We are IntechOpen, the world's leading publisher of Open Access books
Built by scientists, for scientists

4,800
Open access books available

122,000
International authors and editors

135M
Downloads

154
Countries delivered to

Our authors are among the
TOP 1%
most cited scientists

12.2%
Contributors from top 500 universities

CLARIVATE ANALYTICS BOOK CITATION INDEX INDEXED

WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?
Contact book.department@intechopen.com

Numbers displayed above are based on latest data collected.
For more information visit www.intechopen.com

7

Rangelands in Arid Ecosystem

Selim Zedan Heneidy
Department of Botany and Microbiology,
Faculty of Science, Alexandria University
Egypt

1. Introduction

The world's rangelands constitute an important global resource. Range has been defined by the society for range management as land which supports vegetation useful for grazing on which routine management of that vegetation is through manipulation of grazing rather than cultural practices. Grazing systems are biological systems controlled by: a- the biotic factors of climate and site, b- the management inputs and decisions of man, and 3- internal regulatory mechanisms involving feedback.

General introduction for dry lands in which, most of rangelands are distributed, refer to areas with primary productivity limited by water. They cover about 40% of the land surface and contain about one fifth of the human population. This population is typically convergent on areas with relatively lower aridity, further intensifying the stresses on these marginal lands. The concept of marginality applies to these dry lands in a socio-economic sense, where the inhabitants commonly suffer poverty and lack of resources. Anthropogenic activities are almost entirely responsible for these factors. Included with, over-utilization of vegetative cover through improper rangeland management, poorly planned conversion of rangelands to croplands through irrigation schemes, and degradation of soil quality through salinization and input of chemical pollutants. The impacts of these factors on the human society are quite profound and often lead to trans-migration to other eco-regions as well as social and political strife. Thus approaches for management of dry lands resources must be viewed in the broader socio-economic context by providing the opportunities for local communities to explore viable, alternative livelihoods while maintaining their own cultural and societal fabric. Many approaches for managing the scarce water resources are available and form the underpinnings of overall resource management in drylands. These include water harvesting techniques, safe re-use of treated wastewater for irrigation, improving ground water recharge and deficit irrigation. Newer approaches of drylands aquaculture using brackish water and ecotourism also hold considerable promise for the future (UNU/MAP/UNESCO, ACRDA, 2003).

1.1 The Western Mediterranean coastal region

The western coastal desert of Egypt and its hinterland is renowned by its wealth of natural resources. This region has been a point of attraction for development projects due to this richness in natural resources, fine location, good weather and pleasant conditions. Most of the north western desert falls in the arid region except for the coastal strip. Water resources are scarce and variable. As a result the local community has developed a wide range of strategies for managing water resources in this region. Traditionally, they move around for water, pasture and croplands, based on the rainfall pattern. But recently and after being sedentary, together with population growth, overuse of water resources, over grazing and uprooting of indigenous vegetation. Climate changes, and other political and social forces, there has been an increased pressure on land resources that affected its performance and provision of goods and services.

One of the most common forms of land use in the Western Mediterranean coastal region of Egypt is animal husbandry. Its contribution to the livelihood of Bedouin increases from Alexandria to the westward direction. Grazing material and fire-wood as energy sources are two major basic needs of the inhabitants of the western desert of Egypt. The western Mediterranean desert land is one of the richest phytogeographical region in Egypt for natural vegetation because of its high rainfall. The natural vegetation includes many species of annuals, mostly herbs and a few grasses, perennial herbs, shrubs, sub-shrubs, and a few trees. These species represent 50% of the total flora of Egypt. The botanical composition is spatially heterogeneous depending on soil fertility, topography, and climatological conditions but with sub-shrubs dominating the vegetation (Ayyad and Ghabbour, 1977).

The Mediterranean desert west of Alexandria is referred to as Mareotis (or Mariut) and It is one of the arid regions which has a long history of intensive grazing and rain-fed farming. It is seldom found that any one family is engaged either in cultivation or in herding usually there is a mixture of these activities. In such region the yield and nutritive value of consumable range plants are highly dependent upon rainfall (Le Houérou and Hostte 1977; Heneidy 1992). However, the conditions of the pasture and vegetation performance also depend upon rainfall.

The total area of the rangeland is about 1.5 million hectare. The number of animals per folks varies among the Bedouin, and between regions. A herd size of about 200 head of sheep and 60 head of goats, may be reaches to 300 heads. The total number of animals which graze the rangelands is about 1.5 million head, therefore the average stocking rate is one head /ha. (Heneidy, 1992).

There is no consistent range management strategy in control of the season long grazing in the area, which varies mainly with climatic condition, availability of watering points and availability of supplementary feed. Absolutely the stocking rate leads to the problem of overgrazing. Overgrazing has been one of the main factors causing the deterioration of ecosystem productivity in the Mediterranean coastal region. It has resulted in severe reduction of perennial cover, soil erosion and formation of mobile dunes.

Grazing and rain fed farming provide a clear example of the impact of man's disruptive action on arid and semiarid regions. Continued uncontrolled grazing, wood cutting and farming have, however, induced a process of degradation. This is coupled with severe environment, uncertainty of rainfall and a change in socio-economic circumstances, has resulted in an advanced stage of desertification. As a result, the region now is producing at a rate less than its potential, and is continuing to lose the productivity it had. The degradation of renewable natural resources in arid and semi-arid areas has become a matter of great concern. This region includes several types of habitats (e.g. sand dunes, saline depressions, coastal ridges, non-saline depressions, wadies, inland plateau, inland ridges, etc….).The causes of degradation of rangeland in the Mediterranean coastal region of Egypt, are mixes of environmental, socio-political and socioeconomic conditions (Ayyad, 1993; Heneidy and Bidak, 1998). In recent years reclamation and cultivation of desert areas in Egypt became a necessity. The coastal Mediterranean semi-arid stripe and the inland new valley areas are possible promising fields for such a purpose.

2. Methodology

2.1 Selection of stands for vegetation analysis

Several stands were distributed within the study area extending from the non saline depression to the inland plateau. These stands were selected to represent major apparent variations in the physiogonomy of vegetation and in topographic and edaphic features. For sampling of the vegetation, about fifty 1 X 2 m^2 quadrates were located randomly in each stand. The presences of each species in each quadrate were recorded, and the number of its individuals counted. The number of individuals and occurrences of each species in the quadrates was then used to calculate its density and frequency respectively. The line-intercept method was used for estimation of cover. The lengths of intercept of each species in a stand was measured to the nearest centimeter along five, 50 m long transects. This length was then be summed and expressed as a relative value of the total length of the five transects. Relative density, frequency and cover for each perennial species were summed up to give an estimate of its importance.

2.2 Consumption

Consumption is the amounts taken by grazing animals- Consumption depends on many factors and it is differ according to types of livestock. Estimation of the consumption rate was carried out using the Bite method as follows. The flock, which normally consists of about 100 heads, was observed for 24 hours twice a week in each habitat. A particular animal in the flock was observed for five inputs, using field glasses and a tape recorder. During each hour of the daily grazing period, ten animals were observed in a cycle of 50 minutes to represent the hourly consumption behavior to record the observations. Estimation of the consumption of different plant species by the grazing animals is based on three main measures: (a) The number of times each plant species was used in the diet of a single animal (number of bites per unit time). (b) Average size of material removed from each species in one bite. (c) The location on the canopy from which this material was removed. At the end of each month, 20 samples of each species simulating the average bite size were clipped and used to estimate the average of fresh and dry weights of the bite of that species. The weight and the number of bites were used to calculate the fresh and dry weight of consumed material and the amount of water. This technique was applied also by Jamieson & Hodgson, 1979; Chamber et al. 1981; Hodgson & Jamieson 1981; Illius & Gordan 1987; and Heneidy (1992, 1996). The total number of bites per animal per day of each plant species multiplied by the average weight of material removed in each bite will express the amount of material removed per animal per day. This estimate will then be multiplied by the value of the stocking rate of animals in the area to provide an assessment of the amount consumed from different plant species per hectare per day.

2.3 Palatability

Palatability of the range plants was determined and classified into four categories according to the palatability index reported by Heneidy (2000) and Heneidy & Bidak, (1999).

2.4 *Phytomass* (standing crop phytomass, accessible parts, and necromass or litter)

Homogeneity of a stand was judged according to edaphic and physiographic features. The direct harvest method was used for phytomass determination according to Moore and Chapman (1986). All above-ground parts of different life-forms of the most common palatable species were excavated in each stand, and directly weighed in the field. Representative individuals of each species were collected in each stand during two seasons, spring and summer (representing the wet and dry season), for standing crop phytomass determination and also to determine the vegetative and accessible parts (available parts) depending upon the morphology and configuration of the plant species (Heneidy, 1992; 2003a). Nomenclature and identification were carried out according to Täckholm (1974) and the Latin names of species were updated following Boulos (1995).

2.5 Economic value

Economic value of plant species were estimated based on: 1- direct observation in the field; 2- preparing a questionnaire form to the inhabitants. The questionnaire was prepared to obtain information about fuel wood, traditional uses of some plant species; 3- the previous experience in the field of study.

3. Omayed biosphere reserve as a case study

Omayed Biosphere Reserve (OBR) is located in the western Mediterranean coastal region of Egypt (29° 00' - 29° 18' E and 30° 52' - 20° 38' N). It extends about 30 km along the Mediterranean coast from west El-Hammam to El-Alamin with a width of 23.5 km to the south (Fig.1). Its N-S landscape is differentiated into a northern coastal plain and a southern inland plateau. The coastal plain is characterized by alternating ridges and depressions running parallel to the coast in E-W direction. This physiographic variation leads to the distinction of 6 main types of ecosystems:

1- Coastal ridge, composed mainly of snow-white oolitic calcareous rocks, and overlain by dunes. 2- Saline depressions, with brackish water and saline calcareous deposits (i.e. salt marshes). 3- Non-saline depressions, with a mixture of calcareous and siliceous deposits of deep loess. Rainfed farms are a pronounced man made habitat within the non-saline depressions in this region. 4- Inland ridges, formed of limestone with a hard crystallized crust, and less calcareous than the coastal ridge. 5- Inland plateau, characterized by an extensive flat rocky surface and shallow soil. And, 6- Inland siliceous deposits, sporadically distributed on the inland plateau. The deposits of this ecosystem vary in depth and overly heavier soil with calcareous concretions at some distance from the soil surface. This soil is poor in organic matter and nutrients, particularly in the siliceous sand horizon (Heneidy, 2003b).

Fig. 1. Location of OBR in the western coastal desert of Egypt (After UNU/MAP/UNESCO, ACRDA, 2003)

Major economic activities: Raising herds by grazing, intensive quarrying and rainfed cultivation of grain crops, vegetables and orchards depending on water availability (mainly rain). Irrigated land agriculture is another potential acitivity that is introduced due to the extension of an irrigation canal from the Nile delta to the region.

Major environmental/economic constraints: Land degradation, habitat fragmentation, overgrazing, loss of biodiversity, salinization of soil, over exploitation of mineral and water (ground water) resources are the major environmental constraints The economic constraints stems from the general economic status of the local inhabitants that ranges from low to moderate, due to the following:

- Absence of permanent source of income (revenue),
- Lack of skills
- Major activities are seasonal (agriculture and grazing)
- spread of unemployment and thus poverty

Integration of environmental conservation and sustainable development can perfectly be implemented in OBR as the area is an ideal site for the sustainable development of 18 natural resources, by rationalizing ecotourism, rangeland management, propagation of multipurpose woody species, and promoting local industries based on native knowledge and experience of inhabitants. Tourism oriented towards natural history and traditional lifestyle is expected, especially with the spreading of nearby tourist villages. Nature watching (vegetation in spring, birds and wild animals, etc.), ancient devices of rain water harvesting and historical buildings (Zaher Bebars citadel from the thirteenth century) are types of tourist attractions in this reserve.

3.1 Vegetation - Environment relationships

Five major types of habitat are recognized in the study area: coastal sand dunes, inland ridges, non-saline depressions, wadis and inland plateau. Each of these habitats is characterized by local physiographic variations which effectuate variations in vegetation composition and species abundance. The application of the polar ordination, tabular comparisons and principal component analysis, resulted in the classification of vegetation into groups related to environmental and anthropogenic factors.

Dunes are fashioned by the influence of onshore winds which are predominantly north-western. Sand moves inland in a series of transverse dunes. Close to the shore, dunes are relatively small and active. Further inland they become larger and, being more heavily covered by vegetation, tend to become more or less stabilized. They exhibit a typical dune from with gentle windward slopes and steep leeward slopes. In the shelter of stabilized dunes, active deposition of sand in front of steep leeward slopes results in the formation of sand shadows Ayyad (1973). Kamal (1988) distinguished seven main physiographic categories:

i. Sand dunes comprise 5 categories:
   1. Very active baby dunes, lying close to the shore, where erosion and deposition take place are dominated by *Ammophila arenaria,*
   2. Active, partly stabilized dunes, codominated by *Ammophila arenaria*. *Euphorbia paralias*, and *Lotus polyphyllos*,
   3. Stabilized dunes with typical dune form, and where almost no erosion or deposition is taking place are codominated by *Pancratium maritimum* and *Hyoseris lucida*.
   4. Deep protected sand shadows are codominated by *Crucianella maritima, Ononis vaginalis, Echinops spinosissimus and Thymelaea hirsuta*.
   5. Exposed barren rock and escarpment of the coastal ridge, co-dominated by *Deverra triradiata*, *Echiochilon fruticasum* , *Gymnocarpos decandrum*.and *Salvia lanigera*.
   All vegetation groups of both eastern and western provinces of the coastal dunes indicates that the vegetation is co-dominated by *Ammophila arenaria, Euphorbia paralias, Zygophyllum album and Deverra triradiata, sincethese groups* (Kamal, 1988).
ii. The salt marsh is characterized by high density of salt tolerant shrubs (e.g. *Atriplex halimus, Suaeda spp., and Salsola spp*.) .
iii. The rocky ridge habitat is dominated by the subshrub (e.g. *Gymnocarpos decandrum, Anabasis oropediorum* and *A. articulata*, and *Artemisia herba alba).*
iv. The non-saline depression habitat is dominated by *Anabasis articulata Asphodelus ramosus, Plantago albicans, and Thymelaea hirsute.*
v. The inland plateau habitat is dominated by *Thymus capitatus,Globularia arabica*, *Asphodelus ramosus*, *Herniaria hemistemon*, *Scorzonera undulata* and *Deverra tortuosa Plantago albicans,Thymelaea hirsuta*. *Noaea mucronata*, and *Echinops spinosissimus*.

3.1.1 Effect of ploughing on species abundance and diversity

This study focuses on the effect of ploughing on plant abundance, vegetation cover, species richness, and taxonomic diversity during the growing seasons (winter and spring) of 1992 and 2000 in the habitat of inland plateau. Ninety-five species belonging to 27 families were recorded High percentages of life-forms and a large number of species were recorded in ploughed and unploughed stripes in the winter and spring of 2000 (Fig.2). Higher averages of importance values (IVs) and absolute frequencies were recorded for most perennial and annual species in the unploughed stripes compared to the ploughed ones. This may be attributed to crop failure and consequently unfavourable soil conditions. On the other hand, some shrubby species (e.g. *Noaea mucronata* and *Haloxylon coparium*) and perennial herbs

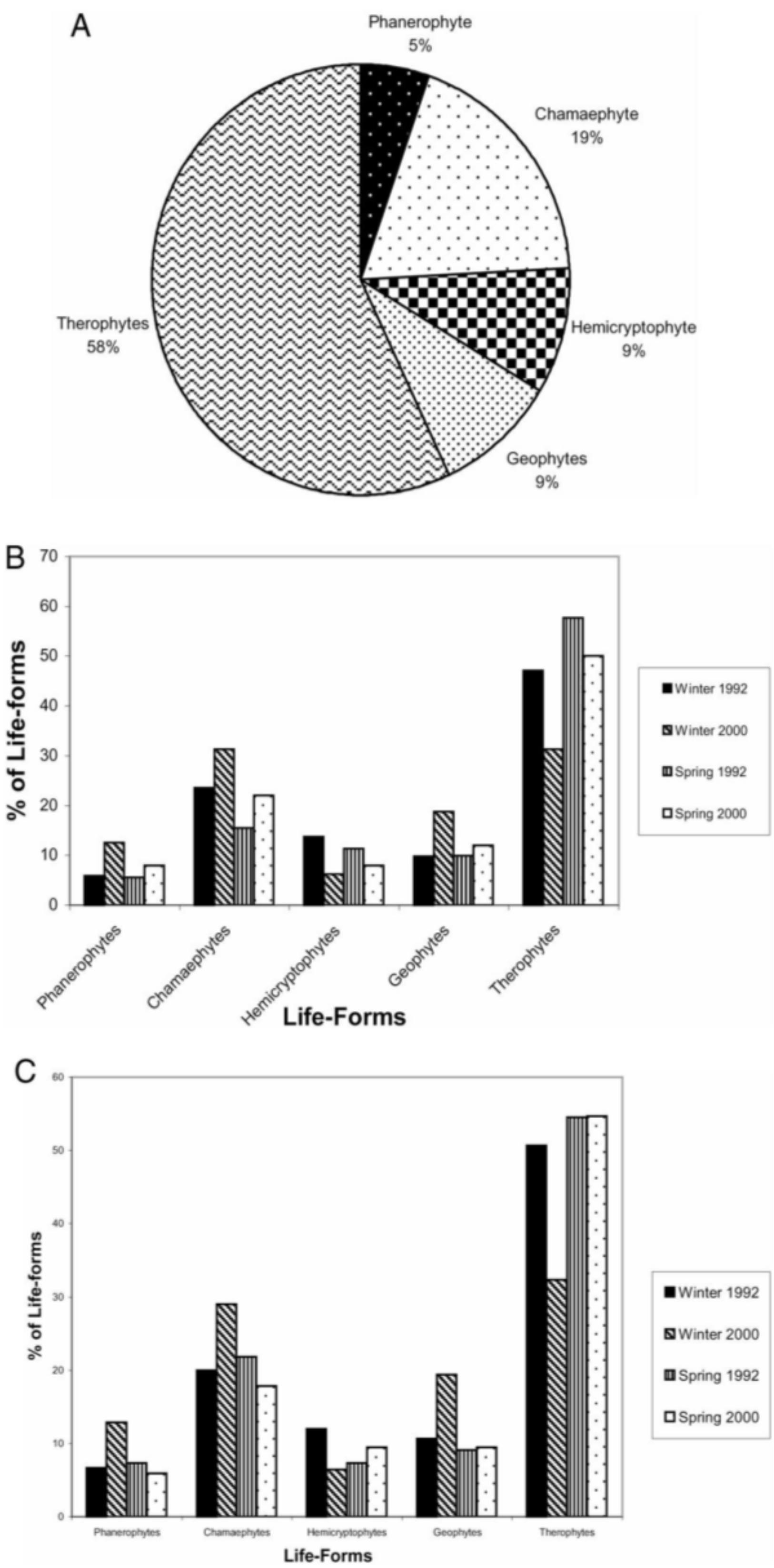


Fig. 2. (A) Different percentages of life forms in the study area. (B) Life form spectrum of the two seasons winter and spring (1992 and 2000) for the ploughed stripes. (C) Life form spectrum of the two seasons winter and spring (1992 and 2000) for the unploughed stripes.

(e.g. *Gynandriris sisyrinchium*) attained higher IVs in the ploughed stripes compared to unploughed ones. This may be attributed to the cultivation of *Prosopis juliflora* trees in the elevated part of the ploughed stripes, which have an ecological role in protecting and enriching the soil with organic matter, thus favouring the growth of these shrubs and perennial herbs. Higher species richness and diversity were associated with low concentration of dominance and low taxonomic diversity in the spring of 2000 in ploughed and unploughed stripes compared to the winter of 1992, for both perennials and annuals. The lowest taxonomic diversities were exhibited in the spring of 2000 for ploughed and unploughed stripes where the vegetation had the largest number of congeneric species and confamilial genera. Higher species richness and diversity characterized the vegetation of the unploughed stripes, especially in winter and spring 2000, as compared to those of ploughed ones. This study also reveals low species richness and diversity of therophytes in winter for both ploughed and unploughed stripes (Kamal et al., 2003).

Species richness and other diversity measures of ploughed and unploughed stripes showed that species richness (Figure 3) was usually high for perennials in the year 2000 in both ploughed and unploughed stripes. It also indicated that the unploughed stripes are substantially the most diverse, as estimated by Shannon's index (H' = 3). The same trend was also notable for annual species (Figure 4). Accordingly the lowest dominance was attained in spring 2000 for ploughed and unploughed stripes.

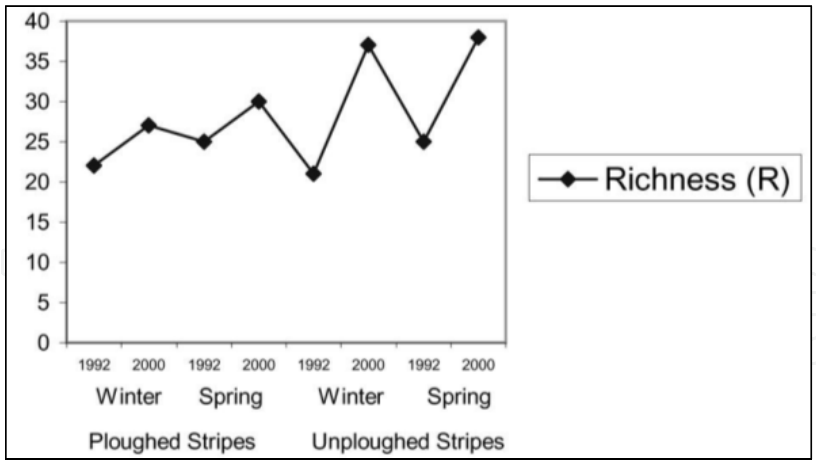
4. Grazing as a major activity

4.1 Existing state

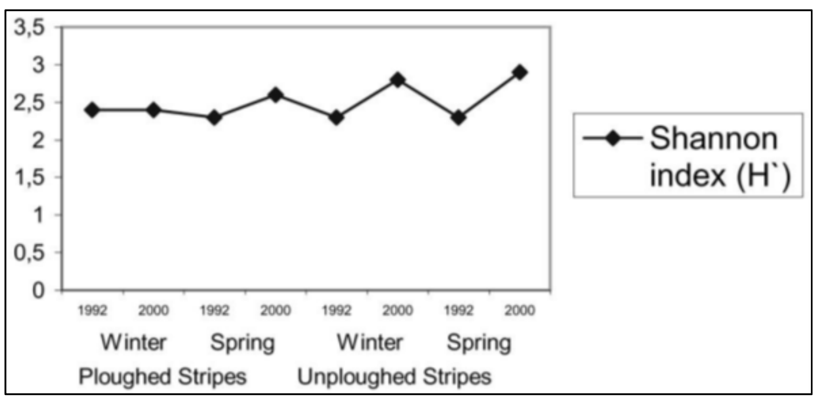
Rangelands constitute about 47% of the total of 332 million hectares. The vegetation resource on these lands is often sparse and droughty. Therefore these lands often require extra measures of management in order to provide forage and wildlife habitat as well as uses on a sustained yield basis (Tueller, 1988).

Generally, one of the most common forms of land use in the western Mediterranean coastal region of Egypt is animal husbandry. Its contribution to the livelihood of Bedouin increases from west of Alexandria to Sallum (border of Egypt). The natural vegetation includes many species of annuals, mostly herbs and a few grasses, perennial herbs, shrubs, sub-shrubs, and a few trees. These species represent 50% of the total flora of Egypt. The botanical composition is spatially heterogeneous depending on soil fertility, topography, and climatologically conditions but with sub-shrubs dominating the vegetation (Ayyad and Ghabbour, 1977). The composition of growth forms in the region expresses a typical desert flora. The majority of species are either annuals (ephemerals) or geophytes (perennial ephermeroid herbs and grasses). Both are "drought evaders" in the sense that the whole plant or the greater part of the photosynthetically active and transpiring (above ground) organs are shed during the rainy season. The majority of other perennials in the study area are evergreen shrubs or sub-shrubs (Chamaephytes).

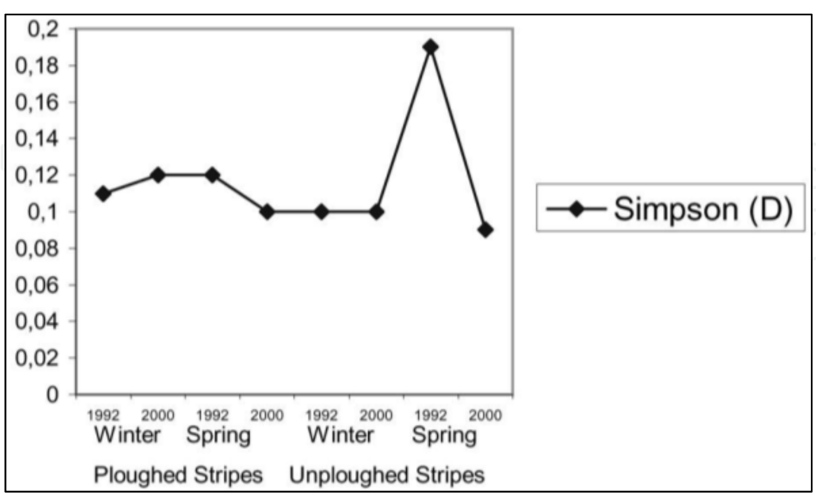
There are three major land uses in the dry lands: rangelands, rain- fed cropland and irrigated land. The following table shows generally about 88% of the dry lands are used as rangelands, 9% are rain-fed croplands, and 3% are irrigated lands in the arid, semi-arid and dry sub-humid climatic zones.



(a)

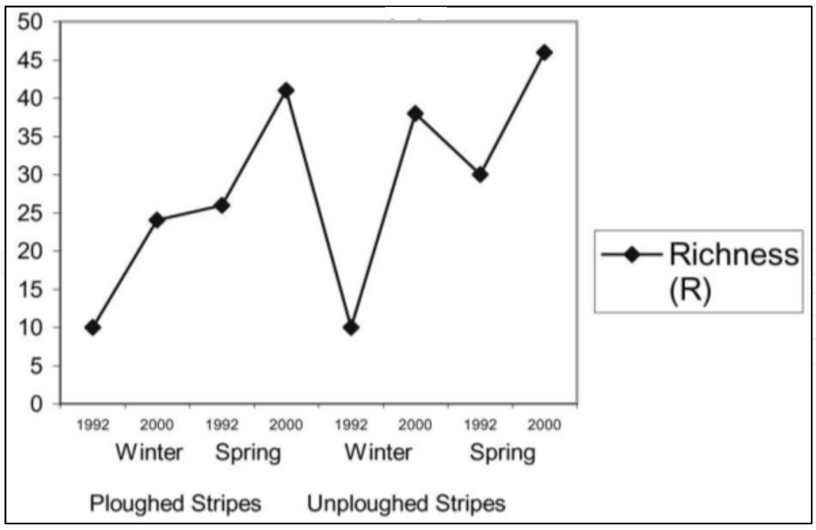


(b)

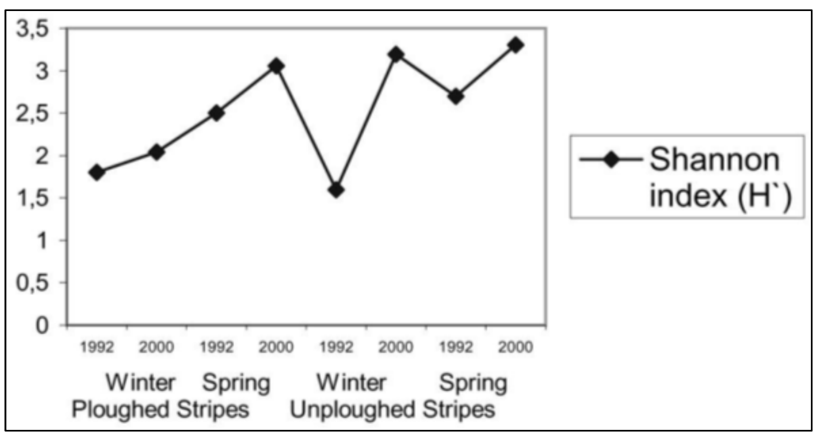


(c)

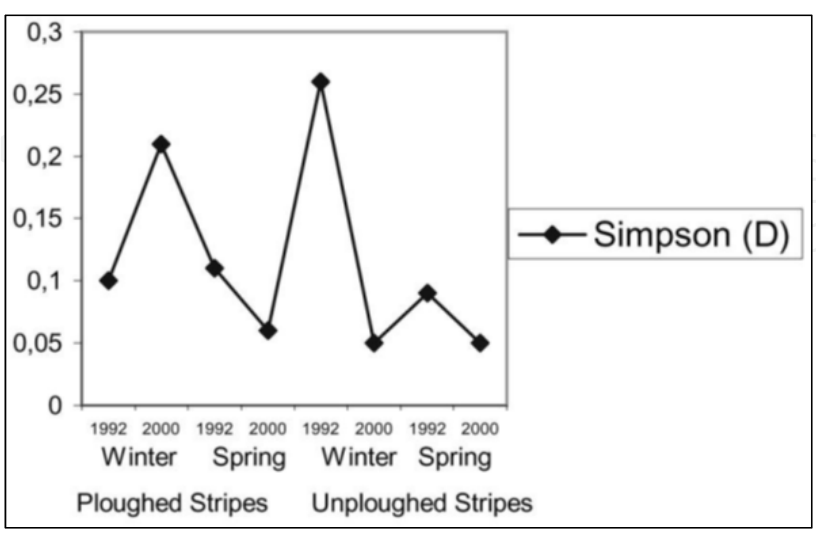
Fig. 3. Diversity indices for ploughed and unploughed stripes (winter and spring of 1992 and 2000) for perennial species. (a) Species richness; (b) Shannon Index; (c) Simpson Index.



(a)



(b)



(c)

Fig. 4. Diversity indices for ploughed and unploughed stripes (winter and spring of 1992 and 2000) for annual species. (a) Species richness; (b) Shannon Index; (c) Simpson Index

Land use area in global dry lands

Type of land use	Area (Hectare)
Rangeland	4,550,000,000
Rain-fed cropland	457,000,000
Irrigated land	145,000,000
Total Area	5,152,000,000

Some of most common rangeland species in the Mediterranean coastal region are *Anabasis articulata, A. oropediorum, Artemisia monosperma, A. herba-alba, Asphodelus ramosis. Convolvulus lanatus, Carduncellus eriocephalus, Eciochilon fruticosum, Echinops spinosissimus, Gymnocarpos decandrum, Helianthemum lippii, H. kahiricum, Lycium europaeum, Noaea mucronata. Deverra triradiata. Periploca aphylla, Scorzonera alexandrina, and Thymelaea hirsuta.*

Table 1 shows a list of plant species with different life-forms, in El-Omayed Biosphere Reserve (Heneidy, 1992).

Species	Life-form	*Pala.*	*Species*	Life-form	Pala.
1- *Achilla santolina*	Ch.	P	87- *Hippocrepis cyclocarpa*	Th.	P
2- *Adonis dentatus*	Th.	LP	88- *Hordium marinum*	Th.	HP
3- *Aegialophia pumila*	Ch.	HP	89- *Hyoscyamus muticus*	Ch.	NP
4- *Aegilops kotschyi*	Th.	HP	90- *Hyoseris lucida*	Th.	P
5—*Ajuga iva*	Geo.	P	91- *Hyoseris scarba*	Th.	P
6- *Aeluropus lagopoides*	Ch.	HP	92- *Ifloga spicata*	Th.	HP
7- *Alhagi graecorum*	Ch.	HP	93- *Imperata cylindrica*	Geo.	P
8- *Alkanna tinctoria*	Ch.	P	94- *Iris sisyrinchium*	Geo.	LP
9- *Allium sp.*	Geo.	LP	95- *Juncus acutus*	Geo.	HP
10- *Ammi visnaga*	Th.	P	96- *Juncus rigidus*	Geo.	HP
11- *Ammophila arenaria*	Ch.	NP	97- *Kickxia aegyptiaca*	Ch.	HP
12- *Anabasis articulata*	Ch.	P	98- *Kochia indica*	Th.	P
13- *Anabasis oropediorum*	Ch.	HP	99- *Lactuca serriola*	Bi.	P
14- *Anacyclus alexandrinus*	Th.	P	100- *Launaea nudicaulis*	Ch.	HP
15- *Anagalis arvensis*	Th.	P	101- *Launaea resedifolia*	Th.	HP
16- *Anchusa azurea*	Th.	P	102- *Limoniastrum monopetalum*	Ch.	LP
17- *Anthemis retusa*	Th.	P	103- *Limonium tubiflorum*	Ch.	LP
18- *Argyrolobium abyssinicum*	Ch.	HP	104- *Lobularia arabica*	Th.	P
19- *Arisarum vulgare*	Geo.	LP	105- *Lobularia maritima*	Ch.	P
20- *Artemisia herba-alba*	Ch.	HP	106- *Lolium perenne*	Geo.	HP
21- *Artemisia monosperma*	Ch.	P	107- *Lotus creticus*	Ch.	P
22- *Arthrocnemum glaucum*	Ch.	P	108- *Lotus polyphyllos*	Ch.	P
23- *Asparagus stipularis*	Ch.	LP	109- *Lycium shawii*	Ch.	HP
24- *Asphodelus ramosus*	Geo.	HP	110- *Lygeum spartum*	Geo.	HP
25-*Astenatherum forsskalii*	Ch.	P	111- *Malva parviflora*	Th.	P
26- *Astragalus spinosus*	Ch.	HP	112- *Marrubium vulgare*	Ch.	LP

Species	Life-form	*Pala.*	*Species*	Life-form	Pala.
27- *Atractylis carduus*	Ch.	P	113- *Melilotus indicus*	Th.	P
28- *Atriplex halimus*	Ph.	P	114- *Moltkiopsis ciliata*	Ch.	HP
29- *Avena barbata*	Th.	P	115- *Narcissus tazetta*	Ch.	LP
30- *Avena sativa*	Th.	P	116- *Noaea mucronata*	Ch.	HP
31- *Bassia muricata*	Th.	LP	117- *Ononis vaginalis*	Ch.	LP
32- *Brassica tournefortii*	Th.	P	118- *Onopordum alexandrinum*	Bi.	LP
33- *Bromus rubens*	Th.	HP	119-*Ornithogalum trichophyllum.*	Ch.	LP
34-*Bupleurum semicompositum*	Th.	P	120- *Otanthus maritimus*	Ch.	LP
35- *Cakile maritima*	Th.	P	121- *Pancratium maritimum*	Geo.	LP
36- *Carduncellus eriocephalus*	Ch.	HP	122- *Pancratium sickenbergeri*	Geo.	LP
37- *Carrichtera annua*	Th.	P	123- *Papaver rhoeas*	Th.	LP
38- *Carthamus lanatus*	Ch.	P	124- *Paronchia argentea*	Ch.	P
39- *Centaurea alexandrina*	Th.	P	125- *Peganum harmala*	Ch.	NP
40- *Centaurea calcttrapa*	Th.	P	126- *Phagnalon schweinfurthii*	Ch.	P
41- *Centaurea glomerata*	Th.	P	127- *Phlomis floccosa*	Ch.	LP
42- *Chenopodium murale*	Th.	NP	128- *Phragmites australis*	Geo.	P
43-*Chrysanthemum coronarium*	Th.	LP	129- *Deverra triradiata*	Ch.	HP
44- *Citrullus colocynthis*	Ch.	NP	130- *Plantago albicans*	Geo.	HP
45- *Cleome africana*	Ch.	NP	131- *Plantago crypsoides*	Th.	P
46- *Colchicum ritchi*i	Ch.	NP	132- *Plantago major*	Ch.	P
47- *Convolvulus althaeoides*	Ch.	P	133- *Polygonum equisetiforme*	Ch.	P
48- *Convolvulus arvensis*	Ch.	LP	134- *Polygonum maritimum*	Ch.	P
49- *Convolvulus lanatus*	Ch.	HP	135- *Prasium majus*	Ch.	HP
50- *Conyza linifolia*	Th.	P	136- *Reaumuria hirtella*	Ch.	LP
51- *Cressa cretica*	Ch.	LP	137- *Reseda decursiva*	Bi.	P
52- *Crucianella maritima*	Ch.	NP	138- *Retama raetam*	Ch.	LP
53- *Cuscuta planifolora*	Th.	NP	139- *Rumex pictus*	Th.	HP
54- *Cutandia dichotoma*	Th.	HP	140- *Rumex vesicarius*	Th.	P
55- *Cynodon dactylon*	Geo.	HP	141- *Salicomia fruticosa*	Ch.	LP
56- *Cyperus rotundus*	Geo.	LP	142- *Salsola longifolia*	Ch.	LP
57- *Dactylis glomerata*	Geo.	HP	143- *Salsola tetragona*	Ch.	HP
58- *Ebenus armitgei*	Ch.	HP	144- *Salsola tetrandra*	Ch.	P
59- *Echinops spinosissimus*	Ch.	HP	145- *Salsola volkensii*	Ch.	LP
60- *Echiochilon fruticosum*	Ch.	HP	146- *Salvia aegyptiaca*	Ch.	HP
61- *Echium sericeum*	Ch.	LP	147- *Salvia lanigera*	Ch.	HP
62- *Elymus farctus*	Geo.	P	148- *Scorzonera alexandrina*	Geo.	HP
63- *Emex spinosus*	Th.	P	149- *Senecio vulgaris*	Th.	P
64- *Eminium spiculatum*	Geo.	NP	150- *Silybum marianum*	Ch.	P
65- *Ephedra alata*	Ch.	NP	151- *Solanum nigrum*	Th.	LP
66- *Erodium cicutarium*	Th.	P	152- *Stipa capensis*	Th.	P
67- *Eryngium campestre*	Ch.	LP	153- *Stipa-grosts ciliata*	Geo.	HP

Species	Life-form	*Pala.*	*Species*	Life-form	Pala.
68- *Euphorbia bivonae*	Ch.	P	154- *Suaeda pruinosa*	Ch.	LP
69- *Euphorbia granulata*	Th.	NP	155- *Suaeda vera*	Ch.	LP
70- *Euphorbia helioscopia*	Th.	LP	156- *Tamarix nilotica*	Ph.	LP
71- *Euphorbia paralias*	Ch.	NP	157- *Teucrium polium*	Ch.	P
72- *Euphorbia peplis*	Th.	LP	158- *Thymelaea hirsuta*	Ch.	P
73- *Fagonia arabica*	Ch.	NP	159- *Thymus capitatus*	Ch.	P
74- *Filago desertorum*	Th.	HP	160- *Tribulus terrestris*	Th.	LP
75- *Foeniculum vulgare*	Ch.	P	161- *Trigonella stellata*	Th.	HP
76- *Frankenia revoluta*	Ch	LP	162- *Typha domingensis*	Geo.	NP
77- *Fumana thymifolia*	Ch.	LP	163- *Urginea undulata*	Geo.	NP
78- *Fumaria parviflora*	Th.	LP	164- *Urtica urens*	Th.	LP
79- *Globularia arabica*	Ch.	P	165- *Vaccaria pyramidata*	Th.	LP
80- *Gymnocarpos decandrum*	Ch.	HP	166- *Varthemia candicans*	Ch.	P
81- *Halocnemum strobilaceum*	Ch.	LP	167- *Verbascum tetoumeurii*	Bi.	LP
82- *Haplophyllum tuberculatum*	Ch.	LP	168- *Vicia sativa*	Th.	P
83- *Helianthemum kahiricum*	Ch.	HP	169- *Zilla spinosa*	Ch.	P
84- *Helianthemum lippii*	Ch.	HP	171- *Zygophyllum album*	Ch.	NP
85- *Herinaria hemistemon*	Ch.	LP			
86- *Hippocrepis bicontorta*	Th.	P			

Table 1. Wild plant species recorded in Omayed Biosphere Reserve.
Ch. = Chymophytes, Th. =Therophytes, Ph. Phanerophytes, and Geo. = Geophytes.
Pala.= Palatability, P. = Palatable, HP. = High palatable, LP.= Low palatability,
NP.= unpalatable, Bi.= Biennial, and *Asphodelus microcarpus* = *A. ramosus* = *A. aestivus*
(After Heneidy, 2002a).

4.1.1 Palatability and preference

Palatability of range land species is a very complex notion, very difficult to generalize as it is linked to many factors that vary in time and place. Some of these variables are linked to the plant, other to the animal, while a third category depends on various environmental factors (Heneidy, 1992, 1996: Le Houéou, 1994). In the north western Mediterranean region, Heneidy (1992) recorded that the temperature is the most effective factors on the animal behaviour. One approach to recording food selectively is based on observation of feeding animals (Bjustad et al., 1970). Grazing animals change their behaviour, and hence their food preferences in relation to differences in temperature and rainfall (Castle and Halley, 1953). Given a free choice, herbivores exhibit marked preferences amongst the available foods but will rarely eat one food to the exclusion of all others. Selectivity of herbage expresses the degree to which animals harvest plants or plant parts differently from random removal. Van Dyne and Heady (1965) use ratios between the proportion of any species, part of plant, or group of plants in the diet, and the proportion of that item in the herbage available to the animal as an expression of relative preference (or selectivity ratio). Using such ratios for the vegetation of the present study has resulted in ranking of perennial species growing in the different habitats during spring as follows (Table 2).

It is interesting to note that species with the highest ranks of relative preference are those with relatively lower availability or abundance. For example, *P. albicans* is the species with the highest selectivity ratio in the habitats where it grows. It's share in the diet selected by animals in season of maximum consumption is more than fourfold its share in the available forage for the animals. This species represents less than 5% of the grazeable phytomass in the range, but as high as about 22% of the diet consumed. This is also true in the case of *H. lippii* which provides available forage not more than 7%, while it contributes up to 19% of the animal diet especially in the ridge habitat. On the other hand, the species ranked as of lower selectivity ratio are those which are more available or abundant in the ridge. Fore example, *E. fruticosum* has a proportion in the animal diet (about 13%) of one third its proportion in the available forage (about 40%). Le Houéou (1980a) discusses such relationship between palatability and abundance, and states that all other attributes being equal, the palatability of a given taxon is inversely related to its abundance in the range, except for a few species which are specially relished in all circumstances. *A. microcarpus* in the present study represents such species whose selectivity by animals is independent of their abundance on the range. It's selectivity is related more to the phenological development of the plant. Consequently, its highest selectivity ratio is attained during winter at the phase of flower bud development. At this phase, the animals consume much of these flower buds (up to 40% of the diet), while they represent not more than 4% of the available forage. On the other hand, when the above-ground shoot of *A. microcarpus* dries up during and summer and autumn, it provides about 30% of the material available for grazing and constitutes more than 50% of the animal diet.

Rank	Non-saline depression		Ridge		Inland plateau	
	Species	Selectivity ratio	Species	Selectivity ratio	Species	Selectivity ratio
1	*Plantago albicans*	4.69	*H. lippii*	2.69	*P. albicans*	5.02
2	*Helianthemum lippii*	3.81	*G. decandrum*	2.36	*A. microcarpus*	3.09
3	*Asphodelus ramosus*	2.23	*A. ramosus*	1.78	*H. lippii*	1.50
4	*Gymnocarpos decandrum*	0.82	*A. articulata*	0.87	*G. decandrum*	1.27
5	*Anabasis articulata*	0.47	*T. hirsuta*	0.19	*E. fruticosum*	0.34
6	*Eiochilon fruticosum*	0.30	--		*A. articulata*	0.29
7	*Thymelaea hirsuta*	0.16	--		*T. hirsuta*	0.11

Table 2. Relative preference (or selectivity ratio) in OBR (After Abdel-Razik et al., 1988a).

Many studies (e.g. Cook, 1972; Dicko-Toure, 1980; Le Houéou, 1980b) refer to the relationship between palatability of a given species or taxon, its stage of development (phenology), its relative abundance on the rangeland, and its chemical composition. Cowlishow and Alder (1960) assert that palatability of a given species changes because of changing characteristics that an animal can recognize by its senses of sight, taste and smell. Table 2 shows a list of plant species and their palatability in Omayed Biosphere Reserve. 63% of these species are palatable while, 42% of them are highly palatable.

5. Biomass and productivity

El-Kady (1980) estimated the effect of protection and controlled grazing on the vegetation composition and productivity as well as the rate of consumption of phytomass by domestic animals and their grazing behavior, in the ecosystem of non-saline depression. Plots were fenced and different grazing pressures were applied in the vegetation in these plots. Changes in the density, cover, frequency, phytomass and the phenological sequence of species were recorded and compared to those of the same species outside the fenced plots. Remarkable increases were recorded in total density and cover of perennials, in frequency and presence of animals, and in phytomass as a result of protection and controlled grazing. It was concluded that partial protection and controlled grazing could be of better consequence than full protection: light nibbling and removal of standing dead by domestic animals may promote vigor and growth of defoliated plants, and the availability of nutrients may be enhanced by the passage of herbage through their guts and out as feces.

Heneidy (1992) reported that the annual above-ground dry matter production of the rangeland at Omayed area in the different habitats were about 2833 kg/ha in the non-saline depression, 1448 kg/ha in the ridge, and 4416 kg/ha on the inland plateau habitats. In general preliminary field observations on the behaviour of grazing animals indicated that almost all the consumed forage is contributed by sixteen perennial species (most common) and annuals (Table 3) throughout the year. In general the total phytomass of new growth was highest in the habitat of the inland plateau, and lowest in the ridge habitat.

Habitat	**Non-saline depression**			**Ridge**			**Inland plateau**		
	Above-ground		**Below-ground**	**Above-ground**		**Below-ground**	**Above-ground**		**Below-ground**
Asphodelus ramosus	71.43	**28.6**	35.29	7.94	**16.2**	14.13	87.11	**39**	43.15
Plantago albicans	7.82	**4.8**	3.08	--		--	12.47	**9**	3.11
Carduncellus eriocephalus	3.53	**0.8**	0.89	--		--	--		--
Echinops spinosissimus	--		--	0.89	**0.6**	0.61	0.66	**0.4**	0.28
Scorzonera alexandrina	--		--	10.95	**2.9**	7.98	3.37	**0.8**	2.53
Echiochilon fruticosum	107.08	**21.1**	15.91	--		--	69.6	**21**	10.83
Helianthemum lippii	7.5	**4.5**	1.47	6.6	**3.9**	1.3	10.22	**7.3**	1.58
Gymnocarpos decandrum	51.87	**5.0**	5.75	53.8	**6.9**	5.76	60.74	**8.0**	7.49
Deverra triradiana	2.89	**0.59**	0.45	10.61	**3.6**	2.93	8.52	**2.1**	0.63
Convolvulus lanatus	12.69	**2.3**	0.18	--		--	16.2	**2.2**	1.66
Noaea mucronata	4.29	**1.3**	0.85	20.0	**5.6**	3.74	21.6	**1.9**	2.89
Artemisia monosperma	28.59	**9.5**	5.39	--		--	--		--
Artemisia herba alba	--		--	5.98	**0.24**	1.84	4.38	**0.1**	0.88
Anabasis articulata	411.9	**92.4**	74.32	111.6	**23**	26.39	1011	**251**	96.79
Anabasis oropediorm	--		--	13.53	**3.1**	2.73	15.9	**3.8**	2.94
Thymelaea hirsuta	826.7	**104**	414.8	382.73	**39**	231.67	1160	**99**	77.5
Annuals	2.3	**2.3**	--	0.9	**0.9**	--	1.13	**1.13**	--

Table 3. The total standing crop phytomass (old organs + new-growths) and below-ground biomass (gm/dr.wt/m²) of different organs of species in the different habitats at Omayed. Above-ground (old organs + new growths), Bold value = New growths (grazeable parts).

In general the total phytomass accessible to grazing animals (kg/ha} varied remarkably with season and habitats, from a minimum of 308 kg/ha in the ridge habitat to maximum of 1543 kg/ha in the habitat of inland plateau. Inland plateau habitat is characterized by (1) Remarkably higher annual production (Accessible); (2) Remarkably higher nutritive value; and

(3) Presence of palatable species (browse species) e.g. *Astragallus spinosis, Anabasis oropediorum, Salsola tetragona, Lygeum spartum* and *Lycium europaeum* (Plate 1). Therefore, it is recommended that the shepherds should extend the grazing area further to the inland habitat.

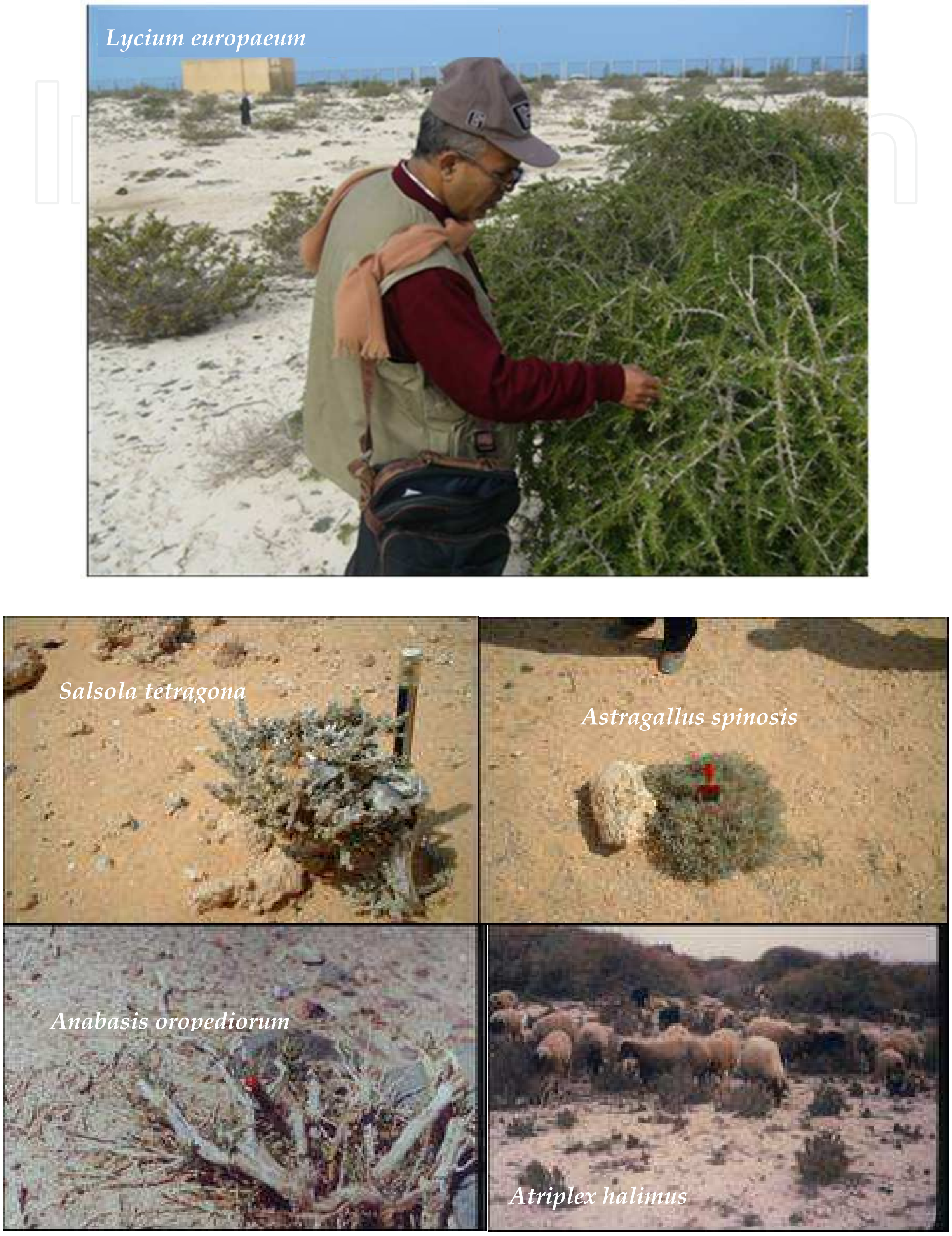


Plate 1. *Overgrazing of highly palatable species (*After Heneidy, 2003b)

The highest contribution by perennial herbs in all habitats was attained during winter and spring (13%, and 10.9% in the none-saline depression, 12.7% and 13.5% on the ridge, and 9.5% and 8.3% on the inland plateau). On the other hand, the maximum contribution by most subshrubs was attained during spring. The contributions by subshrubs in the habitats of non-saline depression, the ridge and the inland plateau in spring were 15%, 14.5% and 10.1% respectively.

5.1 Accessible (consumable) biomass

The accessible dry matter production of the subshrubs and forbs together (maximum values of the different seasons) is estimated by Heneidy (1992) as about 741 kg/ha/yr in the non-saline depression, 371 kg/ha/yr on the ridge and 745 kg/ha/ yr on the inland plateau (average of 677 kg/ha/yr, equivalent to about 4.5 kg/ha/yr/mm rainfall). For sub-shrubs te accessible dry matter production represents about 4,5, and 2% of total above-ground phytomass in the non-saline depression, on the ridge and on the inland plateau respectively, while they contribute about 30,20, and 19% to the amount of consumable forage in the tree habitats respectively. On the other hand, The accessible dry matter production of forbs represents about 4,6 and 3% of total above-ground phytomass in the non-saline depression, on the ridge and on the inland plateau, while they contribute about 31, 34 and 27% to the amount of consumable forage in these habitats respectively. The accessible dry matter production of shrubs is about 491, 253, and 879 kg/ha/yr in the three habitats respectively (average of 554 kg/ha/yr, equivalent to about 3.7 kg/ha/yr/mm rainfall). The accessible dry matter production of the large shrubs represents about 5,7, and 6% of total above-ground phytomass in the non-saline depression, on the ridge and on the inland plateau respectively, although they contribute about 10, 39 and 11% to the amount of consumed forage in the three habitats respectively (the higher percent of contribution of shrubs to the diet on the ridge is due to the presence of the highly palatable species (*Anabasis oropediorum*). This indicates that the shrubs form the skeletal structure of the community, provide the needs for the long term conservation, and share in the annual cycling of material through the food chain. The above mentioned results indicate that a relatively high annual primary production is provided by the rangeland under study (about 3016 kg/ha, equivalent to 20.0 kg/ha/yr/mm rainfall), most of which is used to build up the ligneous structural component of the plant community. Only about 18.4% of the total above–ground annual production is accessible to the grazing animals. Heneidy (1995) reported that the accessible biomass in the different habitats in the east of Matrouh (rocky plateau as about 436, flat plateau is 292, rocky ridge is 620, non-saline depression is 776, and saline depression is 393 kg/ha.). Table 4 summarizes the biomass and accessible parts in the different habitats during the two seasons. The highest total above-ground phytomass of the vegetation is produced in the rocky ridge during the wet season (1897 ± 843 kg ha^{-1}) where, the contribution of perennials is 86% while the lowest is in the saline depression (675 ± 22.9 kg ha^{-1}) where the contribution of perennials is 91%. However, the highest accessible parts are produced in the non-saline depression 864 ± 35 and 400 ± 64.3 kg ha^{-1} during wet and dry seasons respectively. Table 5 showed the RUE for primary production level as an average and accessible production of different habitats.

Habitat		Rocky plateau	Flat plateau	Rocky ridge	Non-saline depression	Saline depression
T.A.G	Spring	1053 ± 110	1347 ±176	1897 ± 843	1427 ± 68	675 ± 22.9
	Summer	637 ± 92.8	733 ± 66	796 ± 186	881 ±126	557 ± 53
Accessible biomass	Spring	510 ± 41	708 ± 69	744 ± 188	864 ± 35	356 ± 23.6
	Summer	199 ± 22.6	218 ± 22	231 ± 34	400 ± 64.3	208 ± 26.2

Table 4. Total above-ground (TAG) biomass and accessible biomass (mean ± standard error (SE) kg ha^{-1}) in different habitats during the two seasons.

Habitat	Rocky plateau	Flat plateau	Rocky ridge	Non-saline depression	Saline depression
NPP (kg ha^{-1}yr^{-1})	412.7 ± 78.5	668.9 ± 185.2	1083 ± 674	547.4 ± 73.4	169 ± 5.30
Rainfall (mm)	77.8 ± 13.7	59.9 ± 13	75.2 ± 11	74.7 ± 14.5	107.3 ± 9.2
Accessible (kg ha^{-1}yr^{-1})	309.8 ± 32.2	488 ± 68.2	499 ± 165	471 ± 69.7	149.5 ± 1.8
RUE to primary production	5.3	11.2	14.4	7.3	1.6
RUE to accessible	3.9	7.5	6.6	6.3	1.4

Table 5. The net primary production (NPP), accessible production (mean ± SE as kg ha^{-1} yr^{-1} mm^{-1}) and rain use efficiency (RUE) of different habitats.

The primary productivity of the pasture in different habitats ranges from 169 ± 5.3 to 1083 ± 674 kg ha^{-1} yr^{-1} in habitats of the saline depression and rocky ridges respectively. The accessible production level reached its maximum in the habitats of rocky ridge (449 ± 165 kg ha^{-1} yr^{-1}) while the minimum is attained in the saline depression (149.5 ± 1.8 kg ha^{-1} yr^{-1}).

Measurement of plant biomass or productivity has been of interest to range workers and ecologists for some times because herbivores depend directory upon plant biomass for their food (Milner and Hughes, 1970). On the other hand, any ecological argument in land use planning in arid rangelands should be based on a through knowledge of the harvestable primary productivity. Study of the vegetation by Heneidy, (2002a) indicated that it consists of 39 perennial species and 43 annuals. The grazeable (mostly new-growth) phytomass is either accessible or non-accessible to the grazing animals due to morphological configuration of the plant. A portion of the accessible phytomass is actually grazed and another portion is left over (Heneidy, 1992). The study also reveals that the study area is vegetitionaly rich and the woody species are the most abundant life-forms. The woody species are considered the skeletal part of the grazing system in arid ecosystem (Abdel – Razik et al., 1988a). The grazing system represents 60 to 80% of the utilization land of North Africa area in terms of economic output (Le Houèrou, 1993). In the study area most of the land is used as grazing land.

Most perennial species exhibit their greatest vegetative activity during winter and spring, and they are less active or dormant during summer. This observation agrees with that noticed by Abdel-Razik et al. (1988a) at Omayed in the northwestern region. However, some shrubs and sub-shrubs are active throughout the whole year. These species are more conservative in the use of their own resources, especially soil moisture and have developed a root system that is capable of exploiting soil moisture and minerals from a large volume of soil and at depth that is permanently wet, which in-turn enables them to extend their activities under conditions of moisture stress Ayyad et al. (1983). This behavior of plant species occurs in some species in the study area. This type of species plays an important role in the sustainable production of the natural forage of the pasture.

(Noy-Meir, 1973) suggested that the bulk of primary standing biomass of the community in semi-arid regions is made up of woody life-forms. This means that accessible parts do not depend upon the primary above-ground phytomass, but depend upon the configuration and morphological shape of the species and their life-forms (Heneidy, 1992). Fritzi and Bradley, (1992) recorded that the production level of herbivores may depend more upon plant architecture than on the particular species of natural enemies present.

The annual average of the primary production in the western desert was 590 ± 117 kg ha^{-1} yr^{-1}, while the accessible production was 410 ± 39 kg ha^{-1} yr^{-1}, compared with that of the woody steeps in arid zones which ranges from 300 to 600 kg ha^{-1} yr^{-1} (Le Houérou, 1972). This value is less than that obtained by Abdel-Razik et al. (1988a) and Heneidy (1992) at Omayed in the coastal region (668 and 720 kg ha^{-1} respectively). However, the average of annual forage yield in the saline depression habitat in coastal region was 1560 kg/ha (Heneidy and Bidak 1996) which is three times higher .

The RUE factor is the quotient of annual primary production by annual rainfall. RUE tends to decrease when aridity increases together with the rate of useful rains, and as potential evapotranspiration increases. But it also strongly depends on soil condition and, more than anything, on vegetation condition particularly on its dynamic status. It thus greatly relies on human and animal impact on the ecosystems. The RUE is a good indicator of ecosystem productivity (Le Houérou, 1984).

The average of accessible dry matter production per mm rainfall ranges from 7.5 to 1.4 kg ha^{-1} yr^{-1} in the habitats of flat plateau and the saline depression respectively. The average Rain Use Efficiency (RUE) was 5.1 kg ha^{-1} yr^{-1} mm^{-1} for accessible production while for primary production was 10 kg ha^{-1} yr^{-1} mm^{-1}. In Comparison, the average of the grazeable dry matter production per mm rainfall at Omayed area is 4.8 kg ha^{-1} yr^{-1} (Abdel-Razik et al., 1988a) while that average of RUE was 10.4 kg ha^{-1} yr^{-1} mm^{-1} at salt marshes in the coastal region (Heneidy and Bidak 1996). Actual RUE figures throughout the arid zones of the world may vary from less than 0.5 in depleted subdeseric ecosystems to over 10 in highly productive and well managed stepped (Le Houérou, 1984).

Generally, the great variations in the productivity levels in different sites are due to variations in soil, climate, vegetation types, and grazing pressure. Consequently Coefficient of Variation (CV) was taken as a measure of this relative variation in production responsiveness at different sites. Calculated CV of the primary production (1.2) indicates that there is a great variation between sites. This variation does not depend upon rainfall and only may hide other factors as mention above (e.g. life-forms, soil condition, topography and human impact ..etc). This result agrees with results obtained by Le Houérou (1988) where he assessed that variability in primary production does not depend only on rainfall, but also on ecosystem dynamic, soil surface condition and texture. The following Table summarizes the average of the primary, production and accessible production ± SE on one hand, and RUE, carrying capacity (CC), Coefficient of Variation (CV), Production to Rain Variability Ratio (P/RVR) on the other hand.

Item	Average value	Rain Use Efficiency (RUE)	P/RVR	CV	Carrying capacity ha/ head	
					Range	Mean ± S.E
Primary production (kgd.wt.ha^{-1} yr^{-1}) ± S.E	590 ± 117	8.7	2.4	1.2	0.5 – 4.4	1.7 ± 0.17
Accessible production (kgd.wt.ha^{-1} yr^{-1}) ± S.E	388 ±35	5.1	1.1	0.54		
The rainfall (mm) ± S.E	75.4 ± 6.7	--	--	0.5		

Carrying capacity ranged from 0.5 to 4.4 ha head^{-1}. The variability of annual production was 1.2 times that of the variability of annual precipitation. Production to Rain Variability Ratio (P/RVR) averages 2.4 world-wide in primary production than in accessible. Conversely, P/RVR increases when rainfall decreases and with ecosystem degradation. Finally natural vegetation is affected by rainfall variability in its composition, structures, morphology, ecophysiological adaptation and physiological processes. RUE decreases with rainfall and with the depletion status of the ecosystem (biomass, permanent ground cover, organic matter, microbial activity), (Le Houérou, 1988).

The relative highly annual production of the range land under study as compared to the average production of North Africa which varies between 200 ton ha^{-1} yr^{-1} (Le Houérou, 1975 and Sarson & Salmon, 1977) may be attributed to the fact that its vegetation is composed mainly of perennials that can exploit moisture substantial at deep layers of the soil. It is also represents a good production level if compared with the production level at Omayed area 80 km west of Alexandria (Heneidy, 1992). However, this area needs more studies and a good plan for improvement as rangeland within the carrying capacity of the ecosystem, for a sustainable development.

5.2 Biomass and production in the three main habitats

Heneidy (1992) reported that the annual above-ground dry matter production of the rangeland at Omayed area in different habitats was about 3833 kg/ha in the non-saline depression, 1448 kg/ha in the ridge, and 4416 kg/ha on the inland plateau habitats. In general preliminary field observations on the behaviour of grazing animals indicated that almost all the consumed forage is contributed by sixteen perennials (Table 3) throughout the year. In general the total phytomass of new growth is highest in the habitat of the inland plateau, and lowest in the ridge habitat are summarized in the following Table:

Production kg/ha/yr.		
Habitat		
None-saline depression	Ridge	Inland Plateau
3833	1448	4416
Accessible		
----	308	1543

5.3 Necromass

Generally, pasture production depends, among various factors, on the type and intensity of management, e.g. grazing pattern and stocking rate. Such practices can significantly influence species, life-form and growth-form of plants. Herbivory can also affect the structure and functioning of the community. Therefore, a relatively large proportion of annual productivity is either incorporated in ligneous parts of standing dead material near the end of growth period, since most of species, except the evergreen shrubs, are dormant during the dry summer season. Besides, intense defoliation during the growing season may conserve sufficient soil moisture to allow for adequate growth during the late season even during years with below average precipitation. Therefore, it may be concluded that the accessible forage in the area can support at least three fold the present stocking rate, provided that the supplementary feed be also tripled. In general, the contribution of shrubs to the consumed diet on the ridge habitat is higher than that in the non-saline depression and the inland plateau habitats. Conversely, the contribution of annuals in the non-saline depression is much higher compared to those in the other habitats. In detail the average necromass (Kg/ha) exhibited notable variations with habitat and season (Table 6). For example in the non-saline depression it varied between 46.2 kg/ha in summer and 262.2 kg/ha in autumn, on the ridge it varied between 14.4 kg/ha in spring and 159 kg/ha in autumn, and on the inland plateau it varied between 20.7 kg/ha in soring and 156.6 kg/ha in summer. It may be noted that most of the litter was contributed by shrubs and subshrubs. The annual rate of litter production is about 465, 174 and 177 kg/ha in the non-saline depression on the the ridge and the inland plateau respectively. Thus the average litter loss in the three habitats was about 333 kg/ha/yr, which represents less than 11% of annual production of the area. This may confirm the notion that substantial proportion of production of dry matter is invested in the ligneous structural component of the community.

Season	Autumn			Winter			Spring			Summer		
Habitat	I	II	III	I	II	III	I	II	III	I	II	III
Litter	262	159	131.5	87.8	39.5	92.4	50.3	14.4	20.7	46.2	28.1	156.6

Table 6. Seasonal variations in the necromass (Kg dry wt./ha) in different habitats, I = Non-saline depression, II= Ridge, and III = Inland plateau.

5.4 Ecological stress on the grazing ecosystem

The desert ecosystem is exposed to different types of stress as the following:

1- Overgrazing, 2- Woodcutting, 3- Aridity, 4 – Salinity, and different types of human activities, and 5- Erosion of soil surface (e.g. Plates 2A, B, C and D). Rangelands constitute approximately 90% of the country's land surface area. The products are renewable; thus the ranges are capable of providing continuous goods and services such as forage, fiber, meat, water and areas for recreation. These resources are considered by many people to be an integral part of their traditional Arab heritage, which adds special importance to their value. Concomitantly, rangelands are now in a poor condition due to pressures that have either altered or destroyed them as a result of overgrazing, uprooting of plants and off-route use by vehicles. These factors have resulted in an almost complete removal of vegetation cover, a speeding up of the desertification process and the destruction of wildlife habitats.

Vegetation and land degradation is still widespread in the Mediterranean region. Degradation results from various kinds of mismanagement of the land. This include the introduction or expansion of agro forestry systems with multiple-use of the land to develop tourism, wildlife, hunting and sports, combined with extensive grazing of livestock and game and timber production from elite clones of selected high yielding or highly valued species.

5.5 Causes of land degradation

These causes are essentially linked, either directly or indirectly, to soil denudation in areas, which, because of their topography, slope, geological substratum and soils are erosion-prone. They also may be subjected to sedimentation, flooding, water logging, salinisation and alkalization for reasons of the same nature.

Soil surface denudation, in turn, results from a number of causes that may be natural or man-induced.

a. Natural causes play a minor role in Mediterranean region.
b. Man-induced causes play by far a major role. These are the following and may act in isolation or in combination of two or more causes:

1- Deforestation due to over-exploitation either for timber, firewood, charcoal, often combined with over-browsing; 2- Long standing overstocking and overgrazing; 3- Forest and shrub land wildfires, combined or not with over-browsing; 4- Inappropriate grazing systems and patterns: heavy stocking combined with continuous grazing; 5- Clearing for cultivation of land that is inappropriate to cropping without adequate precautions of water and soil conservation; 6- Inadequate tillage practices (down slope, steep ground, utilization of disc plough in sandy soils etc.); 7- Unsound cultivation practices and crop distribution patterns; 8- Chemical exhaustion of soil nutrients involving lack of fertility, inappropriate crop rotation practices favouring the leaching of soil nutrients, or export of nutrients consecutive to wild fires. The coastal belt of the western desert of Egypt has some potential of natural productivity and is the site of a variety of landuse and development programme. The main activities include grazing, agriculture, and woodcutting and over collection especially Matruh to Salloum. Woody plants are, in many instances, the only source of fuel for the desert inhabitants. Batanouny (1999) reported that along the coastal line from Alexandria to Alamein, the sand dunes represent a landscape with special characteristics and features. For more than two decades, due to the conspicuous socio-economic changes, privation, open-door policy in economy and other political changes in Egypt, a great part of the coastlines, has been destroyed. This is due to the continuous construction of summer resort villages. The consequences of the human activities in the area are numerous. These include impacts on the soil, water resources, the flora and fauna, migration birds, trends of the indigenous people, and the cultural environment.

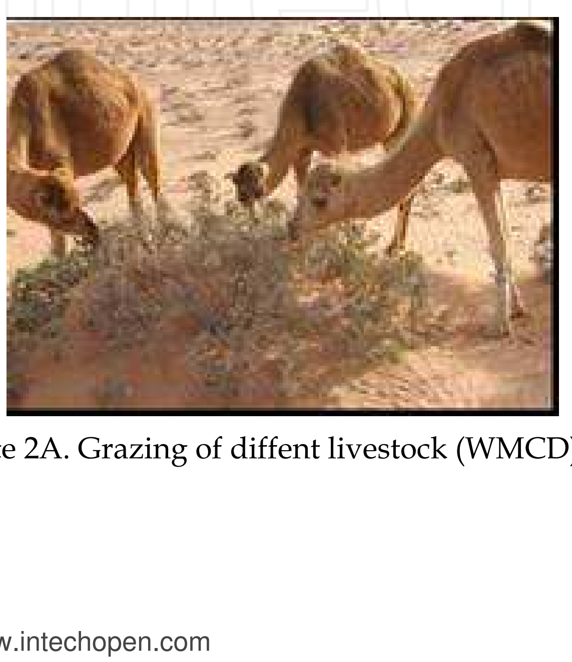


Plate 2A. Grazing of diffent livestock (WMCD) (After Bidak et al., 2005).

Plate 2B. Habitat lost along the western Mediterranean coast (remnants of Abu-sir ridge) (After Bidak et al., 2005).

Plate 2C. Wood collecting as a fuel (After Bidak et al. , 2005).

Plate 2D. Wind erosion (After Bidak et al. , 2005).

Human activity over thousands of years on the Mediterranean landscape has resulted in major management problems. This long period of intensive grazing, fire cycles, and cutting caused degraded or drastically changes in the natural vegetation of the area (Cody, 1986) and have created a mosaic ecosystems which represent degradation stage (Di Castri, 1981).

Bedouins in Maruit region depend on fuel wood collection from the natural vegetation as an essential source of energy. The daily fuel wood collected by a household was about 29 kg. The quantity used was about 24 kg/ha, which equal 8.8 ton/year. The excess represents a waste that should be controlled (Heneidy & El-Darrir 1995). All these activities have their effects on the ecological balance of the ecosystem especially if they are carried out at a rate higher than the rate of regeneration of vegetation cover. Heneidy et al. (2002c) recorded, in Omayed Biosphere Reserve that the human activities have more impact on the vegetation than the over grazing by livestock, where various activities (e.g. wood cutting and collection) have different impacts on the plant diversity.

The causes of degradation of the vegetation in the western desert are mixes of environmental, socio-political and socio-economic conditions. Three main lines may be suggested for the initiation of a long-term strategy for the restoration and conservation of degraded vegetation:

a. Establishment of pilot areas for protection and controlled grazing in each of the main habitats and communities.
b. Initiation of a cooperative system for grazing management between the main social sectors (tribes).
c. Formation of an extensive programme me for propagation of endangered species, it is necessary that the decisionmakers and land-users participate in the planning and execution of the activities along these three lines, and that extension services and incentives be ensured in order to encourage their participation. Ayyad (1993) initiated a test programme me for propagation of multipurpose species in the Mediterranean desert and put the main items for executive (1- seed bank, 2- establishment of seed banks, 3- establishment of nurseries, and 4- demonstration of field experiments).

5.6 Plants and their defenses

The role of physical defensive factors by range specie against livestock has been interest to many range management researchers. In natural ecosystem, plants are associated with a great number of potential predators and pathogens. Nearly all ecosystems contain a wide variety of bacteria, fungi, nematodes, mites, insects, mammals and other herbivores. By their nature, plants cannot avoid these enemies simply by moving away, but they protect themselves in other ways. The cuticle, periderm, thorns, stinging hairs, and tough, leathery leaves help deter herbivores feeding (Taiz & Zeiger, 1991). Heneidy and Bidak (1998) studied the type of defenses in the range species in the coastal Mediterranean region of Egypt. The vegetation of the region is composed of rangeland species of different life-forms . However, some of these plants may avoid or resist grazing animals by different mode of defenses (spiny leaves or branches, compact woody structure, taste, and fragrant smell.

This study depends upon recorded notes through 12 years including daily field observation of different flocks (e.g. grazing behaviours, walking, grazing time, resting time, drinking, number of bites from each species and preference) (Abdel- Razik, et al. 1988a Heneidy, 1992). Heneidy and Bidak (1999) reported that some of the rangelands species have ability for adaptation that avoid grazing activity and how these defenses affect on the palatability, aversion, and consumption.

Fifty-two plant species(44 species perennials and 8 annuals) belonging to 19 families have different defensive mechanisms were recorded in the study area. The type ,degree and the percentage of defense, life-forms, and abundance of each species are presented in Table (7).

Species	Type of defense	Defense%	Family	Growth Form	Abundance
1. Spiny organs	Spiny branches	100	Leguminosae	P. herb	Common
Alhagi graecorum					
Anacyclus alexandrinus	Weak spiny plant	80	Compositae	Annual	Common
Asparagus stipularis	Spiny plant	80	Liliaceae	Sub-shrub	Few
Astragllus sieberi	Spiny branches	100	Leguminosae	Shrub	Few
Astragllus spinosus	Spiny plant	80	Leguminosae	Shrub	Few
Atractylis carduus	Spiny plant	100	Compositae	P. herb	Commn
Carduncellus eriocephalus	Spiny plant	80	Compositae	P. herb	Commn
Carthamus lanatus	Spiny plant	80	Compositae	P. herb	Commn
Centaurea alexandrina	Spiny plant	100	Compositae	P. herb	Commn
Centaurea glomerata	Woolly, spiny	60	Compositae	Annual	Commn
Centaurea pumilio	Woolly, spiny	50	Compositae	P. herb	Rare
Echinops spinosissimus	Spiny fruits	80	Compositae	P. herb	Commn
Emex spinosa	Spiny stipules	25	Polygenaceae	Annual	Few
Fagonia arabica	Spiny plant	100	Zygophyllaceae	Sub-shrub	Commn
Juncus rigidus	Spiny branches	100	Jancaceae	Geophyte	Commn
Noaea mucronata	Spiny plant	100	Chenopodiaceae	Sub-shrub	Commn
Onopordum alexanrinum	Spiny branches	80	Compositae	P. herb	Rare
Salsola vermiculata	Spiny plant	70	Chenopodiaceae	Sub-shrub	Commn
Traganum nudatum	Spiny plant	100	Chenopodiaceae	P. herb	Commn
Xanthimum spinosum	Spiny fruits	50	Compositae	Annual	Few
Zilla spinosa	Spiny plant	100	Cruciferae	Shrub	Commn
2. Woody and spine –like					
Convoloulus lanatus	W. spine branches	60	Convolvulaceae	Sub-shrub	Commn
Kickxia aegyptiaca	W. pine branches	70	Scrophulariaceae	Sub-shrub	Few
Lycium shawii	W. spine branches	80	Solanaceae	Tall shrub	Commn
Moricandia nitens	W. spine branches	70	Cruciferae	Sub-shrb	Few
Periploca aphylla	W. spine branches	100	Asclepiadaceae	Tall shrub	Few
3. Lathery leaves					
Adonus dentatus	Odour	100	Compositae	Annual	Common
Artemisia herba-alba	Woolly, odour	100	Compositae	Sub-shrub	Common
Chenopodium murale	Odour	100	Chenopodiaceae	Annual	Common
Cleome arabica	Sticky, odour	100	Cleomaceae	Sub-shrub	Rare
Haploophyllum tuberculatum	Sticky, odour	100	Rutaceae	P. herb	Few
Peganum harmala	Sticky, odour	100	Zygophyllaceae	P. herb	Common
Pulicaria incisa	Hairy, odour	100	Compositae	P.herb	Common
Thymus capitatus	Odour	100	Compositae	Sub-shrub	Common
Varthemia candicans	Odour	100	Compositae	Sub-shrub	Common

Species	Type of defense	Defense%	Family	Growth Form	Abundance
4. Leathery and hairy					
Alkana lehmanii	Stiff hairs	100	Boraginaceae	Sub-shrub	Few
Artemisia monosperma	Woolly hairy	100	Compositae		Common
Echichilon fruticosum	Woody, hairy	100	Boraginaceae	Sub-shrub	Common
Echium sericeum	Stiff hairy	100	Boraginaceae	Sub-shrub	Common
Marrubium vulgare	Woolly	100	Labiatae	P. herb	Few
Moltkiopsis ciliata	Stiff hairs	100	Boraginaceae	P. herb	Few
Phlomis floccosa	Stiff woolly	100	Labiatae	P. herb	Few
Plantago albicans	Woolly leaves	80	Plantagonaceae	P. herb	Common
Verbascum letourneuxii	Hairy acute branches	80	Scrophylariaceae	Bi-herb	Few
5. Leathery and latex					
Euphorbia paralias	Latex	100	Euphorbiaceae	P. herb	Common
Citrullus colocynthis	Leathery leaves	100	Cucurbitaceae	P. herb	Common
Hyoscyamus muticus	Sticky odour	100	Solanaceae	P. herb	Common
6. Weaky plants defense by protection					
Didesmus aegyptius	Hinding	80	Cruciferae	Annual	Comon
Euphorbia hierosolymitana	Hinding	80	Euphorbiaceae	Sub-shrub	Rare
Launaea nudicaules	Hinding	80	Compositae	P. herb	Common
Prasium majus	Hinding	100	Labiatae	Sub-shrub	Rare
Rumex dentatus	Hinding	80	Polygonaceae	Annual	Rare

Table 7. Types of defense, defense percentage, family, growth-form and abundance of the some modified range species in the western coastal region (After Heneidy and Bidak, 1998), W = Woody and P = Perennual.

Aversion factor (AF) was estimated ratio of the relationships between palatability and the degree of protection. The degree of protection acquired by the studied species distinguished into three classes: 100%, 80% and less than 80%. Each of these classes includes three of palatability rates (HP, P, and LP or NP).Table (8) shows that 19 species (31%) are of AF =zero, 53% of which is due to protection and 11% is due to palatability while, 36% is due to both. 46% of these species are AF = 1 where, 58% is due to protection, 25% is due to palatability, and 17% is due to both.

Species	Palatability	Consumed part	Stock	Aversion factor
Alhagi graecorum	Hp	Leaves, branches	CG	Zero*
Anacyclus alexandrinus	P	Leaves, inflorescence	GS	0.5***
Asparagus stipularis	P	Young branches	CG	0.5*
Astragllus sieberi	HP	Leaves, young branches	CG	Zero***
Astragllus spinosus	HP	Leaves, young branches	CG	Zero*
Atractylis carduus	P	Leaves, inflorescence	SCG	0.5***
Carduncellus eriocephalus	HP	Leaves, inflorescence	SG	Zero***
Carthamus lanatus	HP	Leaves, inflorescence	CGS	Zero*

Species	Palatability	Consumed part	Stock	Aversion factor
Centaurea alexandrina	P	Leaves, inflorescence	CGS	Zero**
Centaurea glomerata	P	Leaves, inflorescence	GS	1**
Centaurea pumilio	LP	Young branches	GS	1**
Echinops spinosissimus	HP	Young branches, inflorescence	CG	Zero*
Emex spinosa	LP	Above-ground	GS	1**
Fagonia arabica	NP	--	--	1*
Juncus rigidus	HP	Spiny branches	C	Zero*
Noaea mucronata	HP	Leaves, branches	SGC	Zero***
Onopordum alexanrinum	P	Leaves, inflorescence	CG	0.5***
Salsola vermiculata	P	Leaves, branches	SGC	0.5*
Traganum nudatum	LP	Young branches	GC	1*
Xanthimum spinosum	NP	--	--	1**
Zilla spinosa	P	Young branches	CG	0.5*
Convoloulus lanatus	HP	Leaves, young branches	SGC	Zero**
Kickxia aegyptiaca	P	Leaves, branches	SGC	0.5**
Lycium shawii	HP	Leaves, young branches	SGC	Zero***
Moricandia nitens	LP	Leaves, young branches	SG	1**
Periploca aphylla	HP	Leaves, branches	SCG	Zero*
Adonus dentatus	LP	inflorescence	GS	1**
Artemisia herba-alba	VHP	Leaves, young branches	SG	Zero*
Chenopodium murale	NP	--	--	1**
Cleome arabica	NP	--	--	1**
Haploophyllum tuberculatum	LP	Dead parts	GS	1*
Peganum harmala	NP	Dead parts	SG	1*
Pulicaria incisa	LP	Leaves, inflorescence	GSC	1*
Thymus capitatus	LP	Leaves, branches	SGC	1*
Varthemia candicans	NP	--	--	1*
Alkana lehmanii	P	Leaves, branches	SG	0.5*
Artemisia monosperma	P	Leaves, young branches	SGC	Zero*
Echichilon fruticosum	HP	Leaves, young branches	SG	Zero*
Echium sericeum	LP	Leaves, young branches	GS	1*
Marrubium vulgare	LP	Leaves, branches	SG	1*
Moltkiopsis ciliata	P	Leaves, branches	SG	0.5*
Phlomis floccosa	LP	leaves	GS	1*
Plantago albicans	HP	All above-ground	SG	Zero*
Verbascum letourneuxii	LP	Leaves, young branches	SG	1***
Euphorbia paralias	NP	--	--	1*
Citrullus colocynthis	NP	--	--	1*
Hyoscyamus muticus	NP	--	--	1*
Didesmus aegyptius	LP	All plant	SG	1***
Euphorbia hierosolymitana	NP	--	--	1***
Launaea nudicaules	HP	All above-ground	SG	Zero***
Prasium majus	P	Leaves, branches	SG	Zero***
Rumex dentatus	HP	All above-ground	SG	Zero***

Table 8. Palatability rate, consumed parts, stock and aversion factor of defensed plant species. S = Sheep, G.= Geots, C. = Camels, HP= High palatable LP.= Low palatable and NP.= Unpalatable.

5.7 Browse in grazing lands and types of livestock in Egypt

The role of browse in natural grazing lands varies in importance according to ecological zone. Under temperate climates and in the humid tropics, browse is of limited use in animal production. However, in the Mediterranean isoclimatic zone, the arid and semi-arid tropics and in montane areas, browse plays an essential role in the animal production, and thus greatly contributes to the protein supply of mankind in Africa. For instance, over 250 million heads of domestic animals live in arid, semi- arid and montane zones where browse is an important quantitative component in livestock diets. In the arid zone the main browse species are dwarf shrubs which constitute the bulk of animal feed (Le Houérou, 1980a).

Rangelands in Egypt are dominated by shrubs; most of those are browsed. These "browselands" cover the following surface in 10^3 km^2 (Table 9). In Egypt the main components of rangelands are shrubs, and dwarf shrubs (subshrubs) Heneidy (1992). The area of rangelands in Egypt is about 125.000 km^2. Table 10 shows the livestock populations (10^3).

Country	Total	Semi-arid to humid rangelands zone shrublands (R > 400 mm)	Arid rangelands chamaephytic steppe (400 >R> 100)	Desert rangelands chamaephytic steppe (100 >R> 50)
Egypt	125	0.0	25.0	100.0

Table 9. Egypt browse lands in 10^3 km^2, (After Le Houérou, 1980b).

Country	Cattle	Equines	Sheep	Goats	Camels	Total
Egypt	2150	1600	1940	1400	100	7190

Table 10. Livestock populations (Egypt) in 10^3 (After Le Houérou, 1980b).

The total area of the rangeland in the western Mediterranean region is about 1.5 million hectare. The number of animals per folks varies among the Bedouin, and between regions in the coastal zone. A herdsize of about 200 head of sheep and 60 head of goats may be reaches to 300 heads (Heneidy 1992). The total number of animals which graze the rangelands is about 1.5 million head where, in Omayed biosphere reserve is about 15,000 head (ratio 3 sheep to 1 goat) Heneidy (1992). Therefore the average stocking rate is one head /ha. Duivebooden (1985) reported that the total number of animals is about 1.2 million head of sheep, 0.9 million head of goats, and 0.2 million head of camels. The stocking rate of Omayed was estimated as about 0.5-0.6 head/ha (Ayyad & Ghabbour, 1977; Ayyad & El-Kady 1982), which is much lower compared to the average for the whole area. The average rate averaged throughout the year at Burg El-Arab varies from 0.75 head/ha to 1.0 or 1.5 head/ha (El-Kady, 1983 and Abdel-Razik et al., 1988a). Further more, the calculated stocking rate in the Omayed by Heneidy (1992) is 0.286 head/ha, is far below the regional average practices. It should be mentioned, however, that the calculated stocking rate holds true only for those animals grazing yearlong on the pasture, while twice as much as the resident animals is removed to the areas of irrigated cultivation for most of the year. Consequently, spatial variation in stocking rate occurs. In addation, variation in time occurs, due to the migration of livestock in summer. Stocking rate may be reaches to 1.2 head/ha at

Omayed (Van Duivenbooden, 1985). There is no consistent range management strategy in control of the season long grazing in the area, which varies mainly with climatic condition, availability of watering points and availability of supplementary feed. Absolutely the stocking rate leads to the problem of overgrazing. Overgrazing has been one of the main factors causing the deterioration of ecosystem productivity in the Mediterranean coastal region. It has resulted in severe reduction of perennial cover, soil erosion and formation of mobile dunes.

5.7.1 Grazing pressure

The pressure of grazing at any given moment is defined as a relationship between demand for by animals and a comination of daily herbage increment and standing crop of vegetation. This function is related only indirectly to number of animals and area of pasture (Heady ,1975). El-Kady (1980) recorded that partial protection and controlled grazing, might be of better consequences than full protection.

5.7.2 Stocking rate

The total area of the rangeland in the western Mediterranean region is about 1.5 million hectare. Therefore the average stocking rate is one head /ha. The stocking rate of Omayed was estimated as about 0.5-0.6 head/ha (Ayyad & Ghabbour, 1979; Ayyad & El-Kady 1982), which is much lower compared to the average for the whole area. The average rate averaged throughout the year at Burg El-Arab varies from 0.75 head/ha to 1.0 or 1.5 head/ha (El-Kady, 1983 and Abdel-Razik et al., 1988a). Further more, the calculated stocking rate in the Omayed by Heneidy (1992) is 0.286 head/ha, is far below the regional average practices. It should be mentioned, however, that the calculated stocking rate holds true only for those animals grazing yearlong on the pasture, while twice as much as the resident animals is removed to the areas of irrigated cultivation for most of the year. There is no consistent range management strategy in control of the season long grazing in the area, which varies mainly with climatic condition, availability of watering points and supplementary feed. Absolutely the stocking rate leads to the problem of overgrazing. Overgrazing has been one of the main factors causing the deterioration of ecosystem productivity in the Mediterranean coastal region. It has resulted in severe reduction of perennial cover, soil erosion and formation of mobile dunes.

5.7.3 Forage consumption

Heneidy (1992) reported that the annual consumption of forage by the grazing animals is about 619 kg/ head (average of 1.696 kg/ head/ day). If this value of annual consumption is multiplied by the calculated stocking rate of grazing animals, the consumption rate would be about 0.485 kg/ha/day which is well below the total accessible forage production of different habitats in Omayed. Normally, browse (grazing on shrubs) is supplementary to a herbage based system. It may serve to raise the protein intake for all or part of the year, or it may be essential that animals subsist on browse during cold or dry periods, so that they survive to utilize and breed on the herbage at other times of the year. This indicates the importance of browse species in the area. Taking into consideration that subshrubs constitute the bulk of feed of grazing animals. Such shrubs are therefore valuable in tiding over the periods of limited forage supply. Combining this with the high production levels of woody species, may reflect the importance of such species in arid rangelands. It should be added that the relatively high production levels of some of the perennial herbs ensure a good supply of standing dead material during the dry period that is selected by grazing animals with even higher priority than the available green. The consumption rate of dry matter in the three habitats of the study area (non-saline depression, the ridge, and the inland plateau) is about 0.53, 0.36, and 0.47 kg/ha/day respectively.

The total phytomass accessible to grazing animals (gm dy weight/m^2) varied remarkably with season and habitat, from 30.8 gm/m^2 in the ridge habitat in autumn to 154.3 gm/m^2 in the habitat of inland plateau in spring. The total livestock offtake is estimated to be on the order of 6% of primary production in the study area. Therefore, it seems unlikely that livestock exert a major control on plant biomass.

The monthly variations in the species composition of the daily diet of animals in different habitats are presented in Table 11 (After Heneidy 1992).

Species	Annual mean of daily consumption		
	Non-saline depression	Ridge	Inland plateau
Asphodelus ramosus	694.32	167.27	574.1
Plantago albicans	84.19	--	171.65
Carduncellus eriocephalus	17.58	--	--
Echinops spinosissimus	--	5.73	3.64
Scorzonera alexandrina	--	273.69	62.68
Echiochilon fruticosum	161.21	--	206.15
Helianthemum lippii	111.07	80.08	113.39
Gymnocarpos decandrum	120.66	87.24	163.33
Deverra triradiana	12.34	30.31	20.36
Convolvulus lanatus	26.26		23.86
Noaea mucronata	78.56	71.87	89.7
Artemisia monosperma	200.11	--	--
Artemisia herba alba	--	39.25	18.52
Anabasis articulata	86.03	169.26	38.61
Anabasis oropediorm	--	203.66	66.73
Thymelaea hirsuta	98.35	90.9	63.12
Lycium europaeum	8.1	16.81	15.45
Annuals	168.86	11.44	11.75

Table 11. Variations in the daily consumption rate (gm dry wt/head/day) in the different habitats at Omayed.

Seasonality in consumption behavior of grazing animals in the Omayed site is mainly a function of: (1) variation in the availability of consumable parts of species and their relative palatability, (2) the phenological stages of plants having different nutritional status and characterized their specific chemical composition in energy and mineral elements, (3) the relative need for drinking water, (4) climatic factors, and (5) structure and size of the flock.

The interplay between the previously mentioned three factors let the grazing animal spend periods of voluntary walk over distances that vary between 20 km/day during winter and 9 km/day during summer. These walking experiences represent a transect of about 15 km in length in winter and 7 km in length during summer (Heneidy, 1992). The corresponding grazing time averages about 9 hours/day during winter and 7 hours/day during summer(at the rate of 2.22 and 1.29 km/hour during winter and summer respectively)

Ayyad, (1978) reported that in the Mediterranean desert ecosystem variable input of rain would be matched, under relatively light usage, by the supply of forage, but heavy stocking might so damage the grazing that there would be an enfprced decrease in cattle numbers when the rains failed. If the damage were severe, neither forage no cattle numbers could recover and there would be a sustained fall in yield. Grazing tends to damage the most palatable first and then progressively less palatable species, so reducing their frequency in the community. Not all palatable species, however, need be decreases: some may actually thrive on grazing. In the present study some species exhibited a negative response to protection. These species may have been either of low play abilities and were deprived of light nibbling and removal of standing dead shoot, a practice which usually promotes vigour and growth or they may have been unpalatable and due to competition by the protected palatable species became of lower potential for productivity.

5.7.4 Grazing behavior of animals

Grazing animals do not graze continuously . They have specific periods during the 24 hours daily cycle, when ingestive intake is very high and others when grazing is punctuated by ruminating resting and idling. In the coastal Mediterranean region the grazing times varied between 7 and 9 hours with the increase occurring from summer to winter, and with small differences between animals in their annual grazing time spent on different life forms.)

In general, there are two periods of grazing activity of domestic animals in Omayed area one in the morning and one in the afternoon, with a resting period in between. The peak of grazing activity differs with season and habitat, but it usually occurs either in the early morning or the late afternoon, particularly during summer. In spring and winter, the peak activity may occur towards mid-day.

In general, the grazing activity during the day stats at six in the morning, and ends at six in the afternoon during autumn and spring, while, in summer it starts at eight, and in winter it starts one hour later and ends one hour earlier. The resting period for grazing animals starts at 12 noon, and lasts for two hours during winter and spring, four hours during autumn, and seven hours during summer.

The annual pasture can be divided into two periods: the wet grazing period (winter, spring) and the dry grazing period (summer, autumn). The effective wet grazing period is that period when green pasture availability is sufficient for the animals to satisfy their appetite and meet all nutritional requirements (about 4 or 5 months) depending on the amount and distribution of rainfall. Seligman and Spharim (1987) indicate that, this green period in arid rangelands of the Middle East lasts only 3 months from December till March. In the rainy season most species are in vegetative stage and furnish an adequate supply of forage to the grazing animals. Some species start activity for a few months when the soil moisture is available, after which they go to dormancy or inactivity.

5.7.5 Selectivity of plant species by grazing animals (animal visiting)

The frequency distribution of the number of visits per hour or per day to a plant species may be used as a measure of the non-randomness of its selection by domestic animals Heneidy, 1992). The number of visits per hour to each plant species, irrespective of the number of bites, during one day representing each season was recorded. This number was then classified into classes representing low, medium and high frequency of visits. The χ^2 –test of goodness-of-fit was applied (Table 12). It indicated the probabilities that the difference between the observed and the expected (random) distribution may be attributed to the sampling error.

The goodness –of-fit of the observed ferquency distribution to the expected random distribution of the number of visits per hour during one day representing each season varied with species, season and habitat. The largest number of significant deviations from randomness was that exhibited by *Anabasis articulata*, followed by that of *Deverra triradiana, Thymelaea hirsuta* and *Noaea mucronata.* It is notable that the number of these significant deviations was lowest during summer. The largest number of such deviations was recorded for plants of the non-saline depression, taking into consideration the species common to the three habitats.

Habitat	Non-saline		Ridge		Inland plateau	
Season / Species	Spring	Summer	Spring	Summer	Spring	Summer
Asphodelus ramosus	<0.005	0.25-0.5	0.05-0.1	0.1-0.25	<0.005	0.1-0.25
Plantago albicans	0.25-0.5	0.1-0.25	<0.005	--	0.01-0.025	0.1-0.25
Carduncellus eriocephalus	<0.005	--	--	--	<0.005	--
Echinops spinosissimus	--	--	<0.005	--	--	--
Scorzonera alexandrina	--	--	<0.005	--	--	-
Echiochilon fruticosum	<0.005	0.1-0.025	--	--	0.025-0.5	0.25-0.5
Helianthemum lippii	0.1-0.25	<0.005	<0.005	<0.005	0.1-0.25	0.25-0.5
Gymnocarpos decandrum	<0.005	0.0-0.1	0.25-0.5	0.1-0.25	<0.005	0.05-0.1
Deverra triradiana	<0.005	0.5-0.75	<0.005	0.1-0.25	<0.005	0.025-0.05
Convolvulus lanatus	<0.005	0.5-0.75	--		0.025-0.05	0.01-0.025
Noaea mucronata	<0.005	0.5-0.75	<0.005	0.1-0.25	<0.005	0.01-0.025
Artemisia monosperma	0.1-0.25	0.25-0.5	--		--	--
Artemisia herba alba	--	--	0.005-0.01	0.1-0.25	<0.005	<0.005
Anabasis articulata	<0.005	<0.005	0.01-0.025	0.025-0.05	<0.005	0.01-0.025
Anabasis oropediorm	--	--	<0.005	<0.005	0.05-0.1	0.01-0.025
Thymelaea hirsuta	0.05-0.1	0.01-0.025	<0.005	0.5-0.75	<0.005	0.1-0.25
Lycium europaeum	--	--	<0.005	--	<0.005	--
Annuals	0.005-0.001	--	0.1-0.25	--	<0.005	--

-- These species are not recorded.

Table 12. Probabilities of random distribution of the number of visits/hour by domestic animals to each plant species during one day representing each of the two seasons in the three habitats (After Heneidy, 1992).

Generally the average number of plants visited by each animal was about 1318 per day (Heneidy, 1992) (representing about 12% of the total number of plants if the animal is confined to one hectare). The average numbers of bites was 8235 bite/head/day, with the maximum number during spring.

5.7.6 Water consumption

The temporal variations in the consumption of water by the grazing animals from the rangeland forage in different habitats, as well as the supplementary amounts during the dry period (liter/head/day) are presented in Table (13) assuming that the flock spends the whole grazing day in one habitat.

	October			November			December			January			February			March		
Habitat	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Amount of water from forage	0.4	0.2	0.7	0.7	0.3	1.4	4.6	1.9	4.5	4.5	5.1	4.3	4.7	4.5	5.1	8.7	10.6	6.2
Amount of drinking water	3.0-3.5			2.0-3.0			0.5-0.7			0.0			0.0			0.0		
	April			May			June			July			August			September		
Habitat	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III	I	II	III
Amount of water from forage	8.6	1.7	3.8	5.9	0.9	1.5	1.1	0.4	1.2	0.4	0.4	0.8	0.3	0.3	0.5	0.2	0.2	0.6
Amount of drinking water	0.0			0.8-1.5			3.5-4.0			4.5-5.5			5-5.5			4.4-4.8		

Table 13. Monthly variations of the amount of water (liter/head/day) consumed by the grazing animals from the rangeland forage in different habitats, and that of drinking water from October till September at Omayed (After Heneidy, 1992).

It is notable that the species composition and time period, affect the amount of water available for animal from the natural forage. For example, the amount of water of the rangeland forage on the ridge habitat is higher than in the other two habitats, probably due to the abundance of the more or less succulent species *Scorzonera alexandrina* on the ridge where it is highly consumed by grazing animals. In the non-saline depression the amount of water is greater than on the inland plateau, which may also be due to the high abundance of the succulent species *Rumex pictus* in the former habitat.

In the dry grazing period, the subsidies of concentrates, wheat, barley and remains of onion are supplied to the animals, and supplementary drinking water becomes more necessary. Water consumption by grazing animals depends on five main factors: (1) air temperature, (2) amount of dry matter ingested, (3) water content of the feed, (4) salinity of drinking water, and of feed (Le Houéou et al., 1983; Heneidy, 1992). Heneidy (1992) recorded that sheep and goats in the coastal region do not supply of drinking water during winter and spring, since the water content of the vegetation is sufficient in the study area. However, in the other seasons watering of the flock is necessary. The total annual water intake by the grazing animals was calculated as about 1876 kg/head. Drinking water represents 43% of the total water intake, while the remainder was the water content in the consumed fresh forage.

5.7.7 Faeces, necromass and water loss

The monthly variations of fresh and dry weight of faeces (gm/head/day), its moisture content and the animal water loss are presented in Table (14). The maximum amount of faeces is deposited during February (473.4 gm dr. wt./head/day), while the maximum fresh weight is attained in March (about 1103.7 gm fresh wt./head/day).

The highest moisture contents of faeces are attained during the wet grazing period. The lowest amounts of feces are deposited during the dry grazing period, particularly in October. The maximum water loss in the faeces of animals per day occurs during the rainy period, when the natural forage is enough to meet their feed requirements.

Month	Fresh wt./ (gm/day)	Dry wt. (gm/day)	Moisture content%	Amount of water loss (gm/day)
October	350.0	159.3	54.5	190.7
November	548.0	255.7	53.3	292.4
December	774.6	353.9	54.3	420.8
January	1027.0	302.0	70.6	725.0
February	1080.0	473.4	56.2	607.4
March	1102.7	324.7	70.6	779.0
April	981.6	288.7	70.6	692.9
May	487.5	183.5	62.4	303.9
June	539.0	184.7	65.7	354.3
July	556.0	191.5	65.6	364.5
August	446.6	204.8	54.1	241.7
September	365.3	166.4	54.5	198.9

Table 14. Monthly variations in fresh and dry weight, moisture content, and water loss (gm/head/day) of faeces, (October 1987-88), at Omayed (After Heneidy, 1992).

5.8 Palatability and nutritive value

Palatability of range plant species is a very complex notion, very difficult to generalize as it is linked to many factors that vary in time and place. Some of these variables are linked to the plant, others to the animals, while a third category depends on various environmental factors (Le Houérou, 1980; Heneidy 1996). Based on several years of field observation, chemical composition and energy content help us to know the palatability information of the plant species. In the coastal Mediterranean region numerous factors were considered when classifying a plant as palatable or not: phenological stage, morphological form, odour, taste, chemical composition and its abundance relative to associated species. The topography of the habitat, climate and state of animal itself are all contributing factors (Heneidy and Bidak, 1999).

Abdel-Razik et al. (1988a) reported that the grazing domesticated mammals show highest selectivity ratios (preferences) towards plants with relatively low availability. However, the palatability of a few species of plants is related to their phenological development. Woody plants represent the principle source of most nutrients to grazing animals, including, with the exception of phosphorus, more than adequate minerals and are available throughout the year.

Many physical and chemical factors influence palatability of plant species, of which animal behavior and chemical composition are the most important. The contents of chemical constituents in plants and their digestibility vary independendently between different organs and according to plant age (Le Houéou, 1980a and Heneidy, 1992). Of these, crude protein (CP) is viewed classically as an indicator of the nutritional value of food for ruminants.Abdel-Razik et al. (1988 a,b) reported that the analysis of samples which represent the diet selected by the herbivores indicated that the grazeable proportion of the phytomass of most species had in general, higher nutrient concentration than the non-grazeable proportion. Crude protein was a highest concentration early in the growing season, and was lowest at the end of the dry season. The concentration of total nonstructural carbohydrates (TNC) and in the grazeable parts varied also with life-forms and habitats and crude fibers was lower in the wet season in the young parts. The concentration of lipids in the grazeable parts of different species slightly higher in winter and does not exhibit notable differences between habitats (Heneidy, 1992).

Heneidy (1992) reported that the percentage of digestible crude protein(DCP) in Omayed area is 4.9%, while Heneidy and Bidak (1996) reported that it reached 6.9%. DCP content of the forage in the coastal region at Omayed area is ranked good according to the scale suggested by Boudet & Riviere (1980) who consider a fair DCP percentage between 2.5 and 3.4.

Total digestible nutrients (TDN) is reported by Abdel-Salam (1985) in the coastal Mediterranean region as about 66% DM, while Abdel-Razik et al (1988b) reported annual average value of TDN for consumable forage as 75% DM and Heneidy (1992) reported the annual average of TDN in coastal region as about 67% DM. Heneidy and Bidak (1996) reported that TDN in the saline depression habitat in the coastal region as about 66.2%. Accordingly the energy content in the coastal Mediterranean region equals 0.76 SFU of the halophytes species, while it was estimated by El-Kady (1983) at Omayed as 0.3 SFU. In general, the nutritive value of forage decreases with advancing maturity of plants. This decrease is mainly due to the decrease in protein content together a concomitant increase in the fiberous components and general lignification.

6. Acronyms

AF: Aversion factor
CV: Coefficient of Variation
OBR: Omayed Biosphere Reserve
RUE: Rain Use Efficiency
P/RVR: Production to Rain Variability Ratio
WMCD: Western Mediterranean Coastal Desert

7. Recommendations and some suggestions

1. Degradation of vegetation and even the whole ecosystem due to overgrazing is manifest in almost all the localities in the protectorate. The communal system of grazing

is followed in the protectorate, as well as the other arid and semi-arid ecosystem in the region. While the communal grazing system has certain advantages in an arid range area, it can be an obstacle to rational utilization of the range and to range improvement practices. Individuals try to increase the size of their flocks to obtain the highest possible income, and there is no interest to protect the range by limiting the number of animals or to improve the range by any means.

2. There is a strong view that only a holistic approach should be used to address sustainable rangelands management and pastoral development. The challenge is to address policy issues and to enhance national and regional collaboration to promote exchange of information and experiences as well as to facilitate coordinated national and regional programmes.
3. Various factors affecting plant and animal production in a high potential desert system (arid and semi- arid). Use of cultural treatment for increased forage production, effect of protection, use of native species for rehabilitation work, utilization of supplemented irrigated shrubs in the feed calendar for semi intensive systems, flock management for reduced grazing pressure are among the different aspects studied for integrated management of rangeland resources which have considerable implication in combating desertification.
4. Range Improvement several trials all aimed at the improvement of vegetation for range-livestock production using principles of restoration ecology. Techniques used include protection, seed propagation of indigenous range for reseeding degraded rangelands, use of cultural treatments and establishment of supplementary irrigated vegetation.

8. Acknowledgments

I warmly thank to my wife Dr. Laila M. Bidak, Professor of Plant Ecology, Faculty of Science, Alexandria University and my daughter Nada, for their encouragement, valuable suggestions and patience throughout the preparation of this chapter.

9. References

Abdel-Razik, M.; Ayyad, M. A. & Heneidy, S.Z. 1988a. Preference of grazingmammals for forage species and their nutritive value in a Mediterranean desert ecosystem (Egypt). *J. of Arid Environments* 15: 297-305.

Abdel-Razik, M.; Ayyad, M. A. & Heneidy, S.Z. 1988b. Phytomass and mineral composition in range biomass of a Mediterranean arid ecosystem (Egypt). *Oecol. Plant.* 9 (4): 359-370.

Abdel-Salam, H. 1985. Grazing Capacity per Faddan at Omayed Grazing Area the Northern Coastal Zone Western to Alexandria. Ph. D. Thesis. University of Alexandria. 166 pp.

Ayyad, M. A. 1973. Vegetation and environment of the western Mediterranean coast of Egypt. I. The habitat of sand dunes. J. Ecol., 61:509-523.

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

Ayyad, M. A. 1993. The terrestrial Ecosystems of Fuka-Matruh Area (Egypt). Mediterranean Action Plan- UNEP. RAC/SPA. pp. 33.

Ayyad, M. A. & Ghabbour, S. I. 1977. System analysis of Mediterranean desert ecosystems of Northern Egypt "SAMDENE". Environ. Conse. Vol.4., no. 2, summer. 91-102 pp.

Ayyad, M. A. & Ghabbour, S. I. 1979. Phytosociological and environmental variation in a sector of the western desert of Egypt. *Vegetatio,* 31: 93-102.

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

Ayyad, M. A.; Abdel-Razik, M., and Ghali, N. 1983. On the phenology of desert species of western Mediterranean coastal region of Egypt. *Int. J. Ecol. Environ. Sci.* 9: 169-183.

Batanouny, K.H. 1999. The Mediterranean coastal dunes in Egypt: an endangered landscape, Estuarine, *Coastal and Shelf Science*, 49 (Supplement A), 3-9. Bjustad, A. J., Crawford, H. S. & Neal, D. L. 1970. Determining forage consumption by direct observation of domestic grazing animals. *U.S.Dep. Agri. Misc. Pub.* 1147: 101-104

Bidak, L.M; Heneidy, S.Z; Shaltout, K.H; Al Sodany, Y. & Seif El-Naser, M. 2005. Conservation and sustainable use of Medicinal Plants. Vol.(4). pp 120 pp.

Boulos, L. 1995. *Flora of Egypt: Checklist*. Al-Hadra Publishing, Cairo. 286 pp.

Boudet, G. & Riviere, R. 1980. Emploi practique des analyses fouregeres pour l' apprecietion paturages tropicauz. *Rev. Elev.Med. vet. Pays Trop.* 2 (21):227-266.

Castle, M. E. & Halley, R. J. 1953. The grazing behaviour of dairy cattle of the National Institute for Research in Dairying. *Br. J. Ani. Behav.* 1: 139-143.

Chambers, A. R.; Hodgson, J. and Milne, J. 1981. The development and use of equipment for the automatic recording of ingestive behaviour in sheep and cattle. *Grass and Forage Science,* 36: 97-105.

Chapman, V.J. 1960. Salt Marches and Salt Deserts of the World. Interscience publishers Inc.., New York.

Cody, M. L. 1986. Diversity rarity and conservation in Mediterranean – climate regions. In: Soule, M. E. (ed.) Conservation Biology, the Science of Scarcity and Diversity. Sinaure, Sunderland, M. A. 122-152.

Cook, C. W. 1972. Comparative nutritive values of forbs, grasses and shrubs. In: *Wildland shrubs, their Biology and Utilization*. Ogden, Utah, USDA Forest Service. Gen. Tech. Rep. INT-1: 303-310.

Cowlishow, S. J. & Alder, F. E. 1960. The grazing preferences of cattle and sheep. *J. Agr. Sci.* 54:257-265.

Di Castri, F. 1981. Mediterranean type shrublands of the world. In; dicastri, F., Goodall, D. W. and Specht, R. L. (eds.), Ecosystem of the world. Mediterranean type shrub lands. Elsevier, Amsterdam, 2:1-52.

Dicko-Toure, M.S. 1980. Measuring the secondary production of pasture: an applied example in the study of an extensive production system in Mali. In: *Browse in Africa.* (Le Houéou, ed.) ILCA, Addis Ababa: 247-258.

Duivenbooden, N. V. 1985. The effect of grazing on the growth of subshrubs and the soil-watr balance in the North-western Coastal Zone of Egypt. Student Report, Theoretical Production Ecology, Agriculture University Wageningen, The Netherlands.

El-Kady, H. F. 1980. Effect of Grazing Pressure and Certain Ecological Parameters on Some Fodder Plants of the Mediterranean Coast of Egypt. M.Sc. Univ. Tanta. 97 pp.

El-Kady, H. F. 1983. Animal resources. In: Ayyad, M. A.; Le Floc'h, E. (eds.). An Ecological Assessment of Renewable Resources For Rural Agricultural Development in the Western Mediterranean Coastal Region of Egypt. Pp. 77-79.

Mapping Workshop of C.N.R.S./C.E.P.E. Montpellier: CNRS: 104 pp. Fritzi, S. G. and Bradley, W. K. 1992. The influence of plant architecture on the foraging efficiencies of a suite of Ladybird beetles feeding on aphids. *Oecologia*, 92: 399-404.

Heady, H.F. 1975. *Rangeland Management.* Mc. Graw-Hill, Inc. 480 pp.Heneidy, S. Z. 1992. An Ecological Study of the Grazing Systems of Mariut. Egypt. Report submitted to UNESCO. 51 pp.

Heneidy, S.Z. 1995. A study of rangeland species, biomass and chemical composition in different rainguage sites of eastern Matrouh, Egypt. Submitted to faculty of Agriculture through IDRC Project (Canada and University of Guelph).

Heneidy, S. Z., 1996: Palatability and nutritive value of some common plant species from the Aqaba Gulf area of Sinai, Egypt. Journal of Arid Environments 34,115– 123.

Heneidy, S. Z., 2000. Palatability, chemical composition and nutritive value of some common range plants from Bisha, Region, Southwestern of Saudi Arabia *Desert Inst. Bull. Egypt,* 2: (50):345-360.

Heneidy, S. Z. 2002a: Browsing and nutritive value of the most common range species in Matruh area, a coastal Mediterranean region, Egypt. Ecologia Mediterranea 2: 39–49.

Heneidy, S. Z. 2002b. Role of indicator range species as browsing forage and effective nutritive source, in Matruh area, a Mediterranean coastal region, NW- Egypt. Journal of Biological Sciences, 2: 136-142.

Heneidy, S. Z. 2002c. On the ecology and phytosociology of El-Omayed area, Egypt. *Desert Inst. Bull. Egypt*, 52 (1): 85-104.

Heneidy, S. Z. 2003a. Accessible forage biomass of browse species in Matruh area, a Mediterranean coastal region, Egypt. Pakistan-Journal Of Bilogical Sciences, 6 (6): 589-596

Heneidy, S. Z. 2003b. "Rangelands" In: Sustainable Management of Marginal Dry Lands National UNESCO Commission, Cairo, Egypt. SUMAMAD, pp. 97.

Heneidy, S. Z. & El-Darier, S. M. 1995. Some ecological and socio-economic aspects of bedouins in Mariut rangelands, Egypt. Journal of Union of Arab Biologists Cairo, vol. 2(B): 121-136.

Heneidy, S. Z. &, L. M. Bidak. 1996. Halophytes as forage source in the western Mediterranean coastal region of Egypt. Desert Inst. Bull., Egypt. 49, 2: 283-304.

Heneidy, S. Z. &, L. M. Bidak. 1998. Diversity of the wadi vegetation in Matrouh region, Egypt. *J. of Union of Arab Biologists* Cairo, vol. 6 (B). 13-28.

Heneidy, S. Z. &, L. M. Bidak. 1999. Physical defenses and aversion factor of some forage plant species in the western Mediterranean coastal region of Egypt. *J. of Union of Arab Biologists* Cairo, vol. 9 (B):15- 30. 1999.

Heneidy, S. Z.; Halmy, M., 2007: Rehabilitation of degraded coastal Mediterranean rangelands using *Panicum turgidum* Forssk. *Acta Botanica,* Croatia 66, 161–176.

Heneidy, S. Z.; Halmy, M., 2009: The nutritive value and role of *Panicum turgidum* Forssk. In the arid ecosystems of the Egyptian desert", *Acta Botnica,* Croatia, 68 (1): 127– 146.

Hodgson, J. & Jamieson, W. S. 1981. Variations in herbage mass and digestibility and the grazing behaviour and herbage intake of adult cattle and weaned calves. *Grass and Forage Science*, 36, 39-48.

Illius, A. W. & Gordan, I. J. 1987. The allometry of food intake in grazing ruminants. *J. of Animal Ecol*. 56: 989-999.

Jamieson, W. S & Hodgson, J. 1979. The effects of variation in sward characteristics upon the ingestive behaviour and herbage intake of calves and lambs under continouous stoching management. *Grass and Forage Science,* 34: 273-282.

Kamal, S.A. 1988. A of Vegetation and Land Use in the Western Mediterranean Desert of Egypt. Ph. D. Thesis Alexandria University, 193 pp.

Kamal, S.A.; Heneidy, S. Z. & El-Kady, H. F. 2003. Effect of ploughing on plant species abundance and diversity in the northern western coastal desert of Egypt, Biodiversity and Conservation*, 12: 749-765.*

Le Houéou, H. N. 1972. Continental aspects of shrubs distribution, utilization and potentils: Africa- The Mediterranean region. In: Wildland Shrubs, their Biology and Utilization (McKell, C. M. Blaisde Blaisdell, J.P. and Goodin, J. P. eds.). USDA, US for sero. Gen. Tech. Repo. INT.01: Ogden, Utah.

Le Houèrou, H. N. 1975. The natural pastures of North Africa, types, productivity and development In: *Proceeding of International Symposium on range survey and Mapping in tropical Africa*, Bamako. Addis Ababa, ILCA.

Le Houéou, H. N. 1980a. The role of Browse in the management of natural grazing lands. In: Le Houéou, H. N. (ed.). *Browse in Africa*. pp. 320-338. Addis Ababa, ILCA. 491 pp.

Le Houérou, H. N., 1980b: Chemical composition and nutritive value of browse in tropical West Africa. In: Le Houérou (ed.), Browse in Africa, 261–289. Addis Ababa, ILCA.

Le Houérou,H. N. 1984. Rain use efficiency: a unifying concept in arid-land ecology. *Academic Press Inc*. (London). pp. 213-247.

Le Houérou, H. N. 1988. Interannual variability of rainfall and its ecological and managerial consequences on natural vegetation, crops and livestock. In: di Castri F., Floret Ch., Rambal S., Roy J. (Eds.) *Time Scale and Water Stress- Proc. 5th Int. On Mediterranean Ecosystems*. I.U.B.S., Paris.

Le Houèrou, H. N. 1993. Grazing lands of the Mediterranean Basin. In: Corpland. R. T. (ed.). *Natural grassland, Eastern Hemisphere and Resume. Ecosystem of the World,* Vol. 8b: pp.171-196. Amsterdam: Elsevier Science Publisher.

Le Houéou, H.N. 1994. Forage halophytes and salt-tolerant fodder crops in the Mediterranean basin. In: Squires, V. R. & Ayoub, A. T. (eds). Halophytes as a resource for livestock husbandry: problems and prospects, pp. 123-137. Bordrecht. The Netherlands: Academic Publisher.

Le Houéou, H.N & Hostte, C. H. 1977. Rangeland production and annual rainfall relations in the Mediterranean basin and in the African Sahelo-Sudanian Zone. *J. of R. Manag*. 30 (3): 181-189.

Milner, C. and Hughes, R. 1970. Methods for the management of primary production of grassland. IBP Handbook no. 6, 70 pp.

Moore, P. D. and Chapman, S. R. 1986. *Methods in Plant Ecology*. 588 ppNoy-meir, I. 1973. Desert ecosystems: environment and producers. *Annual Review of Ecology and Systematics,* 4: 25-51.

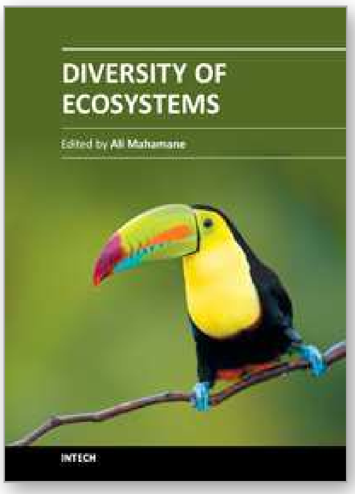
Sarson, M., and Salmon, P. 1977. Eleuage, Paturage et donnees de bass pour un amenayment sylvo-pastural dans la Zone no. 2. MOR 73/016, Rabat FOA/MIN. Agric. Ref. Agric.

Täckholm, V. 1974. *Student's Flora of Egypt.* Cairo university press. 888 PP.Taiz, L. & Zeiger, E. (1991). *Plant Physiology.* The Benjamin Cummings Publishing Compony. INC. California USA. Pp 565.

Tueller, P.T. 1988. *Vegetation Science applications for rangeland analysis and management.* Kluwer Academic Publishers, Dordrecht. 642pp.

UNU/MAP/UNESCO, ACRDA. 2003. Site Assessment Methodology for "Omayed Biosphere Reserve" In: Sustainable Management of Marginal Dryland, SUMAMAD. 97 pp.

Van Dyne, G. M. ; and Heady,H. F. 1965. Botanical composition of sheep and catle iets on a mature annual range. *Hilgardia* 36: 465-492.



Diversity of Ecosystems
Edited by Prof. Mahamane Ali

ISBN 978-953-51-0572-5
Hard cover, 484 pages
Publisher InTech
Published online 27, April, 2012
Published in print edition April, 2012

The ecosystems present a great diversity worldwide and use various functionalities according to ecologic regions. In this new context of variability and climatic changes, these ecosystems undergo notable modifications amplified by domestic uses of which it was subjected to. Indeed the ecosystems render diverse services to humanity from their composition and structure but the tolerable levels are unknown. The preservation of these ecosystemic services needs a clear understanding of their complexity. The role of research is not only to characterise the ecosystems but also to clearly define the tolerable usage levels. Their characterisation proves to be important not only for the local populations that use it but also for the conservation of biodiversity. Hence, the measurement, management and protection of ecosystems need innovative and diverse methods. For all these reasons, the aim of this book is to bring out a general view on the function of ecosystems, modelling, sampling strategies, invading species, the response of organisms to modifications, the carbon dynamics, the mathematical models and theories that can be applied in diverse conditions.

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821