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Vegetation Response to the Abandonment of the Burrowing Mounds of Fat Sand Rat (*Psammomys obesus* Cretzschamar, 1828) on the Coastal Dunes of Northern Sinai, Egypt

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FAT SAND rats (*Psammomys obesus*) are strictly herbivorous and live in densely complex burrows in the desert of North Africa and the Middle East, however little is known about the effect of their foraging and burrowing activities on plant community and species richness. This study evaluated such effects by comparing burrow and mound surface morphology, canopy of the main host chenopod shrub (*Anabasis articulata*), plant cover, abundance and species richness on and off both active and abandoned colonies in the semi-stabilized sand dunes of Northern Sinai. In general, active burrow systems were characterized by less *A. articulata* canopy area, and more soil disturbance with higher and larger burrow mounds dominated by bare ground, dung, and dead and fresh litter. However, mounds abandonment for five years has resulted in significant increases of vegetation cover, plant canopy height, abundance and species richness. The differences in relative abundances and spatial distribution of species between mound and non-mounds of both active and abandoned sites have been reflected in a different plant species assemblages. The results suggest that fat sand rats can have significant direct and indirect, short-term and long-term, effects on vegetation dynamics and structure by their mound building and foraging.

Keywords: *Anabasis articulate*, Herbivory, Rodent digging, Sand dunes, Species richness, Zaranik Protected Area.

The importance of burrowing activities and grazing of rodents as a source of spatial and temporal variation in natural communities is becoming increasingly recognized in ecological theory. Subterranean rodents are important agents as ''bioengineers'' especially those species that affect soil structure and soil processes by their burrowing and foraging activity which is a major source of patchiness in arid regions (Gutterman *et al.*, 1990; Jones *et al.*, 1994; Whitford and Kay, 1999). These rodents excavate vast burrow systems and deposit soil on

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the ground surface as mounds, and strongly alter patterns of resources availability and ultimately affect patterns of plant community structure (Heske *et al.*, 1993; Fields *et al.*, 1999; Van Staalduinen and Werger, 2007).

Burrowing mounds of rodents can influence vegetation structure and dynamics in arid and semi-arid regions by several ways. First, the mounds serve as gaps which create "regeneration niches" where the less competitive plant species can be established and coexist (Guo, 1996). Second, the formation of mounds smothers live plants and litter and slows the rate of succession (Brown and Heske, 1990; Stromberg and Griffin, 1996). Third, the creation of mounds changes soil nutrients and microclimate, thereby alter plant biomass and species composition (Inouye *et al.*, 1987; Boeken *et al.*, 1998; Andersen and Kay, 1999). Fourth, the deposition of buried viable seeds on the mounds by burrow excavation can alter the horizontal and vertical distribution of seed banks, and promote the germination of dormant seeds in the soil seed bank (Guo, 1996; Boeken *et al.*, 1998; Guo *et al.*, 1998; Davidson and Lightfoot, 2006). Fifth, the existence of fresh and abandoned mounds with different resource conditions may lead to the temporal and spatial patterning in plant composition that can contribute to large-scale vegetational diversity and increase the complexity of landscape (Heske *et al.*, 1993; Brock and Kelt, 2004; Davidson and Lightfoot, 2008).

In the deserts of North Africa and the Middle East, the fat sand rat (*Psammomys obesus* Cretzschmar, 1828), a medium-sized rodent, lives in densely packed burrows (Fichet-Calvet *et al.*, 1999). The fat sand rats are folivorous that feed exclusively on plants of the family Chenopodiaceae supplemented by some leguminous plants and annuals (Daly and Daly, 1974; Fichet-Calvet *et al.*, 2000; Tchabovsky and Krasnov, 2002). They cut and take leaves of the plants to their burrows to be eaten later (Daly and Daly, 1974; Shenbrot, 2004). Burrows of *P. obesus* comprise a series of entrance holes, generally originating under fodder shrubs (Daly and Daly, 1974). In many areas burrows occur at high densities, and a single burrow may cover a distinct patch with a few square meters. Furthermore, when excavating caches and constructing tunnels, fat sand rats move soil to the ground surface and deposit it as mounds. Therefore, *P. obesus* can have significant direct and indirect, short-term and long-term, effects on plant abundance and community structure as was shown for other rats by their burrowing and soil ejecta mounds (Heske *et al.*, 1993; Fields *et al.*, 1999; Davidson and Lightfoot, 2008).

Despite fat sand rats are found throughout saline and sandy environments of North Africa and the Middle East, little is known about the ecological nature of their burrowing mounds and their role in shaping plant community attributes. The available studies being focused on the responses of the rats to different vegetation cover as feeding and nesting (Degen *et al.*, 2000; Tchabovsky, *et al.*, 2001; Tchabovsky and Krasnov, 2002; Shenbrot, 2004).

In Egypt, *P. obesus* is found in the sand dunes of north-eastern Desert, Deltaic lakes and North Sinai (Osborn and Helmy, 1980; Basuony, 2000). The Zaranik Protected Area (ZPA) in North Sinai is one of the few relatively undistributed places where the fat sand rats are the most common small mammals, and where their ecological role can be probably evaluated. In ZPA, the semi stable sand dunes with dense and sparse vegetation are among the main habitats of the fat sand rats. In these habitats, the fat sand rats construct their burrows on raised mounds under the chenopod *Anabasis articulata* (Forssk.) Moq., which constitutes a major component of the species diet (Degen *et al.*, 2000). In many areas burrowing occur at high densities, with *A. articulata* shrubs likely to be more heavily grazed than those at greater distances. A large amount of fresh excrements and food remains are scattered around the active burrows with barren and vegetated mounds. Furthermore, there are many abandoned burrows where *A. articulata* host recuperated from the previous exploitation, and surrounded by vegetated mounds. This provides a unique natural experiment where the effect of soil disturbance on plant community attributes can be compared between active and abandoned burrowing mounds as well as with undisturbed non-mound sites. Specifically, the aim of this study was to highlight the following questions: (1) Does the attributes of active burrowing and ejecta mounds of fat sand rats differ from their abandoned counterparts?; (2) Does the abandonment of mounds lead to changes in the relative cover by vegetation, bare ground, or plant litter and canopy height?; and (3) Does plant community structure and species richness change when the mounds are abandoned?

Material and Methods

The study area

The study was carried out on the sand dunes of El-Fulsiyat island at ZPA (31° 14'N and 33°30'E) in North Sinai, Egypt. The island has been protected from grazing by camels, goats and sheep since 1988 (El-Bana *et al.*, 2003). The island has an altitude of 25 m, and occupies 12.5 ha. The climate is arid; the Emberger's degree of aridity is about 13.6 (Shaheen, 1998). Long-term average rainfall is about 82 mm with high variability, and usually extends from October to May (Zahran and Willis, 1992). The monthly relative humidity varies between 68% and 74% with an annual mean of 72%. Soils of the study island are rich in lime with textural classes varying from sand to clayey and silty sand (Shaheen, 1998; El-Bana *et al.*, 2002, 2003).

The vegetation in the study area is dominated by the psammophytes [*Artemisia monosperma* Delile, *Panicum turgidum* Forssk., *Retama raetam* (Forssk.) and *Thymelaea hirsuta* (L.) Endl)] and the halophytes [(*Anabasis articulata* (Forssk.) Moq., *Halocnemum strobilaceum* (Pall.) M. Bieb., and *Zygophyllum album* (Linn.)]. The herbaceous and annual species represent approximately 60-70% of the vegetation (El-Bana *et al.*, 2002, 2003). The formations of phytogenic mounds (nebkhas) by perennial shrubs and grasses are a common feature in the study area (El-Bana *et al.*, 2007).

Methods

To assess the possible changes in plant species composition and microenvironmental conditions associated with burrowing-mound disturbance, 45 shrubs of *A. articulata* were randomly selected: 25 with active burrows and 20 with abandoned burrows. The active burrows were distinguished by their heavily grazed *A. articulata*, and had a large amount of fresh excrements and food remains of showing evidence of use during the past 12 months. With the help of the ZPA Manager and Rangers, the abandoned burrows were identified as those that had been not occupied for five years and had *A. articulata* shrubs recuperated from the previous grazing by fat sand rats.

To characterize the soil disturbance associated with active and abandoned burrows, a plot 8-m × 2-m was placed radiating out in the four cardinal directions from each selected *A. articulata* center to the surrounding undisturbed vegetation. In each plot, the following attributes were measured: (i) the number of burrow entrances; (ii) the maximum length and width of each burrow entrance; (iii) maximal length and width of the burrow area based on the farthest entrances and (iv) the major and minor axes as well as height of each burrow mound. From these data the surface area covered by a burrow system could be estimated, assuming that it approximated to the area of an oval (i.e. $\pi \times$ length/ 2 $\times$ width/2). Furthermore, mound area and volume was estimated. For area, mounds were assumed to be circular with a mean diameter estimated from the two diameter measurements, and volume was approximated as that of a rectangular prism. In addition, the height, width, and length of *A. articulata* plants were measured to estimate their areas in active and abandoned plots.

To estimate the changes in vegetation composition associated with active and abandoned mounds, a series of 20 cm × 20 cm quadrats were sampled on mounds with paired "non-mounds" within each established plot. In each quadrat, number of plant individuals, percent plant canopy cover, canopy height, cover of bare soil, plant litter and dung were estimated at the peak of the growing season (April – May 2005). The species were identified according to Täckholm (1974) and Boulos (1995). Litter and dung cover included both old and fresh feces and food remnants. The data were estimated for each quadrat and the mean value was calculated for each plot. Only mounds that were larger than 30 cm × 30 cm, and away at least 40 cm from other mounds were chosen in order to minimize impacts from adjacent mounds on the sampling points. Paired non-mound sampling points were positioned at least 2.5 m away from each paired mound in the four cardinal directions to represent random control undisturbed sites.

Data analysis

Data were normalized by transformation to square root. Data were analyzed in an Analysis of Variance (ANOVA) framework with the mound/non mound treatment nested within the active/abandoned treatment. Post hoc comparisons were conducted using a Tukey's studentized test to compare number of plant individuals, percent plant canopy cover, canopy height, cover of bare soil, plant litter and dung among treatments. In addition, Kolmogorov-Smirnov test was used to compare the burrow and mound attributes between active and abandoned treatment. All statistical methods were performed according to Zar (1996) and by using the statistical software package SPSS ver. 14.0 for Windows.

Detrended Correspondence Analysis (DCA) ordination based on plant species cover data was used to examine patterns in species composition among the active and abandoned treatment plots. Very rare species (<1% cover) were removed from the analyses (Peet *et al.*, 1998). DCA is a robust technique based on reciprocal averaging (Peet *et al.*, 1998) which is useful for describing and displaying trends in species composition. CANOCO for Windows (ter Braak and Šmilauer, 1998) was used for DCA ordination.

Results

Surveys of the burrow systems revealed a significant difference between active and abandoned burrow attributes as well as their mounds (Table 1). The active burrow systems had a greater surface area than those of abandoned ones, with a higher number of entrance holes and burrow width. The shrub canopy area of *A. articulata* in the active plots was smaller than that of abandoned ones. Active mounds were higher and larger with greater volume than abandoned mounds (Table 1).

TABLE 1. Characteristics of burrows and mounds (±SE) of *Psammomys obesus* under the canopy of *Anabasis articulata* shrub in active and abandoned plots. Probabilities were calculated using Kolmogorov-Smirnov test.

	Active		Abandoned		Probability
Number of burrow entrances	14.23	±2.43	9.63	±1.54	< 0.01
Entrance density (holes m^{-2})	3.42	±0.55	2.15	±0.76	< 0.04
Width of burrow entrance (cm)	8.74	±0.85	6.42	±1.23	< 0.01
Length of burrow entrance (cm)	11.62	±6.82	10.26	±4.64	< 0.07
Surface area of burrow (m^2)	58.65	±9.45	43.72	±7.51	< 0.001
Mound height (cm)	38.43	±7.52	24.72	±8.3	< 0.004
Mound area (m^2)	0.413	±0.124	0.175	±0.086	< 0.003
Mound volume (m^3)	1.837	±0.011	0.045	±0.005	< 0.001
A.articulata shrub height (m)	0.48	±0.16	0.67	±0.24	< 0.02
A.articulata shrub area (m^2)	1.92	±0.76	3.58	±1.89	< 0.01

Compared with abandoned mounds and paired active non-mounds, active mounds were characterized by significantly less vegetation cover and more significantly bare ground, litter and dung (Figs. 1a, b, c). Vegetation cover was significantly higher with 45% on abandoned mounds and with 30% on active non-mounds (Fig. 1a). In contrast, the bare ground cover was significantly lower with 30% on abandoned mounds and with 35% in paired active non-mounds (Fig. 1c).

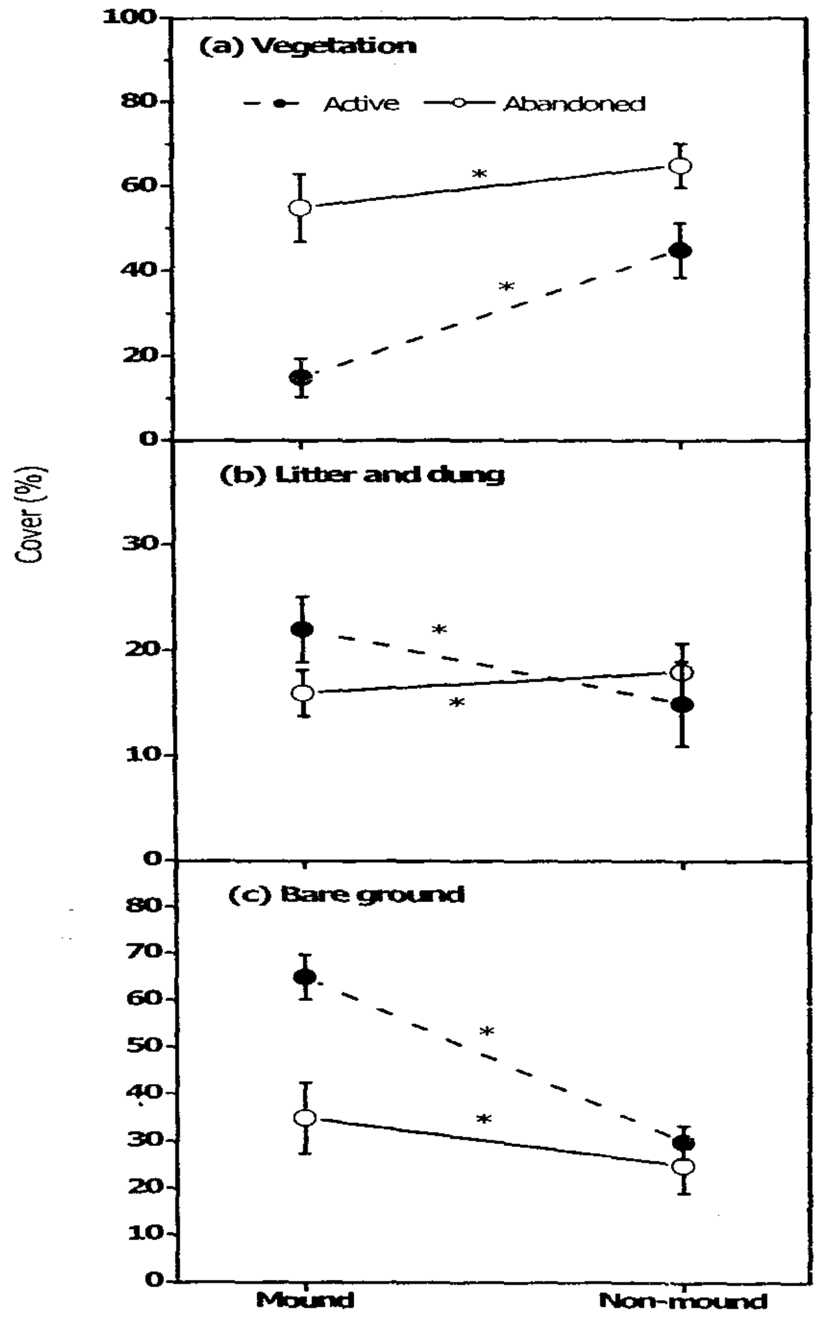

Fig. 1. Mean percentage of soil cover (±SE) by the various surface components on the mound and non-mound microsites at active and abandoned plots. * indicates significant differences at *P*<0.05 (Tukey's studentized range test).

A total of twenty-seven plant species comprising 20 annuals and 7 perennials were encountered in the sampling sites (Table 2). Nine species accounted for 75% of total abundance, and of these, *Atractylis carduus, Bromus rubens,* and *Schismus arabicus* recorded significantly higher abundance on abandoned mounds (Fig. 2a, b). Five species (*Cutandia dichotoma, Filago desertorum, Ifloga spicata, Ononis serrata* and *Senecio glaucus)* were absent exclusively on active mounds, and acquired significantly higher abundance on both active and abandoned non-mounds (Fig. 2a, b). The only geophyte (*Pancratium sickenbergeri*) had significantly higher abundance on active mounds (Fig. 2a, b). These differences in relative abundances and spatial distribution of species were reflected in a clear separation between mound and non-mounds of the active and abandoned sites in the DCA ordination (Fig. 3). The plots of non-mounds and mounds were separated at the lower and the higher end of the first DCA-axis, respectively. The active mounds plots were clearly separated from those of abandoned mounds by the second DCA-axis, however, the overlap detected among the plots of active and abandoned non-mounds.

Plant canopy height was greater on the abandoned mounds than those on paired non-mounds and on the active mounds and non-mounds (Fig. 4a). Canopy height did not differ between active and abandoned non-mounds. Species richness was consistently greater on the non-mounds than on the paired abandoned or active mounds (Fig. 4b). Species richness was lower on active mounds (2.6 species ± 0.8 SE) than on abandoned ones (5.4 species ± 0.6 SE). Total vegetation density was significantly greater on the non-mounds than paired active and abandoned mounds (Fig. 4c), with largest difference between active mounds (28.4 individuals/m^2 ± 5.6 SE) and paired non-mounds (64.8 individuals/m^2 ± 8.1 SE).

Discussion

Fat sand rats burrowing attributes under chenopod shrubs are known to be dependent on the host chenopod shrub, vegetation cover and topography (Fichet-Calvet *et al.,* 1999; Tchabovsky, *et al.*, 2001; Shenbrot, 2004). The present study indicates that burrow attributes under *A. articulata* in the semi-stabilized dunes are larger than those reported in the Negev desert (Tchabovsky *et al.*, 2001). This might be attributed to the fact that habitat distribution of fat sand rats is mainly determined by the relative abundance of its food plants (Fichet-Calvet *et al.* 2000; Tchabovsky and Krasnov 2002; Shenbrot, 2004). In the present study, the burrow systems of fat sand rats were restricted to *A. articulata* where they gnaw off branches and dug a large number of entrances over a much greater area. However, in the Negev desert, the rats showed shifts of their habitats from the open terraces with the sparse and low shrubs of *A. articulata* in summer and autumn to the ephemeral river beds (wadi) with the dense and tall shrubs of *Atriplex halimus* in winter and spring (Shenbrot, 2004). On the other hand, burrowing in the sandy soils of raised mounds beneath the canopies of *A. articulata* shrubs in the study area is conceivably easier than burrowing in the loess soils in the Negev desert.

TABLE 2. Presence percentage of each of the 27 plant species recorded in the mound and non-mound microsites at both active and abandoned plots of fat sand rats in Zarnik Protected Area. C = Chamaephyte, G = Geophyte, H = Hemicryptophyte, T = Therophyte.

Family	Species	Life form	Active		Abandoned	
			Mound	Non-mound	Mound	Non-mound
Amaryllidaceae	*Pancratium sickenbergeri*	G	94	52	18	22
Asteraceae	*Atractylis carduus*	H	52	34	64	20
	Centaurea calcitrapa	H	0	13	12	20
	Filago desertorum	T	0	84	13	33
	Ifloga spicata	T	0	72	20	53
	Launaea nudicaulis	T	0	0	18	26
	Senecio glaucus	T	0	57	16	33
Boraginaceae	*Heliotropium digynum*	C	2	0	3	13
Brassicaceae	*Lobularia arabica*	T	0	13	20	27
Caryophyllaceae	*Herniaria hemistemon*	T	2	42	0	13
	Silene villosa	T	3	0	7	0
Chenopodiaceae	*Bassia muricata*	C	0	4	0	7
	Cornulaca monacantha	C	0	3	6	14
Euphorbiaceae	*Euophorbia granulata*	T	4	0	7	0
Fabaceae	*Lotus halophilus*	T	0	44	18	13
	Ononis serrata	T	0	62	27	93
Geraniaceae	*Erodium laciniatum*	T	0	7	3	0
Neuradaceae	*Neurada procumbens*	T	2	20	0	18
Plantaginaceae	*Plantago ovata*	T	0	13	0	20
Poaceae	*Stipagrostis plumosa*	H	0	27	6	18
	Bromus rubens	T	47	30	96	33
	Cutandia dichotoma	T	0	53	24	72
	Schismus arabicus	T	55	42	82	27
Ranunculaceae	*Adonis dentata*	T	0	22	3	13
Rubiaceae	*Crucianella membranacea*	T	0	7	0	6
Umbelliferae	*Bupleurum semicompositum*	T	0	2	0	18
	Daucus litoralis	T	0	0	4	20

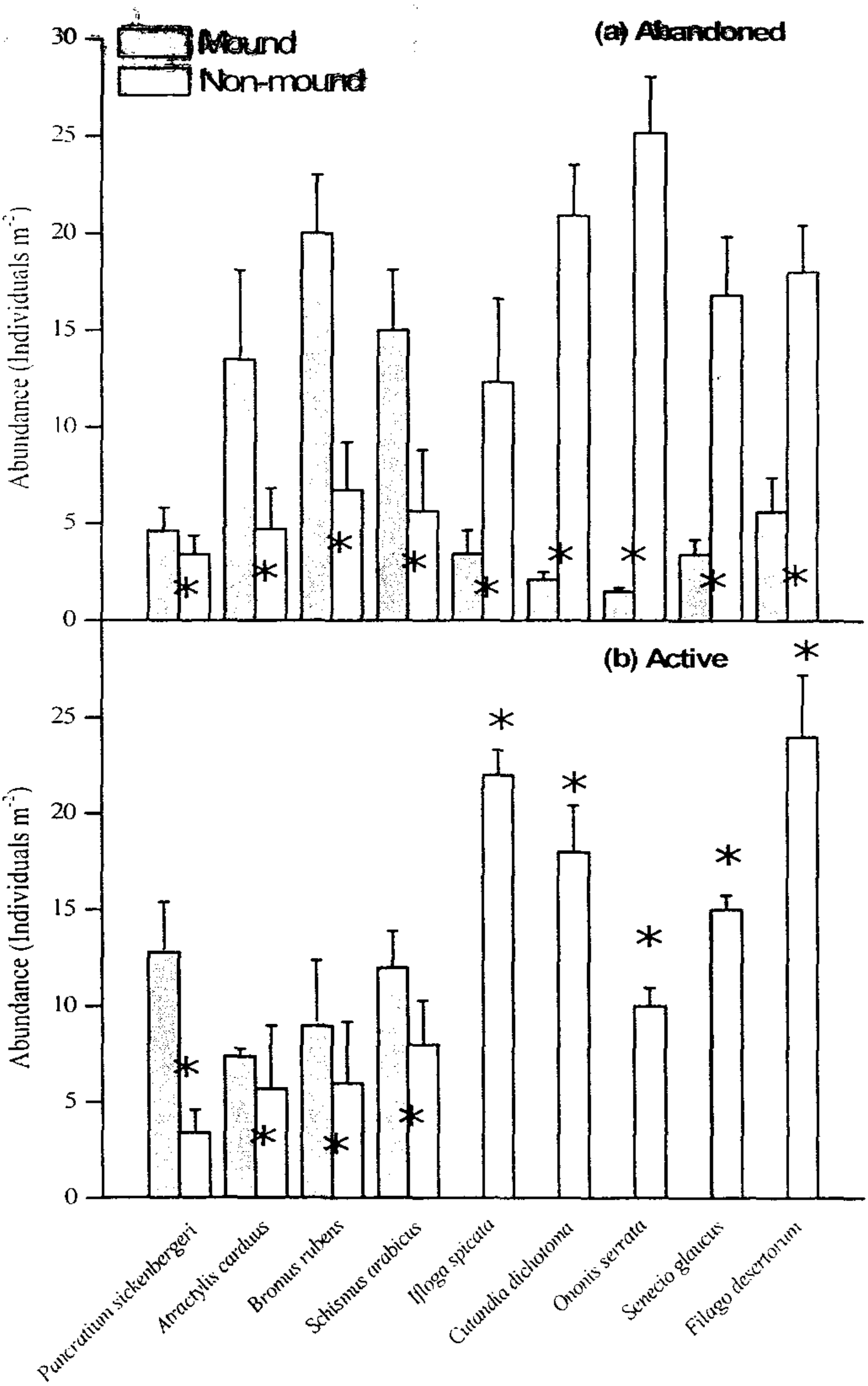

Fig. 2. Mean abundance (±SE) of the dominant plant species at the mound and non-mound microsites of active and abandoned plots. * indicates significant differences at $P<0.05$ (Tukey's studentized range test).

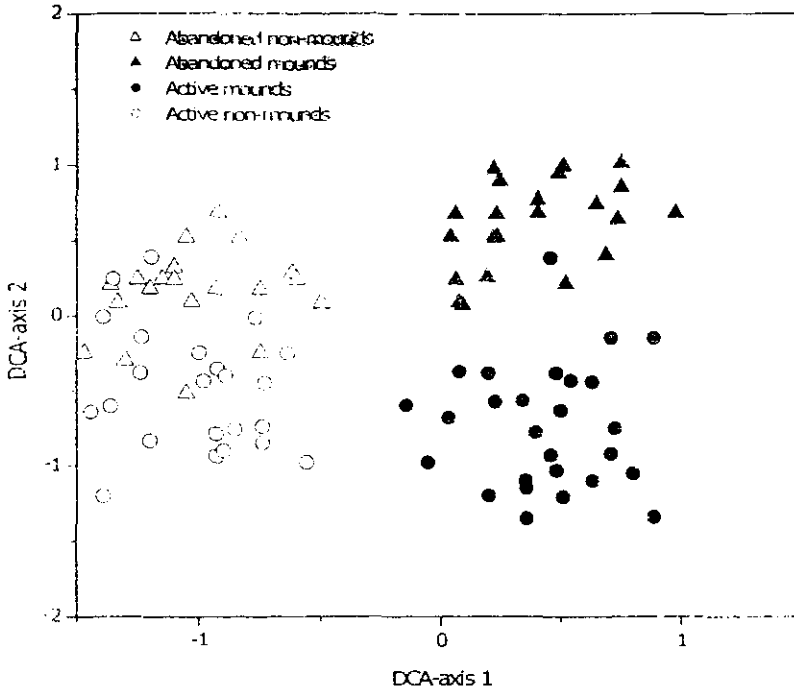

Fig. 3. The first two dimensions of the DCA-ordination based on the differences in plant species composition of active and abandoned plots.

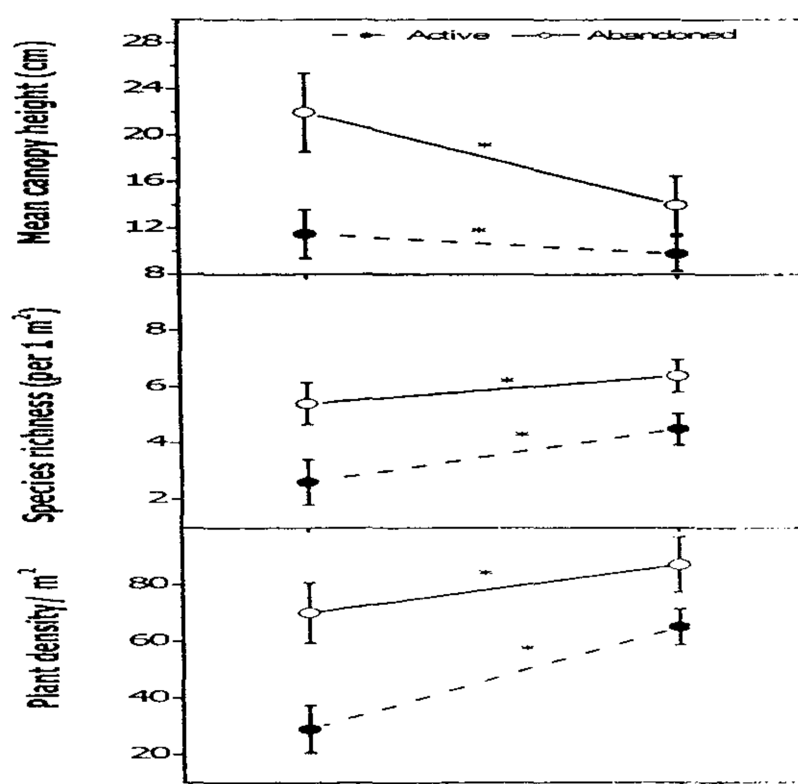

Fig. 4. Mean (±SE) of canopy height (a), species richness (b) and density (c) of plant species on the mound and non-mound microsites of active and abandoned plots. * indicates significant differences at $P<0.05$ (Tukey's studentized range test).

A number of fundamental interspecific differences in burrow and mounds architectures were found between active and abandoned plots. The finding that active burrows covered a larger area with more entrances and mound size, and less canopy area of *A. articulata* than those of abandoned ones are relevant to the activity and foraging behaviour of the fat sand rat, as have been argued for the other rat species (Heske *et al.*, 1993; Guo, 1996; Andersen and Kay, 1999; Davidson and Lightfoot, 2008). The larger shrub size of *A. articulata* in abandoned plots compared to active ones results from the fact that it recuperates in the first, while it is under distinctive angular cutting by rats in the second. The larger surface burrow with higher number of burrow entrances is a probably reflection of the complex burrow systems which have separate chambers for nesting, breeding and storage of food (Fitchet-Calvet *et al.*, 1999, 2000), and their populations tend to be spatially aggregated (Daly and Daly, 1974; Ilan and Yom-Tov, 1990). The foraging behaviour of fat sand rat is almost totally restricted to the area within their burrow systems where they take plant branches to their burrows to be eaten after cleaning out dirt and excreta off the burrows (Daly and Daly, 1974). Therefore, materials excavated during construction and regular cleaning of burrows, and foraging and/or caching activities results in higher and larger mound size with more litter, dung, and bare ground in active plots.

It has been shown that the activities of burrowing rodents in creating and maintaining mounds and the environmental changes due to disturbance and abandonment of mounds produced highly predictable spatial and temporal patterns of small- and large-scale plant community structure and dynamics (Guo, 1996; Rebollo *et al.*, 2003; Davidson and Lightfoot, 2006). The difference in species composition between abandoned and active mounds as well as with non-mounds indicated that mounds of *P. obesus* possibly affect vegetation dynamics by inducing spatial and temporal changes in community attributes. From the data presented in this study, it is clear that the abandonment of *P. obesus* burrowing mounds resulted in increased vegetation cover, plant abundance and richness, vegetation height, and decreased bare ground relative to active plots. The inverse relationship between vegetation cover and bare ground found on abandoned mounds suggests that the decrease in bare ground was mainly a consequence of vegetation recovery. In active plots, soil disturbance activities such as burrowing and mound building could be responsible for reducing vegetation cover and canopy height, and increasing bare ground by disturbing and dislodging plants or covering them with soil. Such negative effects of soil disturbance on vegetation have been reported for other rats (Hobbs and Mooney 1985; Koide *et al.*, 1987; Rebollo *et al.*, 2003).

The kangaroo rat removal and abandoned experiments in the Chihuahuan Desert have demonstrated an increase plant biomass, density and richness on mounds, but this rat is mainly granivory (Mun and Whitford, 1990; Guo, 1996; Davidson and Lightfoot, 2006). This increase has been attributed to the high levels of nutrients due to organic matter accumulation and decomposition (Moorhead *et al.*, 1988; Mun and Whitford, 1990) and also to greater seed availability as a result of cessation of seed predation (Davidson *et al.*, 1985; Kerley and Whitford, 2000). This explanation seems to be not applicable to the present study, as the fat sand rats are mainly folivorous in contrast to granivory feeding of kangaroo rats. Therefore, the fat sand rat seems to change vegetation distribution and resource availability in a different ways to that of kangaroo rats in the Chihuahuan Desert. First, the increase in the abundance of species such as *A. carduus, B. rubens* and *S. arabicus* on the abandoned mounds suggests that their recruitment on the mounds may have been from buried seeds that were exposed during burrow excavations. These species were recorded as dominants on the mounds under several shrubs in the study area (El-Bana *et al.,* 2003, 2007). it is possible that by excavating burrows on the raised mounds under *A. articulata*, the fat sand rats move the buried seeds of these species to the ground surface and deposit them in the mounds. Additionally, *B. rubens* and *S. arabicus* were recognized as disturbance-tolerant as they attained dominance on the human-made mounds (Boeken *et al.*, 1998) and the abandoned vole mounds (Rebollo *et al.*, 2003).

Second, the deposition of abandoned mounds under the canopy of recuperating *A. articulata* may enhance plant growth and establishment through improving soil moisture and nutrients availability. The higher plant abundance and species richness on the mounds under desert shrubs relative to matrix have been attributed to greater or more prolonged availability of soil moisture and nutrients as a result of shading by shrub canopy and organic matter accumulation under shrubs (Schlesinger *et al.*, 1990; Jackson and Caldwell, 1993; De Soyza *et al.*, 1997; El-Bana *et al.*, 2003, 2007).

Third, the differences in height of the mounds created by fat sand rat mounds relative to the surrounding non-mounds could be acting as traps for seeds redistributed by wind as shown by the previous studies of shrub mounds in the study area and other mounds in desert landscape (Brown and Porembski, 1997, 2000; Boeken *et al.*, 1998; El-Bana *et al.*, 2003, 2007). Such effect has been demonstrated by the presence of wind-dispersed seeds species that are dominants in the non-mound such as *C. dichotoma, F. desertorum, I. spicata* and *O. serrata* on abandoned mounds (Fig. 2). These species were also recorded as dominants in the interspaces between shrubs in the coastal and desert sandy dunes (El-Bana *et al.*, 2003, 2007; Tielbörger and Kadmon 1995, 1997).

Many studies have demonstrated that mounds of herbivorous rats affect plant community structure by providing microsites for colonization by the plants that they prefer to eat (Inouye *et al.*, 1987; Guo, 1996). The higher abundance of the annual grasses *B. rubens* and *S. arabicus* on abandoned mounds compared to active ones might support the hypothesis that Gramineae species constitute a major component of the diet of *P. obesus* during winter and spring (Shenbrot, 2004). Furthermore, the active mounds are dominated by *P. sickenbergeri* that is not preferred by herbivores due to its high contents of secondary chemical compounds (Ruiz *et al.*, 2002a, b).

In conclusion, the fat sand rat appears to play an ecological role through its foraging and burrowing mounds in the sand dune ecosystem. The building and abandonment of its burrowing mounds resulted in a mosaic of distinct patch types with different species diversity and community structure. These results suggest that when managing biodiversity and ecosystem function it is important for the landscape managers to consider the fat sand rat as an ecosystem modifier whose removal may result in significant changes in community structure and stability. In this context, further research should be focused on the effect of fat sand rat on plant productivity and diversity along environmental (*e.g.* rainfall and sand stability) and land use (*e.g.* grazing) gradients.

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إستجابة الغطاء النباتي لكثيبات جحورالفأر الرملي المهجورة على الكثبان الرملية الساحلية لشمال سيناء بمصر

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يعتبر الفأر الرملي الدهني من أكلات العشب الإجبارية والتي تعيش في جحورعديدة معقدة التركيب في صحراء شمال أفريقيا والشرق الأوسط ، ومع ذلك لا توجد دراسات وافية عن تأثير نشاطاته الرعوية والحفرية على مجتمعات ووفرة الأنواع النباتية. لذلك تهدف هذه الدراسه لتقييم هذه التأثيرات عن طريق مقارنة الظواهرالسطحية للجحور والكثيبات المصاحبة لها وكذلك مساحة ظلل أفراد النبات العائل الرئيسي (نبات العجرم) ، ووفرة وتنوع الغطاء النباتي ، والأنواع النباتية للمستعمرات المستخدمة والمهجورة وخارج كلا منهما على الكثبان الرملية لشمال سيناء. وقد تميزت نظم الجحور المستخدمة بصغر ظلال نبات العجرم وكبر مساحة الكثيبات الناتجة عن حفرالجحورمع وجود سيادة لسطح التربة العاري ، وكمية الروث والدبال للمادة العضوية الحية والميتة. وعلى النقيض من ذلك فقد أدى هجر الكثيبات لمدة خمس سنوات إلى زيادة ملحوظة في التغطية النباتية ، وفي إرتفاع ظل النباتات ، وفي وفرة وتنوع الأنواع. وقد أدى الإختلاف في الوفرة النسبية وفي التوزيع المكاني للأنواع على الكثيبات المستخدمة والمهملة وخارج كلا منهما إلى ظهور تجمعات نباتية مميزة لكل من هذه المواطن البينية. ومن خلال نتائج هذه الدراسة يتضح أن نشاط الفأر الرملي له تأثيرات مباشرة وغير مباشرة على تركيب وديناميكية وتنوع الغطاء النباتي للكثبان الرملية.

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