							+	
Pocket	Autumn	Nocturnal	592.60								+

removal was also evident with significantly more seeds being removed by all taxa combined during autumn and summer than in winter or spring (three-way ANOVA: $F = 10.15$; $df = 3{,}676$; $p < 0.0001$) (Table 1).

Seed removal – guild specific effects

Analysis of habitat-specific seed removal by each of the three guilds indicated that nocturnal vertebrate removal was higher in the bush-pockets than the thicket (one-way ANOVA: $F = 391.20$; $df = 1{,}232$; $p < 0.0005$). However, seed removal did not differ between habitats for diurnal vertebrates (one-way ANOVA: $F = 1.06$; $df = 1{,}236$; $p = 0.30$) or ants (one-way ANOVA: $F = 1.44$; $df = 1{,}226$; $p = 0.23$) (Figs. 2 and 3). Within the thicket habitat, diurnal vertebrate removal was higher (one-way ANOVA: $F = 46.27$; $df = 2{,}341$; $p < 0.0001$) than nocturnal vertebrate and ant removal. Nocturnal vertebrate seed removal was significantly higher than that of diurnal vertebrates and ants in the bush-pockets (one-way ANOVA: $F = 355.11$; $df = 2{,}353$; $p < 0.0001$) (Table 2).

Seasonal effects were evident within each of the three guilds (Table 2). Nocturnal vertebrates removed significantly more seeds during autumn in bush-pockets and less in the thicket during winter (two-way ANOVA: $F = 3.11$; $df = 3{,}226$; $p < 0.05$). No seasonal differences were found in the removal by diurnal thicket vertebrates, while diurnal bush-pocket vertebrates removed less seed in winter than in summer or autumn (two-way ANOVA: $F = 3.14$; $df = 3{,}230$; $p < 0.05$). Ants removed less seed during winter in both habitats with maximal removal during autumn in the thicket and during spring in the bush-pockets (two-way ANOVA: $F = 2.95$; $d.f. = 3.220$; $p < 0.05$) (Fig. 2).

Discussion

Seed removal experiments do have some shortcomings (Parmenter et al. 1984). The present study was limited in that the granivores could only be distinguished as ants, nocturnal vertebrates and diurnal vertebrates. Due to the presence of a diurnal rodent, *R. pumilio*, and possible diurnal activity by a number of other species, diurnal vertebrate removal rates possibly comprised a combination of removal by both rodents and birds. Granivorous birds, including specialized seed-eaters such as doves (*Streptopelia* spp.) and canaries (*Serinus* spp.), are present in the Alexandria dune field (Tinley 1985; Brown 1990; Bruton 1992). The low removal rates exhibited by ants, in the presence of a seed harvesting species, could be ascribed to the fact that the experimental seed baits lack elaiosomes, and may therefore not be attractive to non-granivorous ants. However, these seeds would still be attractive to granivorous ant species, such as *P. megacephala*. This technique is however well suited to addressing comparative questions, such as the present one.

Patterns of granivory

The importance of nocturnal vertebrates as seed harvesters found here is in agreement with similar studies performed in Israel (Abramsky 1983), North America (Brown et al. 1975; Mares & Rosenzweig 1978; Brown et al. 1979), and South Africa (Bond & Breytenbach 1985; Fraser 1990), where nocturnal seed removal is a result of rodent predation. Seed removal by ants was considerable in the above studies where ants competed with nocturnal vertebrates for the seed resource. This is contrary to the present findings, in which ants were insignificant in seed removal even though they were presented with a mixture of seed sizes. Diurnal removal was more important in the dune field than in Israeli and North American deserts where the diurnal rodents and birds are insignificant as seed harvesters. Forest habitats experience little seed removal by ants, and most seed is removed during the day by rodents (Brown et al. 1975). This is similar to the situation found in the thicket where the diurnal vertebrates removed the most seed, followed by nocturnal vertebrates, with ants removing insignificant amounts of seed.

Patterns of seed removal measured from the arid South African Karoo (Kerley 1991), Australia (Morton 1985) and South America (Mares & Rosenzweig 1978) do not conform with the present study. All of these areas had a significant component of ant seed removal, with rodents being insignificant. Kerley (1991) attributed his results to the fact that the rodent populations of the Karoo were not primarily granivorous but had a diet comprised of insects and foliage. The present results are heavily influenced by the high removal of seeds by the nocturnal vertebrate guild in the bush-pockets.

The elevated levels of seed removal in the dune-field bush-pocket habitats contrast with McLachlan's (1991) findings that in coastal dune fields the ecological role of animals would be less important than in the hinterland. This is based on succession theory which describes increasing biotic organization over time (i.e. distance inland in the case of coastal dune fields). However, succession theory has largely focused on plant communities; little attention has been paid to animal communities or the role of animals across successional gradients. Other important processes which may influence community structure such as herbivory, soil disturbance, and zoochory, still need to be evaluated across coastal dune-field successional gradients in order to further test these ideas.

Gerbillurus paeba exilis: Keystone species?

The significant difference in seed removal between the thicket and bush-pockets can be ascribed to elevated seed removal by nocturnal vertebrates in the bush-pockets, the latter accounting for 88% of the total seed removal by all guilds from both the thicket and bush-pockets combined (Table 2). These high removal rates can be attributed to the activity of the nocturnal murid *Gerbillurus paeba exilis*. Although other nocturnal rodents were captured in the bush-pockets these were also present in the thicket. With *G. paeba exilis* being absent from the thicket, nocturnal removal is significantly lower and diurnal removal (presumably including that of the striped mouse *R. pumilio*) is more important. Both *R. pumilio* and *G. paeba* exilis were observed harvesting seeds from seed trays in the thicket and bush-pockets, respectively. This endemic subspecies of gerbil is therefore hypothesized to be a keystone species (*sensu* Paine 1969) in the dynamics of the bush-pocket seed banks. These gerbils are morphologically adapted (large eyes and ears, bipedal gait) as a proficient forager in a habitat where numerous predators (large spotted genet – *Genetta tigrina*, black-backed jackal – *Canis mesomelas*, spotted eagle owl – *Bubo africanus*) are present (Smith 1993).

Food preference tests have shown that *G. paeba exilis* prefers seeds, although arthropods are important in the diet (Ascaray et al. 1990). The high nocturnal seed removal during autumn may be attributed to population peaks in *G. paeba exilis* which have highest densities during late summer (Ascaray et al. 1991) as well as the decrease in availability of other food sources (e.g. arthropods) at this time (Ascaray et al. 1990) (Fig. 2).

The extent of granivory appears to be highly dependent on the composition of the granivorous communities, despite the limited distance separating these two habitats. We therefore ascribe the altered patterns of seed removal in the bush-pockets to the presence of *G. paeba exilis*. We conclude that *G. paeba exilis* has the capacity to fundamentally alter one of the basic processes operating in the system. The keystone function of *G. paeba exilis* is also strengthened through its capacity to possibly influence plant succession in the dune environment by virtue of its seed caching behaviour. *Gerbillurus paeba exilis* frequently forages on and caches the seed heads of the primary colonizer *Arctotheca populifolia* (Ascaray et al. 1990) and in so doing may enhance seedling germination.

Although no native seed baits were used in this treatment, we hypothesize that in an environment where high density seed banks are prevalent (Ascaray & McLachlan 1990) through seed deposition by aeolian action, the impact by granivores on the vegetation communities could be substantial. These findings further support the contention that coastal dune fields are functionally different from their hinterland (Kerley et al. 1996). This therefore indicates that dune fields should be recognized as discrete functional entities, requiring specific conservation and management approaches.

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For App. 1, see next page.

App. 1. Small mammals, granivorous birds and ants recorded within the bush-pocket and thicket sites of the Alexandria Coastal Dunefield and Woody Cape Nature Reserve. + denotes presence.

Species	Common name	Bush-pocket	Thicket	Comments
Small mammals				
Gerbillurus paeba exilis	Pygmy hairy-footed gerbil	+	-	Nocturnal
Aethomys namaquensis	Namaqua rock mouse	+	+	Predominantly nocturnal
Mastomys natalensis	Multimammate mouse	+	+	Predominantly nocturnal
Mus minutoides	Pygmy mouse	+	+	Predominantly nocturnal
Rhabdomys pumilio	Striped mouse	+	+	Diurnal
Otomys irroratus	Vlei rat	+	+	Predominantly nocturnal
Graphiurus murinus	Woodland dormouse	-	+	Nocturnal
Myosorex varius	Forest shrew	-	+	Nocturnal
Ants				
Anoplolepis steingroeveri	Black pugnacious ant	+	+	
Pheidole megacephala	Brown house ant	+	-	
Camponotus spp.	Spotted sugar ant	+	-	Maculatus group
Crematogaster spp.	Cocktail ants	+	-	Liengmei group
Crematogaster spp.	Cocktail ants	+	-	Peruingyi group
Birds				
Numida meleagris	Helmeted Guineafowl	+	+	Omnivore
Streptopelia capicola	Cape Turtle Dove	+	+	Granivore/omnivore
Streptopelia semitorquata	Redeyed Dove	+	+	Granivore/omnivore
Alpopelia larvata	Cinnamon Dove	-	+	Granivore/omnivore
Serinus flaviventris	Yellow Canary	+	+	Granivore
Serinus gularis	Streakyheaded Canary	+	+	Granivore/insectivore