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# RESPONSE OF SHRUBS AND UNDER-SHRUBS TO PROTECTION AGAINST GRAZING IN TWO ISLANDS OF LAKE BARDAWIL, MEDITERRANEAN COAST OF EGYPT

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The effects of grazing by livestock on three palatable under-shrubs *(Convolvulus lanatus* Vahl, *Moltkiopsis ciliata* (Forssk) I.M. Johnst and *Echiochilon fruticosum* Desf*)* and three shrubs (*Artemisia monosperma* Del., *Thymelaea hirsuta* (L.) Endle and *Zygophyllum album* L.) were studied in two islands at Zaranik, Lake Bardawil (northern Sinai) on the Mediterranean coast of Egypt. For the under-shrubs, seventeen years of protection against grazing has led to an increase in their vigor, cover and density. The density of the palatable shrub *Artemisia monosperma* was greater in the heavily grazed area, while its cover and vigor were higher in the ungrazed area. *Thymelaea hirsuta* and *Zygophyllum album* were more abundant in the heavily grazed area than in the protected area. Soil fine fractions were higher in the protected areas, while soil salinity and organic carbon were higher in the heavily grazed areas. The three shrubs showed positively skewed size distributions in both protected and heavily grazed sites. Recruitment occurred through vegetative sprouts only for the three palatable under-shrubs under the heavy grazing intensity and through both seedlings and vegetative sprouts in the protected areas except for *Convolvulus lanatus*. Results obtained indicate that the three grazing tolerant under-shrubs were under pressure and there is likely to be a decline in their vigor, cover and density unless active grazing control is initiated.

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**Keywords:** Lake Bardawil, grazing, islands, northern Sinai, palatability, regeneration.

Shrubs and under-shrubs are the major components of arid and semi-arid rangelands throughout Egypt and the world (Ayyad and El-Kady, 1982; Noy-Meir, 1990; Van Duivenbooden, 1993; Shaltout *et al.,* 1996). In Egypt, many shrub species are either endangered or vulnerable due to aridity conditions and human activities (Batanouny *et al.*, 1991). The continuous overgrazing, overcutting and uprooting has led to the disappearance of pastoral plant communities, the paucity of trees and shrubs, the reduction of plant cover and soil erosion (Kassas, 1955; Zahran and Willis, 1992; El-Kady and El-Shourbagy, 1994; Helmy *et al.*, 1996).

The major effects of grazing disturbance in plant communities include changes in vegetation structure and composition. In some arid and semi-arid pastoral areas of the world, grazing by domestic livestock can dramatically change the structure of the vegetation by preventing recruitment of trees and shrubs (Chesterfield and Parsons, 1985).

The northern Sinai is about 6.56 million ha. nearly a half million units of livestock and several wildlife species utilize this area. In former times, many places were far from human settlement and there was a chance for the natural vegetation to regenerate (Kassas, 1955). Now, roads are being constructed to most villages and scenic areas thus facilitating movements of large herds between winter and summer grazing grounds and enabling access to rare plant sites. This has resulted in the lack of regeneration of palatable species and a dominance of unpalatable ones. The effect of overgrazing can be seen on satellite imagery of Sinai, where the border between Egypt and Israel becomes clear due to vegetation degradation along the Egyptian side (Tielbörger, 1997). Although the Mediterranean desert rangelands of northern Sinai have been grazed for long periods, no quantitative information are available on the effects of long term heavy grazing on the vegetation and soil. This lack of information is especially critical because the desert environment is easily disturbed and needs a long recovery time.

Zaranik protected area of Lake Bardawil was originally created as a RAMSAR site with great international importance for migratory and resident birds (Salama and Grieve, 1997). The present study is specifically interested in determining the effects of protection upon the abundance and size structure of the common under-shrubs and shrubs and their associated soil variables in two islands of Lake Bardawil. We hypothesize that protection could affect plants since some unpalatable species may benefit from the disturbed condition of the heavy grazed area.



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## MATERIALS AND METHODS

Three under-shrubs *(Convolvulus lanatus, Moltkiopsis ciliata* and *Echiochilon fruticosum)* and three shrubs (*Artemisia monosperma, Thymelaea hirsuta* and *Zygophyllum album)* were sampled in the sand dunes of protected and heavily grazed islands. The population of each species were sampled within ten stands in the protected site and another ten in the heavily grazed one. *Artemisia monosperma, Moltkiopsis ciliata* and *Convolvulus lanatus* were common on the partially stabilized dunes, while *Echiochilon fruticosum, Thymelaea hirsuta* and *Zygophyllum album* were abundant on the stable inter dunes (El-Bana *et al.*, 2002). The plant density and cover were estimated using a modified line-intercept method (Etchberger and Krausman, 1997). The maximum canopy height and average canopy diameter (mean of two perpendicular measurements) of all the individuals of each species within the sampled stands were measured to calculate the canopy volume and the projected areas of individuals (Brooks, 1999). The size index of a species was defined as the mean of its height and diameter (Crisp, 1978; Shaltout *et al.*, 1996).

The soil samples were collected from each stand, air dried, thoroughly mixed and passed through a 2 mm-sieve to separate gravel and debris. Samples finer than 2 mm were analyzed for soil texture and organic matter. The pH and electrical conductivity were determined in an aqueous solution (20 g soil dissolved in 40 ml distilled water and shaken for 2 hrs) using a pH and a conductivity meter.

The D'Agostino-Pearson statistic was used to test normality (D'Agostino *et al.*, 1990). The Mann-Whitney rank sum test was applied to assess the differences between populations and soil in heavily grazed and ungrazed sites (Sokal and Rohlf, 1995).

**Study Area**

The study was conducted at the coastal dunes of two islands (El Fusiyat and El Malty), Zaranik area ($31^0 06'$N and $33^0 28'$E), in the north-east of Lake Bardawil. El Fusiyat was heavily grazed by goats and sheep before 1983 and was not grazed after 1988 (W. Salama, Zaranik Manager, pers. comm.) On the other hand, El Malty is under heavy grazing, as it is occupied by permanently resident Bedouins with their goats and sheep. The elevation of both islands is approximately 20 m a.s.l. They have been assumed similar in productivity because of their proximity, slope angles, exposure, soil and flora (El-Bana *et al.* 2002).

The climate of the study area may be classified as transitional between the Monsoon and Mediterranean climate types, owing to the modification by the elevated Sinai Peninsula. The rainy season extends from October to May, the average annual rainfall is about 82 mm and the annual evaporation about 160 mm (Zahran and Willis, 1992). The dunes in these



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islands are up to 15m height from swale to crest. The overall percentage cover of perennial plants in the protected island is about 50-55%, while in the heavy grazed island is 5-10%. The soil in the study area is sandy and whitish due to the presence of shell fragments.

## RESULTS

Grazing significantly decreased the growth attributes of four out of the six studied species (Table 1). The height, diameter, volume and area of the under-shrubs (*Convolvulus lanatus, Moltkiopsis ciliata* and *Echiochilon fruticosum*) were highly decreased under the heavy grazing (Table 1). The volume differences between ungrazed and heavily grazed were extreme for the three palatable under-shrubs; the volumes of individuals of *Convolvulus lanatus, Moltkiopsis ciliata* and *Echiochilon fruticosum* were 97%, 96% and 92% less, respectively, in the heavily grazed area. The volume of shrub individuals of *Artemisia monosperma* was 82% less in the heavily grazed area. The volumes and areas of the less palatable fibre-shrub *Thymelaea hirsuta* and the succulent-shrub *Zygophyllum album* had significantly increased in the heavily grazed area.

The height/diameter ratios for the palatable under-shrubs (*Convolvulus lanatus, Moltkiopsis ciliata* and *Echiochilon fruticosum*) were significantly greater in the protected site. The two shrubs (*Artemisia monosperma* and *Thymelaea hirsuta*) and the succulent (*Zygophyllum album*) did not show statistically significant differences between the protected and the heavily grazed sites (Table 2). Significant correlations were observed between the individual heights and diameters of the studied species in the heavily grazed and the protected sites (Table 2) except for *Moltkiopsis ciliata* ($r_{(S)} = 0.159$, $p = 0.11$) under heavy grazing.

The size structures of the three palatable under-shrubs (*Convolvulus lanatus, Moltkiopsis ciliata* and *Echiochilon fruticosum*) indicated that most of the individual plants of the studied species belonged to smaller size classes under heavy grazing intensity (Figure 1). Most of these individuals in the small size classes were recent vegetative regrowth that had survived some grazing. These species had neither seedling emergence nor larger individuals in the heavily grazed area. *Convolvulus lanatus* had a few large individuals under heavy grazing intensity compared to *Moltkiopsis ciliata* and *Echiochilon fruticosum* as it included long spine stems. *Moltkiopsis ciliata* and *Echiochilon fruticosum* had positively skewed distributions in the protected area, while *Convolvulus lanatus* had a negatively skewed distribution. The three shrubs (*Artemisia monosperma, Thymelaea hirsuta*) and *Zygophyllum album* had positively skewed distribution in both protected and heavily grazed areas (Figure 1).

**TABLE (1). Comparison of some growth parameters of the studied plant species in ungrazed and heavily grazed sites.**

| Species | Height (m) | | | Diameter (m) | | | Volume ($m^3$) | | | Area ($m^2$) | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ug | Hg | Δ (%) | Ug | Hg | Δ (%) | Ug | Hg | Δ (%) | Ug | Hg | Δ (%) |
| *Convolvulus lanatus* | 0.406 | 0.098 | 75.86 | 0.692 | 0.270 | 60.98 | 0.624 | 0.017 | 97.28 | 0.483 | 0.067 | 86.13 |
| *Moltkiopsis ciliata* | 0.144 | 0.065 | 54.86 | 0.521 | 0.137 | 73.70 | 0.077 | 0.003 | 96.10 | 0.313 | 0.017 | 94.57 |
| *Echiochilon fruticosum* | 0.257 | 0.116 | 54.86 | 0.513 | 0.251 | 51.07 | 0.225 | 0.018 | 92.00 | 0.249 | 0.056 | 77.51 |
| *Artemisia monosperma* | 0.546 | 0.330 | 39.56 | 0.641 | 0.387 | 39.63 | 1.365 | 0.250 | 81.68 | 0.408 | 0.142 | 65.20 |
| *Thymelaea hirsuta* | $0.656^a$ | $0.710^a$ | -8.23 | $0.706^b$ | $0.752^b$ | -6.52 | 2.472 | 2.806 | -13.51 | 0.538 | 0.689 | -28.07 |
| *Zygophyllum album* | $0.220^a$ | $0.286^a$ | -30.00 | $0.392^b$ | $0.490^b$ | -25.00 | 0.152 | 0.450 | -196.05 | 0.161 | 0.277 | -72.05 |

Similar letters indicate non-significant ($P>0.05$) Mann-Whitney rank sum test between pairwise combinations of each parameter.
Abbreviations: Ug = ungrazed; Hg = heavily grazed; Δ= Difference.



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**TABLE (2). Height/diameter ratio and Spearman rank correlation ($r_s$) between height and diameter in ungrazed and heavily grazed areas.**

| Species | Height / Diameter | | $r_s$ (Height x Diameter) | |
|---|---|---|---|---|
| | Ungrazed | Grazed | Ungrazed | Grazed |
| *Convolvulus lanatus* | 0.68 | 0.40 | 0.68 | 0.55 |
| *Moltkiopsis ciliata* | 0.58 | 0.37 | 0.63 | 0.16* |
| *Echiochilon fruticosum* | 0.52 | 0.47 | 0.83 | 0.74 |
| *Artemisia monosperma* | 0.92[a] | 0.97[a] | 0.87 | 0.73 |
| *Thymelaea hirsuta* | 1.02[a] | 1.11[a] | 0.84 | 0.84 |
| *Zygophyllum album* | 0.62[a] | 0.64[a] | 0.92 | 0.79 |

* indicate non-significant correlation (P>0.05).
Similar letters indicate non-significant (P>0.05) Mann-Whitney rank sum test.

Absolute density and cover index of the palatable under-shrubs (*Convolvulus lanatus, Moltkiopsis ciliata* and *Echiochilon fruticosum*) were significantly greater in the protected area than in the heavily grazed one (Table 3). *Thymelaea hirsuta* and *Zygophyllum album* had significantly greater density and cover in the heavily grazed area than in the protected one, whereas the palatable shrub (*Artemisia monosperma*) had a significantly higher density and lower cover in the heavily grazed area.

**TABLE (3). Comparison of absolute density and cover index of species in ungrazed and heavily grazed areas.**

| Species | Density (plants/ 100 m$^2$) | | | Cover (m/ 100 m) | | |
|---|---|---|---|---|---|---|
| | Ungrazed | Heavily grazed | Difference (%) | Ungrazed | Heavily grazed | Difference (%) |
| *Convolvulus lanatus* | 20.0 | 6.8 | 66.0 | 4.2 | 0.9 | 79.9 |
| *Moltkiopsis ciliata* | 18.3 | 5.6 | 69.4 | 3.3 | 0.5 | 85.1 |
| *Echiochilon fruticosum* | 40.2 | 16.0 | 60.2 | 6.7 | 2.5 | 63.1 |
| *Artemisia monosperma* | 95.0 | 110.0 | -15.8 | 12.4 | 6.4 | 48.7 |
| *Thymelaea hirsuta* | 60.0 | 86.0 | -43.3 | 9.9 | 11.2 | -13.1 |
| *Zygophyllum album* | 16.0 | 25.5 | -59.4 | 5.3 | 8.8 | -64.0 |

All values are significantly different (P<0.05) Mann-Whitney rank sum test between pairwise combinations of each parameter.

There were significant differences in the measured soil factors between ungrazed and heavily grazed species (Table 4). There was an increase in the soil fine fractions in the stands under the protection for all studied species except *Zygophyllum album* stands. On the other hand, soil salinity and organic carbon were higher in the heavily grazed stands (Table 4).



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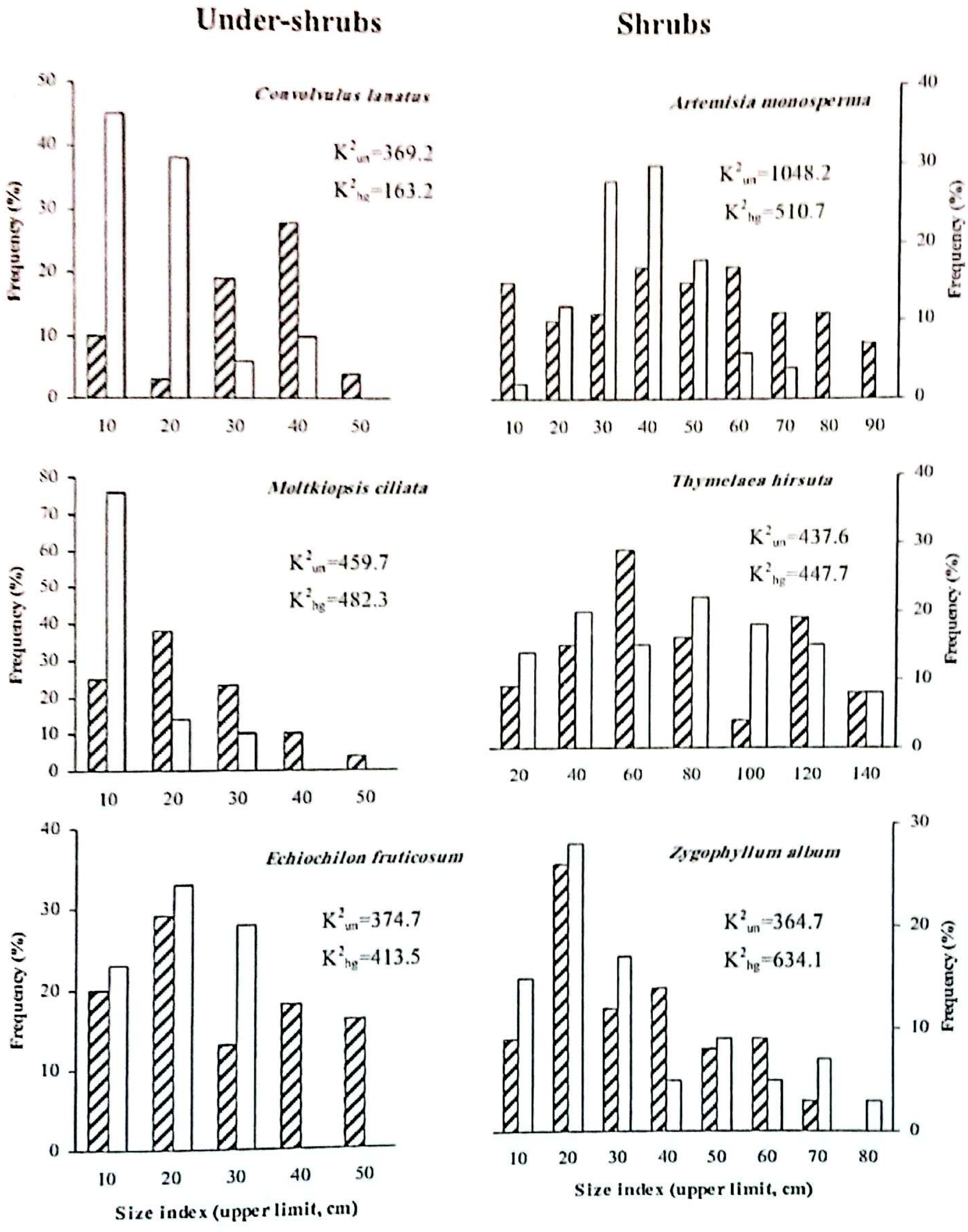


**Fig. (1).** Size-frequency distribution of under-shrub and shrub populations in the ungrazed (stripped bars) and the heavily grazed (blank bars) sites.
Abbreviations: $K^2_{un}$ and $K^2_{hg}$ are the D' Agostino-Pearson test statistic for normality which are significantly different ($p < 0.05$) at the ungrazed and the heavily grazed populations, respectively.

**TABLE (4). Comparison between soil variables of the species populations in ungrazed and heavily grazed areas.**

| Soil variable | *Convolvulus lanatus* | | *Moltkiopsis ciliata* | | *Echiochilon fruticosum* | | *Artemisia monosperma* | | *Thymelaea Hirsuta* | | *Zygophyllum album* | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Ug | Hg | Ug | Hg | Ug | Hg | Ug | Hg | Ug | Hg | Ug | Hg |
| Coarse sand (%) | 80.40 | 87.40 | 78.40 | 89.80 | 79.40 | 90.10 | 94.00 | 96.80 | 92.00 | 95.00 | 68.51 | 84.00 |
| Fine sand (%) | 15.18 | 10.30 | 14.20 | 7.30 | 13.98 | 7.20 | 4.50 | 2.50 | 5.12 | 3.20 | 7.07 | 13.00 |
| Silt + clay (%) | 5.39 | 2.35 | 4.20 | 2.90 | 6.47 | 2.60 | 1.50 | 0.66 | 4.26 | 1.80 | 4.99 | 3.00 |
| EC (mmhos.cm$^{-1}$) | 1.30 | 1.35 | 1.45 | 1.75 | 1.55 | 1.84 | 1.64 | 1.69 | 1.40 | 1.45 | 3.20 | 6.10 |
| Organic carbon (%) | 1.50 | 1.71 | 1.02 | 1.65 | 1.44 | 1.94 | 1.47 | 1.62 | 1.50[a] | 1.53[a] | 1.44 | 1.51 |
| PH | 8.9 | 8.7 | 8.5 | 8.2 | 8.6[a] | 8.5[a] | 8.7 | 8.5 | 8.6 | 8.3 | 7.8 | 7.4 |

Similar letters indicate non-significant (P>0.05) Mann-Whitney rank sum test between pairwise combinations of each parameter.
Abbreviations: Ug = ungrazed; Hg = heavily grazed.

## DISCUSSION

A large number of studies clearly show that long-term heavy grazing leads to reduction in cover of palatable species and the dominance of the unpalatable, chemically defended plant species (Dregne, 1995; Shaltout *et al.*, 1996; Bisigato and Bertiller, 1997). Protection against overgrazing could provide a chance for regeneration and dominance of palatable species. The present study shows that protection during 17 years has resulted in remarkable increases in dimensions, cover and density of palatable species over unpalatable ones. The cover and density of palatable under-shrubs (*Convolvulus lanatus, Moltkiopsis ciliata* and *Echiochilon fruticosum*) were shown to benefit from protection. Similar results were recorded by Shaltout *et al.* (1996) who noted that eleven years of protection in the coastal land of Saudi Arabia improved the abundance of highly palatable species, while the unpalatable species were abundant under heavy grazing. In the western Mediterranean desert of Egypt and in northern Sudan, density and cover of palatable perennials increase as a result of protection and controlled grazing (Halwagy, 1962; Ayyad and El-Kady, 1982). Floret (1981) showed that the populations of *Echiochilon fruticosum* progressed from 33% to 61% after seven years of protection in the Mediterranean arid zone of southern Tunisia. However, some plant species may show a favorable response to grazing. Ellison (1960) found that *Artemisia nova* (palatable shrub) had a higher growth rate after grazing than before. In this study, interestingly, the density of the palatable shrub *Artemisia monosperma* was greater in the heavily grazed area, while its cover was higher in the ungrazed area. This might be due to the ability of this plant to develop shoot-borne roots and hairs on its seedlings under disturbance (Danin 1996). The seed germination of *Artemisia monosperma* might be enhanced by trampling as its achenes are very sensitive to light (Koller *et al.*, 1964); these achenes require a thin cover of sand to germinate (Huang and Gutterman, 1998). Fahn and Cutler (1992) showed that *Artemisia monosperma* is resistant to both covering and uncovering by sand.

The abundance of the glycophyte *Thymelaea hirsuta* and the succulent *Zygophyllum album* were higher in the heavily grazed area. These species are not preferred by herbivores because of their high salt content, low protein content and high concentrations of phenolic compounds and condensed tannins (Kam *et al.* 1997). El-Kady (1987) observed that *Thymelaea hirsuta* is less palatable when fresh, probably due to chemical factors. Noy-Meir (1990) found that the less palatable perennial *Asphodelus aestivus* tended to increase under grazing and he attributed this to its unpalatability when green. Oatham *et al.* (1995) found that protection against grazing for 11 years in Abu Dhabi rangelands has led to a decrease in the abundance of unpalatable *Zygophyllum* species. Munton (1988)



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suggested that the local dominance of *Zygophyllum hamiense* in the Wahiba sands of Oman might be due to overgrazing and elimination of more palatable species.

Size differences in plant populations may be caused directly or through differences in growth rates due to age differences, genetic variation, heterogeneity of resources, herbivory and competition (Weiner, 1985). In the present study, the size differences between ungrazed and heavily grazed populations were highly significant. The populations of the palatable three under-shrubs showed positively skewed size distributions under heavy grazing conditions. The small individuals of these species were recruitments via vegetative sprouting after grazing. The long-term survival of these compensations is expected to be zero, as indicated by the absence of large size classes. Their early survival would be critical during a drought when other forage is unavailable. The seed formation of these under-shrubs under grazing is very limited as flowers and unripe seeds comprise good qualitative forage (Ayyad 1978). Consequently, although individual plants can live long, when the shrubs die completely, regeneration from seedlings is very slow and may not even occur under heavy grazing (van Duivenbooden, 1993).

The size distribution of *Convolvulus lanatus* was negatively skewed in the protected site; this was unexpected since both its cover and density increased. A possible explanation for this inconsistency between the short-term response (juvenile) and the long-term response (cover and density) is that the establishment of *Convolvulus lanatus* was promoted by protection in some years only. In arid and semi-arid zones, some species may thrive under infrequént coincidence of environmental and physical conditions, which favor the establishment of seedlings of some species (Omar, 1991). Kadmon and Leschner (1995) argued that the stability of the sand was the main factor controlling the abundance of species in sand dunes. In the present case, the top-soil is rapidly changing and altering the soil moisture regime and hence resulting in site conditions that favor some species. Danin (1996) mentioned that *Convolvulus lanatus* is unable to generate shoot-borne roots like *Moltkiopsis ciliata* and *Artemisia monosperma* under sand encroachment. The positively skewed size distributions of *Artemisia monosperma, Thymelaea hirsuta* and *Zygophyllum album* in both ungrazed and grazed sites could be attributed to their ability to tolerate a wide range of environmental changes. El-Kady and El-Shourbagy (1994) demonstrated that the dominance of *Artemisia monosperma* and *Thymelaea hirsuta* in the grassland communities in Wadi El-Arish (50 km south-east of the present study area) was due to environmental changes (e.g. air temperature, moisture and soil salinity).

Briske (1996) stated that with increasing grazing intensity, the palatable species have avoidance mechanisms as biochemical compounds



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and/or mechanical deterrents. Young (1987) and Milewski *et al.* (1991) found that browsed *Acacia* shrubs produce a greater density of longer thorns than unbrowsed branches. In the present study, individuals of *Convolvulus lanatus* were spinescent under heavy grazing intensity, while others had soft stems in the protected area. This spiny growth-form might be an adaptation to resist the heavy grazing intensity and to save this species from extinction. However, Danin (1983) also considered that the formation of spines in this species as an adaptation to drought under extreme desert conditions and the spineless form under coastal conditions.

Decumbent canopies are better able to resist grazing because less biomass is accessible to herbivores (Stobbs, 1973) and a greater amount of photosynthetic and meristematic tissues remain to facilitate growth following grazing (Carman and Briske, 1985). The results of present study proved that the height/diameter ratio was less than unity and significantly higher in the protected site for palatable under-shrubs (Table 2). This means that the diameters of these species exceed their heights under heavy grazing intensity and hence individuals of these species tend to expand horizontally rather than vertically. Shaltout and Mady (1993) suggested this growth form as a self-regeneration strategy for the desert trees and shrubs.

The high content of soil fine fractions in the protected site related to the heavily grazed one, could be attributed to the relative higher plant density and cover which may increase the deposition of aeolian fine fractions. This finding has been reported by Danin (1978) and Kadmon and Leschner (1995) in the sand dunes of the northern Negev (85-100 km south-west of the study area). The increase of soil salinity in the heavily grazed area compared to the protected site might be due to the sparser vegetation and the larger soil particles which enhance evaporation and soil erosion (Thalen, 1979; Shaltout *et al.*, 1996). Low vegetative cover and infiltration rates cause diurnal temperature fluctuations, runoff and erosion to increase in grazed areas (Ellison, 1960). The relatively higher organic carbon content in the soil of heavily grazed populations could be attributed to grazing, causing dead material to come in contact with the soil surface where microbial decomposition is greater. This result confirms the findings of Ayyad and El-Kady (1982); Abulfatih *et al.* (1989); Hajar (1993) and Shaltout *et al.* (1996).

In general, there is strong evidence that many grazing tolerant species in arid and semi-arid regions are under stress due to heavy grazing (Noy-Meir, 1990; Omar, 1991; Shaltout *et al.*, 1996; Bisigato and Bertiller, 1997) and that there is likely to be a decline in all such species unless active control of grazing is initiated. Results in this study indicated that the three grazing tolerant under-shrubs responded to protection with a sharp increase in density, cover and seedling regeneration. The loss of seedling regeneration of these species under heavy grazing can have serious implications for the long-term survival. Given the general lack of seed production observed in this study under heavy grazing, it is important to protect these species by fencing and to manage these fragile rangelands.

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## REFERENCES

Abulfatih, H.A.; H.A. Emara and A. El-Hashish (1989). Influence of grazing on vegetation and soil of Asir highlands in south western Saudi Arabia. *Arab Gulf J. Sci. Res.*, 7: 69-78.

Ayyad, M.A. (1978). A preliminary assessment of the effect of protection on the vegetation of the Mediterranean desert ecosystem. *Taeckholmia*, 9: 85-101.

Ayyad, M.A. and H.F. El-Kady (1982). Effect of protection and controlled grazing on the vegetation of a Mediterranean desert ecosystem in northern Egypt. *Vegetatio*, 49:129-139.

Batanouny, K.H.; M.N. El-Hadidi and A.G. Fahmy (1991). In "*The Egyptian Plant Red Data Book*". Cairo University Publications.

Bisigato, A.J. and M.B. Bertiller (1997). Grazing effects on patchy dryland vegetation in northern Patagonia. *J. Arid Environ.*, 36: 639-653.

Briske, D.D. (1996). In *"Ecology and management of grazing systems*: Strategies of plant survival in grazed systems: a functional interpretation. (Hodgson, J. and A.W. Illius, eds) p. 37-67. Wallingford: CAB International.

Brooks, M. (1999). Effects of protective fencing on birds, lizards and black-tailed hares in the Western Mojave desert. *Environ. Manage.*, 23: 387-400.

Carman, J.G. and D.D. Briske (1985). Morphologic and allozymic variation between long-term grazed and non-grazed populations of *Schizachyrium scoparium* var. *frequens*. *Oecologia*, 66: 332-337.

Chesterfield, C.J. and R.F. Parsons (1985). Regeneration of three tree species in arid-south-eastern Australia. *Aust. J. Bot.*, 33: 715-732.

Crisp, M.D. (1978). Demography and survival under grazing of three Australian semi-desert shrubs. *Oikos*, 30: 520-528.

Danin, A. (1978). Plant species diversity and plant succession in a sandy



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area in the Northern Negev. *Flora*, 167: 409-422.

Danin, A. (1983). In *"Desert vegetation of Israel and Sinai"*. Cana, Jerusalem.

Danin, A. (1996). *In "Plants of desert dunes"*. Adaptations of desert organisms. Berlin: Springer-Verlag.

D'Agostino, R.B.; A. Belanger and R.B. Jr. D'Agostino (1990). A suggestion for using powerful and informative tests for normality. *The Am. Stat.*, 44: 316-321.

Dregne, H.E. (1995). Erosion and soil productivity in Australia and New Zealand. *Land Degrad. Rehabil.*, 6: 71-78.

El-Bana, M.I.; A.A. Khedr; P. Van Hecke and J. Bogaert (2002). Vegetation composition of a threatened hypersaline lake (Lake Bardawil), North Sinai. *Plant Ecol.*, 163: 63-75.

El-Kady, H.F. (1987) A study of range ecosystems of the Western Mediterranean coastal desert of Egypt. *Ph.D. Thesis. Technical Univ. Berlin.*

El-Kady, H.F. and M.N. EL-Shourbagy (1994). Vegetation changes in North Sinai within three decades. *J. Coastal. Res.*, 10: 978-986.

Ellison, L. (1960) Influence of grazing on plant succession on rangelands. *Bot. Rev.*, 26: 1-78.

Etchberger, R.C. and P.R. Krausman (1997). Evaluation of five methods for measuring desert vegetation. *Wildlife Soc. B*, 25: 604-609.

Fahn, A. and D. Cutler (1992). In "*Xerophytes*". Berlin, Borntraeger.

Floret, C. (1981). The effects of protection on steppic vegetation in the Mediterranean arid zone of Southern Tunisia. *Vegetatio*, 46: 117-129.

Hajar, A.S.M (1993). A comparative ecological study on the vegetation of protected and grazed parts of Hema Sabiha, in Al-Bahah region, south western Saudi Arabia. *Arab Gulf J. Sci. Res.*, 11: 258-280.

Halwagy, R. (1962). The incidence of biotic factors in northern Sudan. *Oikos.*, 13: 97-117.

Helmy, M.A.; A.A. Moustafa; R.H. Abd El-Wahab and K.H. Batanouny (1996). Distribution behavior of seven common shrubs and trees growing in South Sinai, Egypt. *Egypt. J. Bot.*, 36: 53-70.

Huang, Z.Y. and Y. Gutterman (1998). *Artemisia monosperma* achene germination in sand: effects of sand depth, sand/water content, cyanobacterial sand crust and temperature. *J. Arid Environ.*, 38: 27-43.

Kadmon, R. and H. Leschner (1995). Ecology of linear dunes: effect of surface stability on the distribution and abundance of annual plants. *Adv. in GeoEcol.*, 28: 125-143.

Kam, M.; I.S. Khokhlova and A.A. Degen (1997). Granivory and plant selection by desert gerbils of different body size. *Ecology*, 78: 2218-2229.

Kassas, M. (1955). *Rainfall and vegetation belts in arid NE Africa*. Plant Ecology Proceeding of the Montpellier Symposium. UNESCO, 49-77.

Koller, D.; M. Sachs and M. Negbi (1964). Spectral sensitivity of seed germination in *Artemisia monosperma*. *Plant Cell Physiol.*, 5: 79-84.

Milewski, A.V.; T.P. Young and D. Madden (1991). Thorns as induced defenses: experimental evidence. *Oecologia*, 86: 70-75.

Munton, P. (1988). Vegetation and forage availability in the sands. *J. Oman Studies, Special Report No.* 3: 241-250.

Noy-Meir, I. (1990). Responses of two semi-arid rangeland communities to protection from grazing. *Israeli J. Bot.*, 39: 431-442.

Oatham, M.P.; M.K. Nicholls and I.R. Swingland (1995). Manipulation of vegetation communities on the Abu Dhabi rangelands. I. The effects of irrigation and release from long-term grazing. *Biodivers. Conserv.*, 4: 696-709.

Omar, S.A.S. (1991). Dynamics of range plants following 10 years of protection in arid rangelands of Kuwait. *J. Arid Environ.*, 21: 99-111.

Salama, W. and A. Grieve (1997). The Zaranik experience. *Sandgrouse*, 18: 14-17.

Shaltout, K.H. and M.A. Mady (1993). Current situation of the raudha's woody plant populations in the Central Saudi Arabia. *Fed. Rep.*, 104: 503-509.

Shaltout, K.H.; E.F. EL-Halawany and H.F. El-Kady (1996). Consequences of protection from grazing on diversity and abundance of the coastal lowland vegetation in Eastern Saudi Arabia. *Biodivers. Conserv.*, 5: 27-36.

Sokal, R.R. and F.J. Rohlf (1995). In "*Biometry*". New York, *Freeman and Company*, 887pp.

Stobbs, T.H. (1973). The effect of plant structure on the intake of tropical pastures. I. Variation in the bite size of grazing cattle. *Aust. J. Agr. Res.*, 24: 809-819.

Thalen, D.C.P. (1979). In "*Ecology and utilization of desert shrub rangelands in Iraq*". The Hague: *Junk Publishers Hardbound*, 448pp.

Tielbörger, K. (1997). The vegetation of linear desert dunes in the north-western Negev, Israel. *Flora*, 192: 261-278.

Van Duivenbooden, N. (1993). Grazing as a tool for rangeland management in semi-arid regions: a case study in the north-western coastal zone of Egypt. *Agr. Ecosyst. Environ.*, 43: 309-324.



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Wiener, A. (1985). Size hierarchies in experimental populations of annual plant. *Ecology.*, 66:743-572.

Young, T.P. (1987). Increased thorn length in *Acacia drepanolobium* – an induced response to browsing. *Oecologia,* 71: 436-438

Zahran, M.A. and A. J. Willis (1992). In "*The vegetation of Egypt*". Chapman and Hall, London, 424pp.

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# استجابة تجمعات الشجيرات وتحت الشجيرات للحماية من الرعي في الجزر الصحراوية لبحيرة البردويل على ساحل البحر المتوسط

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تناولت الدراسة تأثير الحماية من الرعي على ثلاثة من العشائر النباتية الشجيرية وهي العـــادر *Artemisia monosperma* ، المتنـــان *Thymelaea hirsuta* والرطـــريط *Zygophyllum album* وثلاثة عشائر نباتية تحت شجيرية رعوية مستساغة وهـــي الرخامـــة *Convolvulus lanatus* والحلمـــة *Moltkiopsis ciliata* والكحلـــة *Echiochilon fruitcosum* في الجزر الصحراوية لبحيرة البردويل بشمال سيناء.

أوضحت الدراسة أن الحماية من الرعي لمدة ١٧ عاما نتج عنها زيادة في حجم وكثافة أفراد العشائر النباتية تحت الشجيرية ، وعلى العكس ارتفعت كثافة نبات العادر في المنطقة المتأثرة بالرعي الجائر بدرجة أكبر من المنطقة المحمية بينما زادت أحجام نبات العادر في منطقة الحماية.

أوضحت الدراسة ارتفاع في السيادة لنباتات المتنان والعادر في منطقة الرعي الجائر ، كما تبين وجود ارتفاع في عدد أفراد نبات الرخامة من البادرات في منطقة الحماية عنة في منطقة الرعي الجائر. كما أوضحت الدراسة زيادة نسبة حبيبات التربة الناعمة في منطقة الحماية ، بينما ارتفعت الملوحة ونسبة المادة العضوية للتربة في منطقة الرعي الجائر.

تبين من نتائج هذه الدراسة أن العشائر النباتية الرعوية تحت الشجيرية توجد تحت ضغوط متزايدة من حيوانات الرعي بمنطقة الدراسة ويلزم برنامج لتأهيل وتكاثر هذه الأنواع في بيئتها الطبيعية خارج المنطقة المحمية حيث يندر وجودها.