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PHYTO-ECOLOGICAL OBSERVATIONS IN NORTHERN OMAN

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ABSTRACT

The present study has evolved out of a limited field work during a short visit to Oman. It is an attempt to record more detailed data on the plant communities and their habitat features in three sectors of northern Oman. The rainfall in the surveyed area exhibits wide variation as regards its amount and regime. The study area comprises different ecosystems, including mountains, wadis, plains, sebkhas, cultivated fields, water ponds and canals, etc. Each of these systems is differentiated into various habitats, which can be distinguished according to their physiography, edaphic conditions and plant cover. Any particular habitat supports a definite community. The study revealed the occurrence of 22 communities, defined by their dominant species. The most widespread community is that dominated by *Acacia tortilis*. The study revealed that the variations in topography and soil characteristics have a marked influence on the water resources and consequently on the distribution of the plant communities. The weed flora as well as the aquatic plants in particular habitats are investigated.

INTRODUCTION

Ecological and phytosociological studies in Oman are fragmentary and the vegetation of the country is not yet explored. Generally, botanical studies are represented by brief accounts of the plants by visiting botanists who paid short visits to the country. The only recent contributions of importance to the knowledge of vegetation of some parts of Oman are the two informative articles by Mandaville (1977 & 1980) and that of Radcliffe-Smith (1980).

Also, our present knowledge of the flora of Oman is still incomplete, but not so meagre as is commonly believed. The first collection of plants was performed by the French explorer of the Orient P.M.R. Aucher-Eloy, who travelled in Muscat in 1883 and explored the Jebel Akhdar area. His collection was kept in different herbaria in Europe. The 250 species collected by Aucher-Eloy comprise the main material

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providing the Jebel Akhdar records given by the monumental work of Boissier in his *Flora Orientalis* (1867-1988) as well as Blatter's *Flora Arabica* (1919-1936) and Schwarz's *Flora des tropischen Arabien* (1939).

The present study, though in a limited area compared to the vast area of the country, is an attempt to record more detailed data on the plant communities and their habitat features in the area surveyed. The prevailing environmental conditions and their effect on the pattern and distribution of the plant communities have been investigated. The aquatic plants growing in particular habitats are studied. Also, the weed flora in the cultivated fields as well as the plants growing in wasteland in the vicinity of cites and plantations are given.

The present work has evolved out of a limited work during an excursion over the period February 27 to March 8, 1985.

THE SURVEYED AREA

Oman is a vast country with widely different and varied physiographic features and environmental conditions. The surveyed area is confined to a limited sector in northern Oman. It is regretted that the study area does not include the high range of Jebel Akhdar. However, the surveyed area comprises many eco-geomorphological systems, which could be further subdivided into different habitats identified by the correlation to the differences in physiography, edaphic and biotic factors. Furthermore, it is possible to differentiate several plant communities; each has its own characteristic habitat features.

The investigated stands are located along the roads crossed by the authors during the study. A glance to Fig. 1, which shows the location of the study area, shows the route of the excursion. This route covers the following sectors:

1. The area along the road from the capital region (Ruwi) to Qurayat, with a distance of about 84 km. This road crosses a range of mountains with elevations upto 1000 m above sea level. In Jebel Abu Da'ud, which borders the part of the road before Qurayat on its northern side, there are points reaching an elevation of 1190 m. The road crosses the middle part of a wadi, the tributaries of which drain Jebel Al-Hazimah and Jebel Al-Abyad. Near Qurayat, the road extends in the wide alluvial delta of a large wadi.

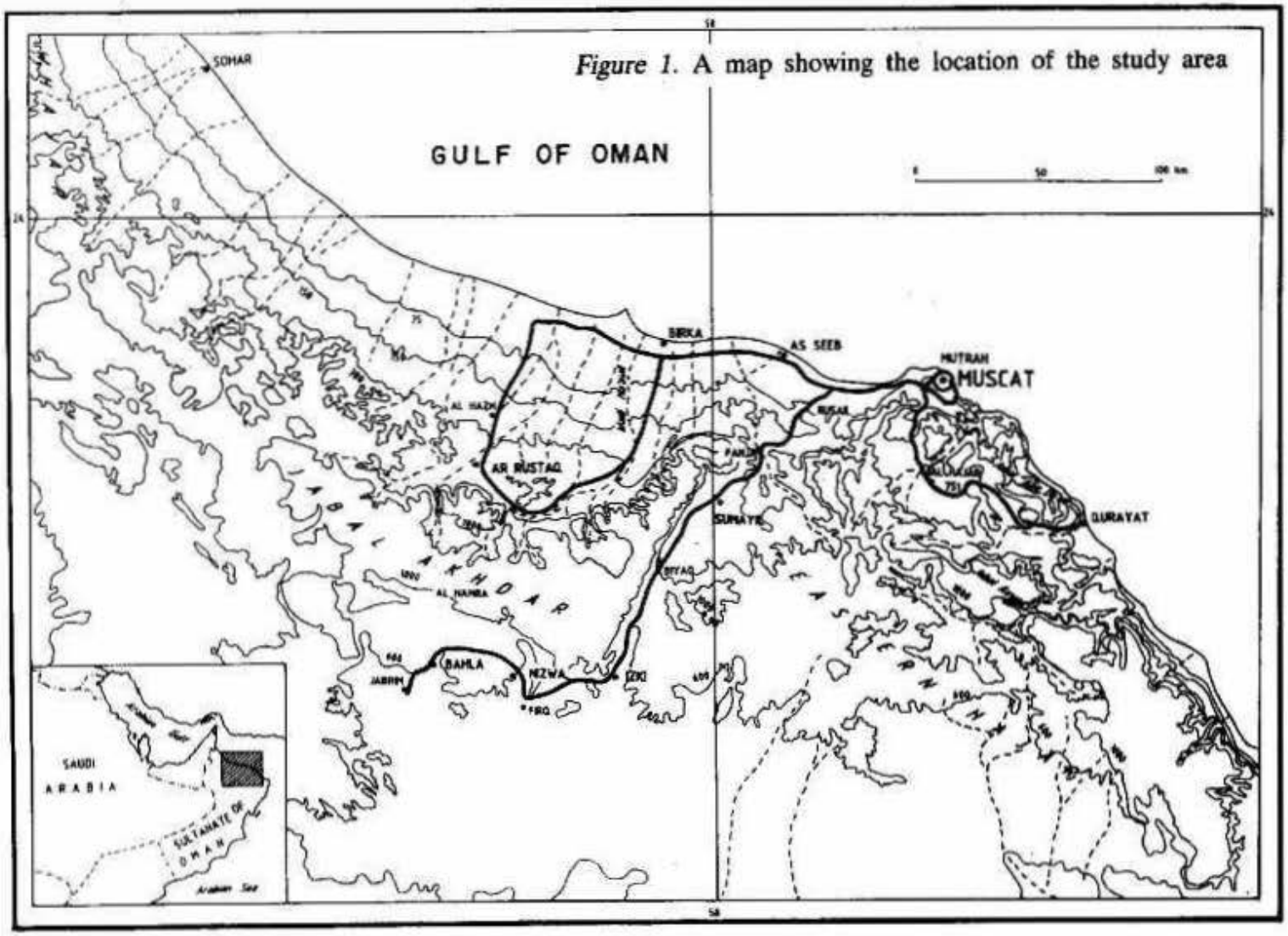

Figure 1. A map showing the location of the study area

2. The road from the capital region to the inner region till Jabrin, via Bidbid, Sumayil, Biyaq, Izki, Nizwa and Bahla. The road runs in the major "divide" between the Gharbiya, or western Jebel, and the Sharqiya, or the eastern Jebel. The vegetation was studied in different habitats along the road; including the wide plants, date-palm plantations, wadis, slopes... etc. The most western reach of the excursion was Jabrin, where the finest Oman's castle was built in the late seventeeth century (Photo 1, pl I).

In this sector of the study area, the vegetation of wadi Al-Hijri, W. Tanuf, W. Bahla, Al-Hamra area, Al-Misfat area (Photo 2, Pl. I) and the area near Falaj Dares and Wadi Kalbu near Nizwa was investigated. The weed flora was studied.

3. The road from the capital region to ArRustaq, via Birka in Batinah, the tributaries of Wadi Maáwil and al-Wabi. The road from ArRustaq to Al-Hazm was followed to reach Batinah near Al-Musanea and then to Birka and Muscat.

In this sector, the Batinah coastal plain, the foothills of the mountains, the tributaries of Wadi Maawil, ArRustaq and Al-Hazm were surveyed. The weed flora of the date-palm plantations at Al-Hazm was studied.

CLIMATE

The climatological data in Oman are too scanty, Meteorological records are kept since a few years. Nevertheless, rainfall records in Muscat are kept since 1893. The available rainfall data at four stations in the study area are given in Table 1. The two coastal stations, namely Muscat and Sohar, have an average annual rainfal of 103.7 and 106.3 mm, respectively. At both stations, rainfall occurs all the year around, except in September at Muscat and September and October at Sohar. The rainiest months at both stations are January, December and February. Rainfall over the period May-October does not exceed 6 mm per month.

The rainfall data at ArRustaq do not provide us with a true picture as they are representing one year record. Generally, these data show that the highest rainfall occurs in August. It is regretted that there are no more available data for rainfall at this station. In view of the elevation of this station, its geographical position and the plant life, one may expect higher rainfall than the data given for the year 1978.

Table 1

Average monthly rainfall (mm) at four stations in northern Oman. Data for Muscat and ArRustaq obtained from Oman Statistical Yearbook 1978.

Month	Muscat (83 years)	Sohar . .	ArRustaq (one year)	Nizwa . .
January	29.0	27.9	9.5	19.0
February	18.7	16.8	11.5	40.0
March	11.2	8.8	19.5	12.0
April	8.5	11.0	—	15.0
May	2.3	5.7	—	15.0
June	1.7	0.6	—	8.0
July	1.6	5.0	8.0	31.0
August	1.9	3.7	24.0	9.0
September	—	—	12.0	4.0
October	1.7	—	—	4.0
November	7.6	8.5	—	3.0
December	19.5	18.3	—	4.0
Total annual	**103.7**	**106.3**	**88.3**	**198.0**

The highest rainfall in the study area is at Nizwa, amounting to 198 mm per year. Rain occurs in all months of the year with values ranging from 3 mm in November to 49 mm in April. The rainiest months are April (49mm), February (40mm) and July (31 mm). Over the period from September to December, the average monthly rainfall ranges from 3 to 4 mm.

These data evince that the pattern of distribution of the monthly rainfall differs from one part of the study area to the other.

Records at Muscat taken over a period of 83 year (Fig. 2) show that the annual rainfall varies from about 10 mm in 1922 to 260 mm in 1944. The quotient of variation, which is the ratio of maximum annual to the minimum annual rainfall, reaches 26 at Muscat.

Heavy, but sporadic rains of local nature do occur in the area. These rains result in severe torrential floods. A particular tragic example of flash flood occurred in June 1890, when cyclonic storm hit Oman and between midnight on the 4th and midnight on the 5th, 28.3 mm of rain fell. The water rose with such violence that seven hundred people were drowned. According to Arab historians, there were incidents of heavy spring rainfall which caused severe destruction of the villages.

Air temperatures are high in summer at all stations in the study area, but are mild in winter months. The average monthly maximum temperatures are 40.9°C at Muscat, 38.9°9C at Sohar, 43.3°C at ArRustaq and 41.7°C ay Nizwa. On the other hand, the averages monthly minimum temperatures are 16.3°C, 12°C, 12.2°C and 8.6°C at Muscat, Sohar, ArRustaq and Nizwa, respectively. These data show how far the plants in the study area are subjected to wide seasonal fluctuations of air temperature.

The climatic diagrams (Walter 1955) of Muscat, Sohar, ArRustaq and Nizwa (Fig. 3) exhibit that all the months at the three former stations are to be regarded as arid. On the other hand, at Nizwa the three peaks of the rainfall curve minimize the aridity and at least February and April can be considered as relatively humid periods.

PLANT COMMUNITIES AND HABITAT FEATURES

The vegetation exhibits recognizable units distinguished on the bases of their floristic composition and the prevailing habitat features. The rugged topography leads to the occurrence of widely different habitats, each with particular soil attributes, water resources and consequently different plant communities. Each community is named after the dominant species, which gives the community its physiognomy. The three studied sectors vary as regards the pattern and amount of rainfall. Therefore, each sector will be treated seperately.

I. Plant communities along Muscat-Qurayat road

1. **Acacia tortilis** community

The dominant plant exhibits a conspicuous wide distribution in the habitats encountered in this study. It is the most widespread tree in Arabia. In view of its wide geographical distribution, the community has different associates in the various localities.

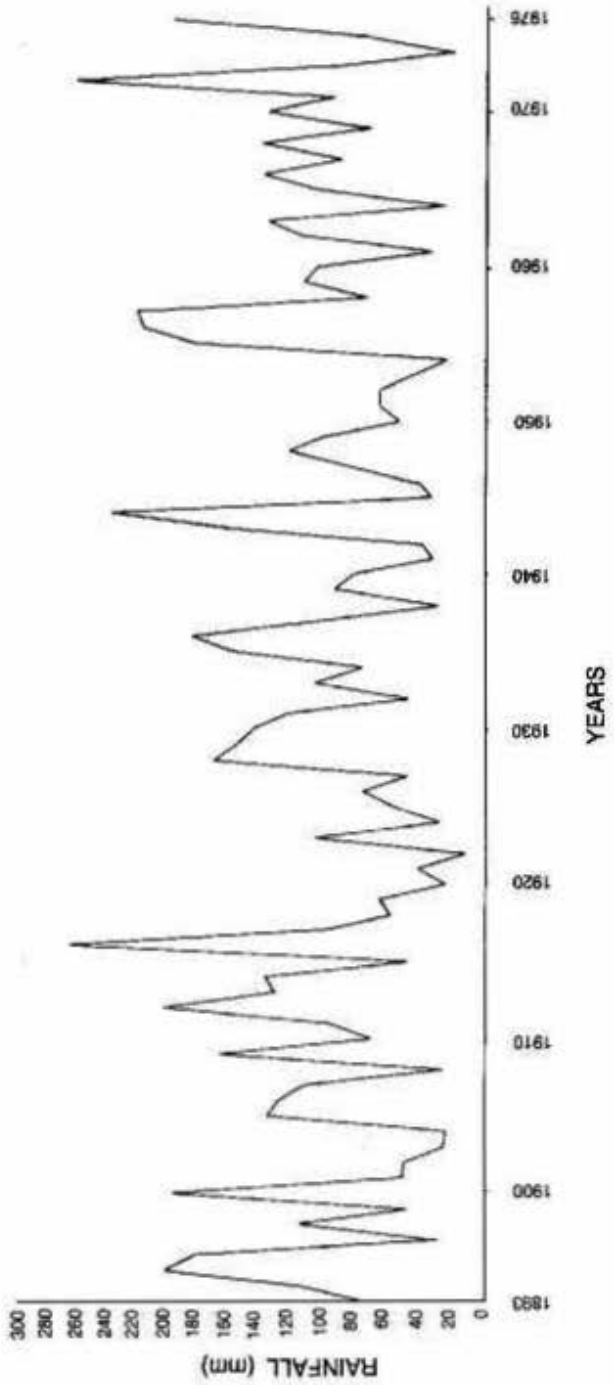

Figure 2. Rainfall records at Muscat over the period 1893-1976

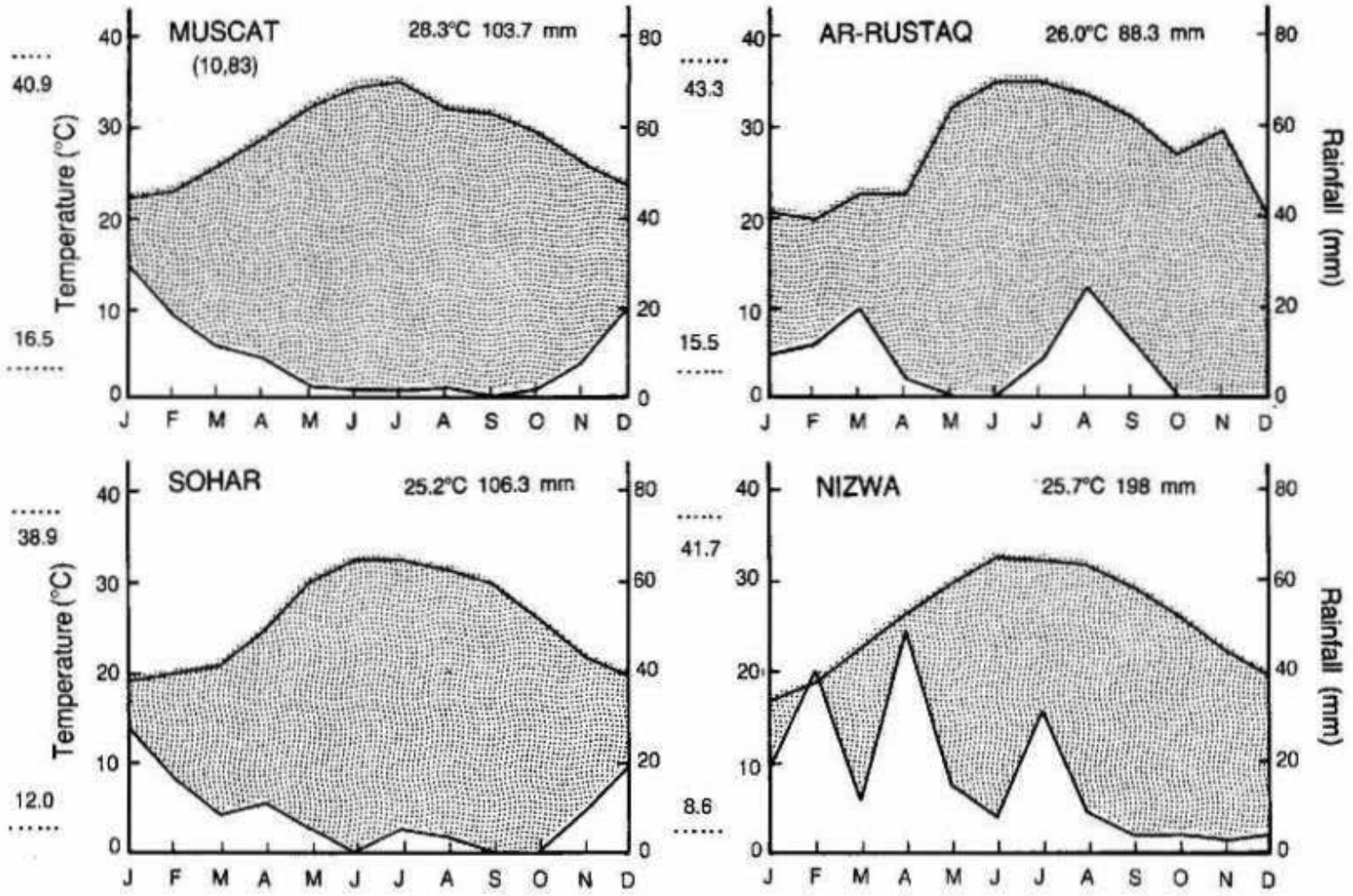

Figure 3. Climatic diagrams at four stations in the study area.

In the study sector, this community abounds in wide valleys with deep wadi-fill (Photo 3, pl. II). The ground surface is covered with gravels and pebbles with different colours. The habitat supporting this community is subjected to severe water erosion.

The plant cover is about 30% and is mainly represented by the dominant plant, which aquires heights of 3 to 6 m. Associate species include *Rhazya stricta* (Harmal), *Lycium shawii* (Awsaj), *Gaillonia aucheri*, *Taverniera glabra* (Asmat), *Boerhavia coccinea* and *Indigofera argentea*.

Due to the harsh environmental factors, mainly water deficiency, the ephemeral plants are weekly represented by a few species. As a result of the prevailing drought, these ephemerals escaped it by reducing their vegetative growth and producing flowers and fruits at earlier stages for their lives. For example, the *Aizoon canariense* plants, though small with a diameter not exceeding 2 cm produced fruits (1-5 fruits / plant). Usually, under ample water supply conditions, this plant produces hundreds of fruits. Other ephemerals as *Aristida adscensionis* and *Tribulus pentandrus* exhibit the same phenomenon.

Variation in the local topography results in the appearance of special microhabitats. A depression of a few centimetres below the ground surface leads to the accumulation of thin alluvial sediments. Such a slight depression harbours a very dense ephemeral growth with an average density of 600 individuals per sq. m. This is the average of 10 quadrats, each is $1m^2$. The slightly elevated ground has no ephemeral growth. The most common species in the depression include *Aizoon canariense, Aristida adscensionis, Arnebia hispidissima, Tribulus pentandrus* and *Plantago* sp.

Human impact is remarkable in the wide wadis supporting the *A. tortilis* comunity. This can be evinced from: (a) overgrazing as evident from the scarcity and even the absence of palatable species, (b) the appearance of ruderal plants under the canopy of *Acacia* trees and (c) trees cut for firewood (Photo 4, pl. II). Herds of grazing animals gather in the shadow of *Acacia* trees. This is clear from the obvious trampling effect under the canopies of these trees. In these sites, there is a remarkable growth of *Chenopodium murale* seedlings with a density of 100 individuals / sq.m. This phenomenon demonstrates how animals play a paramount role in the dessimination of weed seeds which they would transfer from the cultivated areas. Other species below the canopy of the *Acacia* trees, which enjoy the shade and relatively better water conditions than the sunny sites, include

Aizoon canariense, Turibulus pentandrus and *Eragrostis barrelieri.* It is to be noted that donkeys, sheep and goats occupy the central part of the wadi, while the hills and the slopes are utilized by goats.

2. **Acacia tortilis-Maerua crassifolia** Community

This community occurs on the terraces bordering the main channels of wadis crossing the mountains. The habitat supporting this community is characterized by the presence of stones, pebbles and gravels on the ground surface. Fine sediments are confined to the pockets among the stones and around the plants in the form of low mounds. This habitat is subjected to severe water erosion and it is not infrequently encroached by torrential floods in rainy years. Trapping of dead plant material and fine sediments by growing plants on their sides towards the upstream of the wadi is an indication. The main wadi bed, which is the lowest part as regards the local topogrphy, is usually devoid of perennial plant growth. This is due to the effect of torrents which remove the fine soil and leave only lag material of gravels and pebbles. Hence, there is no ample chance for the growth and establishment of perennials.

The plant cover is about 20%. This is mainly represented by perennials. The ephemeral plant growth is thin and is represented by stunted individuals. Ephemerals appear mainly on islands of fine deposits in the wadi.

The main associates include *Ziziphus spina-christi,* which shares the tree layer with the dominant species. Other associates are *Rhazya stricta, Iphiona scabra, Taverniera glabra* (grazed), *Ochradenus aucheri, O. baccatus, Cymbopogon schoenanthus* (Idhkhir), *Corchorus depressus* and *Boerhavia coccinea* and *B. elegans. Forsskalea tenacissima* is a very common associate growing in the pockets among the rocks and boulders.

The ephemerals recorded in this community include *Aizoon canariense, Aristida adscensionis, Asphodelus fistulosus, Rumex vesicarius, Erodium laciniatum, Tribulus pentandrus, Zygophyllum simplex, Morettia philaeana* and *Cenchrus setigerus.*

Grazing is obvious in this community, and the vehicles crossing the wadi have a remarkable effect on the plant life through their influence on the soil characteristics.

3. **Acacia tortilis - Euphorbia larica** community

This community is common on the rocky slopes (Photo 5, pl. III). The plants are confined to the crevices between the rocks and the pockets among the boulders. The water revenue of this habitat is much less than that of low parts in the wadi. Therefore the plant cover is thin (5-10%) and the *Acacia* trees are not as high as those in the wadi. On the slopes, they attain heights of one to three metres. The co-dominant plant *Euphorbia larica* (Asbaq) is a succulent leafless undershrub.

The associates include scattered individuals of *Rhazya stricta, Iphiona scarba, Cleome trifoliata, Ochradenus baccatus, O. aucheri, Cymbopogon schoenanthus, Morettia canescense* var. *parviflora, Cometes surratensis, Tribulus pentandrus, Aristida adscensionis, Chrozophora oblique, Heliotropium longifolium, Indigofera argentea* (grazed), *Fagonia kassassii, Eragrostis barrelieri, Echinops* sp. and *Euphorbia* sp.

In the pockets among the rocks, there is a particular chenopod, aff. *Salsola* sp. growing along the elevated margins of the community, where is no ample room for the growth of *Acacia tortilis.*

4. **Maerua crassifolia - Euphorbia larica** community

This community occurs on the slopes at higher elevations. *Acacia* is replaced by *Maerua.* The slopes supporting this community are stony, very steep and are covered with large blocks and boulders.

The plant cover ranges from 20 to 30%. The shrub and tree layer includes *Rhus aucheri.* Other associates include *Lavandula subnuda, Cymbopogon schoenanthus, Iphiona scabra, Tephrosia haussknechtii, Glossonema edule, Polygala erioptera, Convolvulus pilosellifolius, Andrachne telephoides, Aristida adscensionis, Faqonia bruguieri, Stipagrostis plumosa, Micromeria biflora, Launaea cassiniana, Heliotropium longifolium, Boerhavia elegans* and *Bromus* sp.

5. **Prosopis cineraria - Salsola longifolia** community

A few kilometres before Qurayat, there is a wide plain representing the delta of a wide wadi. This plain is lower than the mountains and higher than the littoral plain. The soil salinity is expected to be intermediate between that of the mountains and the coastal plain. The community dominated by *Prosopis* and *Salsola* occupies this sector. In some parts of this plain, due to increased salinity, halophytic plants are apt to dominate.

The soil supporting this community is deep, fine-textured and of alluvial origin. In particular sites the soil surface is covered with a slat crust.

The plant cover is about 80%. *Prosopis* is tree attaining 10 m high, while *Salsola* is a shrub with an average height of one metre. The succulent leaves of *Salsola* are shed when they are loaded with salts, which is considered a mechanism by which the plant gets rid of excess salts.

The associates include *Tamarix tetragyna* (Athl), *Limonium stocksii, Cressa cretica, Aeluropus massauensis* (all are salt secreting plants) and *Atriplex leucoclada* (salt shedding with bladders).

In particular sites along the man made trails water accumulates leading to the appearance of a dense growth of *Scirpus litoralis.*

Some weeds, escaping from the neighbouring cultivated area, grow in this community, e.g. *Setaria verticellata, Solanum nigrum and Malva parviflora.* Individuals of *Gossypium* sp. have been recorded in this habitat (Photo 6, pl. III).

6. **Tamarix tetragyna** community

In the coastal part of the wadi delta, the soil is saline. Such a habitat supports a halophytic community dominated by *Tamarix tetragyna* (Photo 7, pl. IV). The plant cover is 50 to 70%. The dominant plant may form pure populations. However, in low parts *Arthrocnemum glaucum* grows prosperously.

7. **Tephrosia apollinea** community

In the mountainous area of the studied sector, there is a particular habitat at the feet of the hills. In such a habitat, there is a considerable accumulation of fine-textured sediments, which are usually impregnated with pebbles. It receives considerable amounts of water from the elevated hills. A community dominated by *Tephrosia apollinea* occurs in this habitat.

The plant cover is about 40% and is represented mainly by the dominant plant. *T. apollinea* is not palatable, and hence it is not subjected to destruction by animals as the associates. The interspaces between the adult plants is occupied by numerous seedlings of this plant. The associates include *Aerva javanica, Taverniera glabra* (grazed), *Cenchrus setigerus* and *Morettia philaeana.*

8. **Cymbopogon schoenanthus** community

The drainage systems of the wadis comprise innumerable ravines and tributaries which lead the runoff water to the main channel of the wadi. The beds of these tributaries are sloping steeply. Therefore they are usually rocky and water eroded. Fine sediments are trapped by the rocks and they fill the crevices and pockets among them. This habitat supports a community dominated by *Cymbopogon schoenanthus* (Photo 8, pl. IV). This plant is an aromatic grass. It has filiform leaves which become coiled and turn reddish in colour when they dry. The tussock formed by this plant is usually dry to its periphery. These dry leaves are those produced in the former growing season and died in the dry season. After rains new leaves and culms are produced from the dormant buds protected by the dead leaves. This is a mechanism by which the plant reduces its transpiring surface during the dry season. It can be considered a partial death for the sake of survival.

The plant cover is thin; not exceeding 10% and the main associates are chasmophytes. Among the associates one mentions *Hyparrhenia hirta, Capparis mucronifolia* (Lasaf), *Forsskalea tenacissima, Euphorbia granulata, Taverniera glabra, Pergularia tomentosa* and *Fagonia indica*. A few individuals of *Lycium shawii* occur in the shade of the rocks.

The ephemeral associates include *Aizoon canariense, Aristida adscensionis Asphodelus fistulosus, Zygophyllum simplex, Reichardia tingtana, Arnebia hispidissima, Rumex vesicarius* and *Cenchrus setigerus.*

In some particluar sites, where fine deposits accumulate, there is a dense ephemeral growth of *Aizoon canariense* and *Asphodelus fistulosus.*

II. Plant communities along Muscat-Nizwa road Nizwa area

1. **Acacia tortilis-Fagonia indica** community

This community occurs in the gravelly wadi beds. The habitat supporting this community is subjected to water erosion. The ground surface is covered with large pebbles and gravels, which are in some sites compact together forming an armoured desert pavement. Nevertheless, in lower parts accumulation of fine sediments results in the growth of plants. Though the overall scenery shows the dominance of *Acacia* and *Fagonia*, yet the latter species and some associates exhibit local abundance as a result of the mosaic occurrence of islands with fine deposits.

The plant cover is 10% but increases to almost 20% in low parts and runnels crossing the wadi bed. The *Acacia* trees are widely spaced with a low density of one individual per 100 sq.m on the average. The co-dominant *Fagonia* exhibits variable densities depending on the local topographic variations.

The associates include *Rhazya stricta, Tephrosia quartiniana* (with local abundance in small drainage lines), *Ochradenus aucheri, Convolvulus pilosellifolius* and *Gaillonia aucheri.*

Along the road sides, there is an ephemeral growth of scattered individuals of *Tribulus pentandrus* and *Aristida meccana.*

2. **Iphiona scabra** community

The plants crossed by the road from Muscat to Nizwa are occupied by a widespread cummunity dominated by *Iphiona scabra.* These plains are characterized by undulating landscape. The unevenness of the ground surface results in a mosaic pattern of the surface deposits. Elevated parts are covered by compact gravels and pebbles underlain with fine sediments. In low parts, fine deposits are found between the stones on the ground surface.

The plant cover varies from 15 to 25%. The associates include scattered individuals of *Acacia tortilis, Fagonia indica, Ochradenus aucheri, Convolvulus virgatus, Gaillonia aucheri, Tephrosia quartiniana, Farsetia longisiliqua, Euphorbia larica, Jasonia montana* and *Salvia schimperi.* Due to recent rains in the area, the moistened alluvial deposits support a dense ephemeral growth of *Asphodelus fistulosus.*

3. **Ziziphus spina-christi** community

This community occurs in wadis at higher elevations than those supporting the afore-mentioned communities. It occupies the main channels of these wadis, which collect runoff water from vast catchment areas (Photo 9, pl. V). These wadis have severely eroded wadi beds, which are covered by large blocks and boulders. In narrow parts of these wadis, the walls of the wadi are very steep; they usually support chasmophytic plants.

The plant cover ranges from 20 to 30%, which is mainly contributed by the dominant plant (wild Sidr) *Ziziphus spina-christi.* Its trees attain heights of 10 m or more and their trunks have diametres of about 60 cm.

The associates include *Ficus salicifolia, Acacia tortilis, Lycium shawi* (grazed) *Nerium muscatense* (Haban), *Acridocarpus orientalis* (Qafas), *Capparis mucronifolia* (Lasaf), *Fagonia indica, Tephrosia quartiniana, Euphorbia larica* and *Indigofera intricata* (grazed).

In one of the wadis supporting this community, Wadi Al-Hajri, the canal of a falaj is constructed along the side of the wadi at a level higher than that of the wadi bed. This canal supplies the Tanuf Water Bottling Factory with water. The seepage of water from the constructed canal gives the chance for the growth of many chasmophytes in the crevices between the rocks (Photo 10, pl. V). The plant species recorded on the upright wall supporting the canal include *Lavandula subnuda* (Somer), *Capparis mucronifolia, Cocculus penduius* (climbing on *Ziziphus* trees), *Micromeria biflora, Lindinbergia indica, Ficus salicifolia,* and *Pennisetum setaceum.*

4. **Acridocarpus orientalis** community

This community occurs in the drainage line (5-10 m wide) which cross the undulated stony plains along the road from Nizwa to Bahla. These runnels have gravelly beds with fine alluvial deposits. It seems that this habitat receives more water resources as compared to the slightly elevated stony terraces bordering it.

The plant cover is 20-30%. The common associates include *Acacia* aff. *seyal, Maerua crassifolia, Lycium shawii, Ochradenus aucheri, Fagonia indica, Tephrosia quartiniana, Indigofera intricata* and *Euphorbia larica.* It is to be noted that *Fagonia* preponderates in gravelly sites, while *Tephrosia* increases in sites with alluvial deposits.

5. **Fagonia indica** community

This community occupies the plains covered with large gravels and pebbles. These pebbles are underlain with compact fine deposits. It should be noted that this community occupies slightly elevated sites, while the *Acridocarpus* community abounds in the runnels (Photo 11, pl. VI).

The plant cover differs by the variation of the local topography and ranges from 10 to 20%. The associates are *Rhazya stricta* and *Tephrosia quartiniana.* A few, widely spaced individuals of *Acacia* aff. *seyal* are recorded in this community.

6. **Zygophyllum mandavilli** community

This community occupies the wide gravelly plains between Nizwa and Bahla. (Photo 12, pl. VI). The ground surface is covered with dark-coloured gravels and pebbles. These are underlain with fine compact sediments, which are impregnated with pebbles and gravels. Undulations in this habitat lead to the disappearance of plant growth in the elevated parts, except a few stunted individuals of the dominant plant. *Z. mandavilli* is a succulent perennial (Photo 13, pl. VII).

The plant cover is about 40%. The density of the dominant plant as well as the plant cover increase in the drainage lines crossing the plain. There is a variety of species appearing in these runnels including *Tephrosia purpurea, Rhazya stricta, Maerua crassifolia, Cadaba glandulosa, Ochradenus aucheri, Fagonia indica, Euphorbia larica, Acacia* aff. *seyal, Pteropyrum scoparium* (Sidaf) and *Sageretia spiciflora* (Nimt).

7. **Euphorbia larica** community

This community occupies the steep stony slopes in the mountainous area between Al-Hamra and Al-Misfat (Photo 14, pl. VII). The plant cover is low; being about 10% The main associates include *Acacia* aff. *seyal, Tephrosia purpurea, Crotalaria wissmanii, Fagonia indica, Ochradenus aucheri* and *Aristida meccana.* Rare plants include *Acridocarpus orientalis, Aerva javanica* and *Lycium shawii.* The dominant plant is collected for use as firewood for pottery (Photo 15, pl. VIII).

8. Hydrophytic Plant Communities

In particular sites in the study sector, there may be a chance for the accumulation of water all the year around. This usually occurs in areas receiving spilled water from agricultural activities and in ponds in the main channels of the wadis in the mountainous region. Irrigation canals in Sumayil transferring water from the falaj to the fields have their banks inhabitat by *Arundo donax* (Photo 16, p. VIII). In Biyaq, the water spilled from the palmgroves accumulates in ditches and depressions. This results in the growth of dense populations of *Typha domingensis.* (Photo 17, pl. IX). Along the margins of such sites occupied by *Typha,* there are many species as *Saccharum spontaneum, Juncus rigidus, Phargmites australis* and *Tamarix nilotica.* On the moist ground in the shade of these plants there are mats of *Phyla nodiflora.*

In Wadi Bahla, the accumulation of runoff water in permanent ponds results in the growth of many hydrophytes, e.g. *Potamogetn nodosus* (Photo 18, pl. IX), *Najas pectinata, Typha domingensis, Cyperus laevigatus, Scirpus tuberosus, Cyperus schimperianus, Bacopa monieri, Polygonum* sp. *Juncus rigidus,* and *Phyla nodiflora* on the margins.

III. Plant communities in ArRustaq-Batinah area

1. **Salvadora persica** community

Though *Salvadora persica* (Arak) is recorded in the mountainous area, yet it dominates a community in the coastal plains of Batinah. The dominant plant forms sizeable mounds of wind blown fine sediments; reaching a height of 5 m. The soil is very deep and fine-textured. It is usually transported by wind. The plant cover is about 40% and is mainly represented by the dominant plant. Associates include *Zygophyllum simplex, Z. qatarense, Tribulus ochroleocus, Chrozophora obliqua* and *Faqonia ovalifolia.*

The subterranean stolons and sometimes the aerial branches of *Salvadora* are used by the natives as a toothbrush. The use of these toothbrushes, known as miswak is recommended by the Prophet (El-Ma'ayergy *et al.* 1984).

2. **Zygophyllum qatarense** community

This community occupies vast areas in Batinah desert coastal plain (Photo 19, pl. X). The landscape is almost even and gently sloping towards the Gulf of Oman. The soil is deep, and both wind and water erosion are remarkable.

The plant cover is about 40%. The common associates include *Acacia tortilis, Cornulaca leucacantha, Tribulus ochroleuocus, Neurada procumbense* and *Stipagrostis plumosa.*

Many new farms have been established in this area. Agriculture depends on ground water extracted from wells dug in the alluvial deposits of the wadi-fill. These wadis have their upstreams in the mountainous terrain westwards.

3. **Acacia tortilis** community

The community dominated by *Acacia tortilis* (Samr) has a wide distribution in this sector as in the other parts of the surveyed area. In the ArRustaq-Batinah area, this community abounds in different habitats. It occurs in the desert coastal plain as well as in the wadis crossing the mountainous ridges. Due to the mosaic pattern of soil deposition and erosion, the plant growth exhibits a mosaic pattern also.

Generally, the main associates of this community include *Fagonia indica, Tephrosia purpurea, Taverniera glabra, Euphorbia larica, Ochradenus aucheri, Cornulaca leucacantha* and *Pteropyrum scoparium*. In some sites there are some trees of *Ziziphus spina-christi*.

4. **Pteropyrum scoparium** community

The community occurs in the runnels crossing the desert plains (Photo 20, pl. X). The dominant plant occurs in microsites where alluvial deposits accumulate. It is interesting to know that the leaves of this plant are eaten by the natives. These leaves are usually sold in the local market in Oman and the United Arab Emirates. (Photo 21. pl. XI).

The plant cover is low; being about 15%. The associated species include *Tephrosia purpurea, Fagonia indica, Cenchrus setigerus, Farsetia longisiliqua, Iphiona scabra, Ochradenus aucheri, Forsskalea tenacissima, Aristida meccana,* and *Asphodelus fistulosus.*

Weed Flora of Cultivated Fields and Gardens

The weed flora of the different crops and vegetables are distinctive and exhibit seasonality. However, in the study area due to wide differences in air temperatures from one locality to the other, one expects to collect summer and winter weeds in the same season in different localities. The importation of crop and vegetables seeds help in the introduction of many weeds in Oman. Generally, it is not the place here to give a comprehensive study of the weeds. During the present study, the weed flora of five localities were investigated. The studied farms and gardens are located at different localities in the study area, namely in Al-Rumais experimental farm near Muscat, a farm in Biyaq, a garden in Nizwa, the experimental farm of the Agricultural School at Nizwa gardens and orchards at Al-Misfat and a date-palm plantation at Al-Hazm (Photo 22, pl. XI). Table 2 shows a list of the collected plant species and their distribution in the five studied localities.

Plants Growing in Waste Places

Sites along the margins of fields, gardens and farms as well as waste places near human settlements support different plant species. Usually these plants receive more water supply than the desert plants. They may be considered growing in a more or less man-made habitats. Among these species one may mention *Calotropis procera* (Shakhr, Oshar), (Photo 26, pl. XIII), *Schanginia aegyptiaca, Salsola baryosma, Abutilon pannosum, Withania somnifera, Desmostachya bipinnata* (Photo 27, pl.

XIV), *Saccharum spontaneum*, *Tecomella undulata* (Farfar, along a canal of falaj Dares) (Photo 28, pl. XIV), *Salsola rubescens* (Photo 29, pl. XV), *Aerva javanica* (Raa), *Dicanthium anulatum*, *Dierophytum indicum* (Melihlah, along the hedges of a garden at Biyaq) (Photo 30, pl. XV), *Amaranthus graecizans*, *Andropogon distachyos* and *Ochradenus aucheri*.

Table 2

A list of the weeds collected from different localities in northern Oman.

I - Al-Rumais Experimental farm, near Muscat,
II - Date palm and alfalfa plantations in Biyaq,
III - Experimental farm, Agric. School, Nizwa,
IV - Garden and orchard, Date-palm factory, Nizwa,
V - Date-palm plantation, Al-Hazm
VI - Orchards and gardens, Al-Misfat.

Species	I	II	III	IV	V	VI
A. *Dicotyledons*						
Amaranthaceae						
Amaranthus graecizans	+		+	+		
Amaranthus hybridus	+		+			
Aristolochiaceae						
Aristolochia bracteolata (Photo 23, pl. XII)					+	
Boraginaceae						
Gastroctyle hispida			+			
Heliotropium supinum		+				
Caryophyllaceae						
Spergularia salina			+			
Chenopodiaceae						
Chenopodium murale	+	+	+	+		
Compositae						
Centaurea intybus						+
Flaveria trinervia (Photo 24, pl. XII)		+		+		+

Contd. Table 2

Species	I	II	III	IV	V	VI
Pulicaria orientalis		+				
Sonchus oleraceous		+	+			
S. tenerrimus	+					
Urospermum picroides					+	+
Xanthium spinosum		+				
Convolvulaceae						
Convolvulus arvensis	+	+				
Cruciferae						
Sinapis arvensis			+		+	
Sisymbrium irio		+	+		+	
Euphorbiaceae						
Andrachne telephoides					+	
Euphorbia geniculata				+		
E. prostrata				+		
E. peplus					+	
Frankeniaceae						
Frankenia pulverulenta			+		+	
Gentianacea						
Centaurium pulchellum				+		
Labiatae						
Ocimum hadiense					+	
Leguminosae						
Astragalus hamosus				+		
A. tribuloides			+			
Cassia italica			+			
Melilotus indicus	+	+		+	+	
Malvaceae						
Abutilon pannosum	+				+	

Contd. Table 2

Species	I	II	III	IV	V	VI
Malva parviflora					+	
Nyctaginaceae						
Boerhavia coccinea						+
Plantaginaceae						
Plantago amplexicaulis			+			
Polygalaceae						
Polygala erioptera			+	+		
Portulacaceae						
Portulaca oleracea	+		+			
Primulaceae						
Anagallis arvensis	+	+	+	+	+	
Ranunculaceae						
Ranunculus muricatus						+
Rutaceae						
Haplophyllum tubrculatum			+			
Sapindaceae						
Cardiospermum halicacabum					+	
Dodonea viscosa		+				
Scrophulariaceae						
Antirrhinum orontium		+				
Veronica cymbalaria						+
Solanaceae						
Slonaum nigrum	+				+	+
S. incanum (Photo 25, pl. XIII)			+		+	
Withania somnifera					+	
Tiliaceae						
Corchorus trilocularis					+	
Grewia erythraea					+	
Verbinaceae						
Phyla nodiflora		+			+	

Contd. Table 2

Species	I	II	III	IV	V	VI
B *Monocotyledons*						
Cyperaceae						
Cyperus rotundus	+					
Gramineae						
Chloris virgata			+		+	
Cynodon dactylon	+	+	+	+		
Dactyloctenium aegyptium	+		+			
D. sindicum			+			
Dinebra retroflexa			+			
Echinochloa colonum			+	+		
Eragrostis cilianensis			+			
E. poaeoides	+					
Pennisetum orientale		+	+			
Polypogon monspliensis		+				
Setaria verticellata	+			+		
S. viridis				+		
Sporopolus spicatus	+		+		+	
Liliaceae						
Asphodelus fistulosus			+		+	

CONCLUDING REMARKS

Though the present study covers a small area of Oman and has been carried out in a short time, yet it aims at giving more or less detailed data and information of the plant life. It may serve as a basis for future detailed studies.

Oman is situated at the margin of two moisture bearing air masses, one coming from the Mediterranean and the other from the Indian Ocean, and in consequence rainfall is irregular. Wilkinson (1977) writes: one of the reasons of the unpredictability of

rainfall is that the mountain range of Oman lies at the boundary of two meteorological regions, that of the Saharo-Arabian subtropical hot desert and that of the Indian Ocean monsoon region. The rainfall data at Muscat evince the considerable variations in total annual rainfall. The seasonality of rainfall varies from one station to the other and at the same station from year to year. Despite the low annual rainfall, it is not infrequent that a few centimetres of rain fall within a short time turning the dry wadi beds into rushing torrents, which sweep everything before them. The different stations in the study area exhibit different temperature regimes. This is referred to the altitudenal variations.

The present study evinces the remarkable role of topography in the distribution of the recognized plant communities. Such a role is due to the considerable effect of topography on the water resources and the soil attributes in any habitat. Runoff is a factor of utmost importance in increasing the water resources of some habitats. Topography acts to collect and redistribute the water; a phenomenon which increases the effectiveness of the limited amount of rainfall. Soil properties, especially the physical attributes, are controlled by the topographic features and by the physical agents of transport. Low parts with regard to the local topography (collecting areas) receive runoff water, water-borne and wind-blown sediments. On the other hand, elevated parts have limited water resources and shallow soil, which is usually more coarse-textured than those in low parts. In a desert wadi, changes in topography lead to the differentiation of a number of microhabitats; each supports a particular plant assemblage (Batanouny 1973). Modification of the soil properties and the water resources through the effect of topographic affect the distribution of the plant communities (Batanouny 1985).

The communities recorded in this study are dominated by plants of different life and growth forms. These dominants have different water requirements; including xerophytic and hydrophytic plants. They, also, exhibit different affinities towards salinity; some of are halophytes with various mechanisms of salt tolerance and resistance. The dominant plant species of the recognized communities can be classified into the following groups:

1. Desert trees: *Acacia tortilis, Ziziphus spina-christi, Prosopis cineraria* and *Maerua crassifolia.*
2. Desert shrubs: *Salvadora persica, Acridocarpus orientalis* and *Pteropyrum scoparium.*
3. Halophytic shrubs: *Tamarix tetragyna*

4. Non-succulent undershrubs: *Tephrosia apollinea, Iphiona scabra* and *Fagonia indica.*
5. Succulent undershrubs: a) Non-salt accumulting: *Euphorbia larica*
   b) Salt accumulating: *Zygophyllum mandavilli, Z. qatarense* and *Salsola longifolia.*
6. Grasses: *Cymbopogon schoenanthus*
7. Hydrophytes: *Potamogeton nodosus, Najas pectinata* and *Typha domingensis.*

The human impact on the vegetation of the surveyed area is obvious. The effects of man on the vegetation may be direct on the vegetation cover itself or indirect through their influence on the other components of the ecosystem. Human activities observed in the study area and affecting the plant cover directly include cutting or uprooting of ligneous species for firewood, overgrazing, collection of plants for food and medicinal purposes. Among the direct human effects one may mention the activities accompanying the development process including industrial activities, expansion of irrigated agriculture, construction of roads and the off-road vehicles. In the words of Mandaville (1975) "Woodcutting, relatively heavy grazing, and some trampling by livestock have obviously been going on for generations and have strongly affected the appearance and composition of the vegetation even in the more protected ravines".

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PLATE I

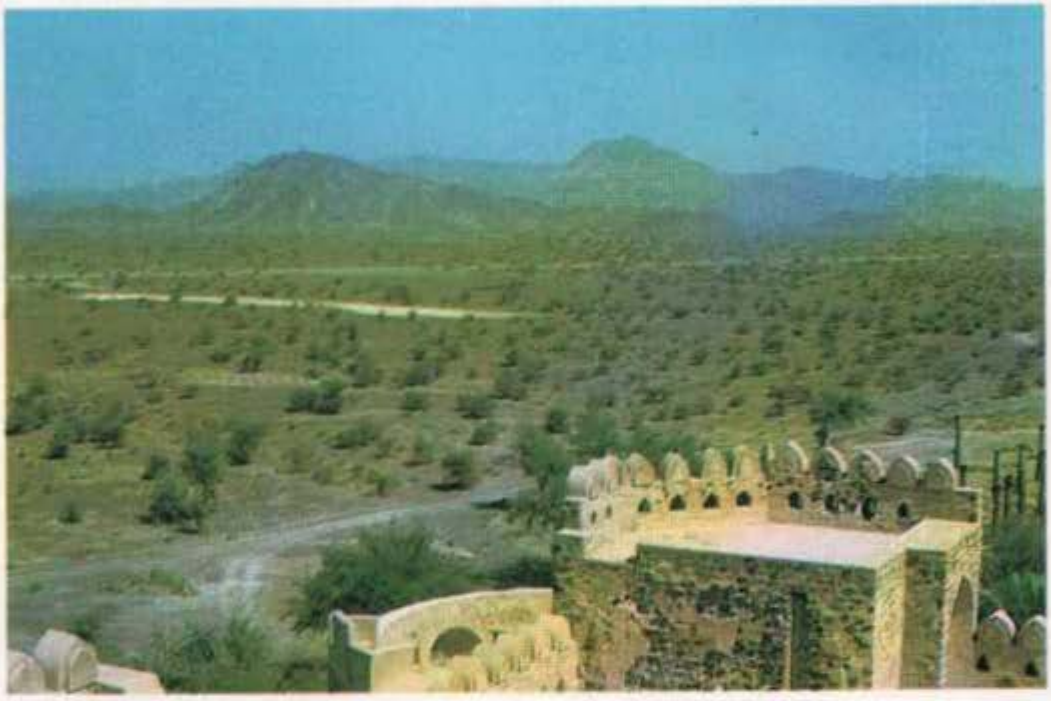

Photo 1. An overview from Jabrin's castle showing vast areas occupied by *Acacia tortilis* community.

Photo 2. Al-Misfat area with dense date-palm plantations and houses built in the mountains.

PLATE II

Photo 3. *Acacia tortilis* community occupying a wadi crossing Muscat-Qurayat road.

Photo 4. Tree felling for firewood; *Acacia tortilis* community, Muscat-Qurayat road.

PLATE III

Photo 5. *Acacia tortilis* - *Euphorbia larica* community on the rocky slopes; Muscat-Qurayat road.

Photo 6. *Gossypium* sp. growing in a wadi near Qurayat.

PLATE IV

Photo 7. *Tamarix tetragyna* community in the downstream of a wadi near Qurayat.

Photo 8. *Cymbopogon schoenanthus*(L) Spreng, growing in the rocky beds of ravines.

PLATE V

Photo 9. *Ziziphus spina-christi* community occupying a wide wadi near AL-Hamra.

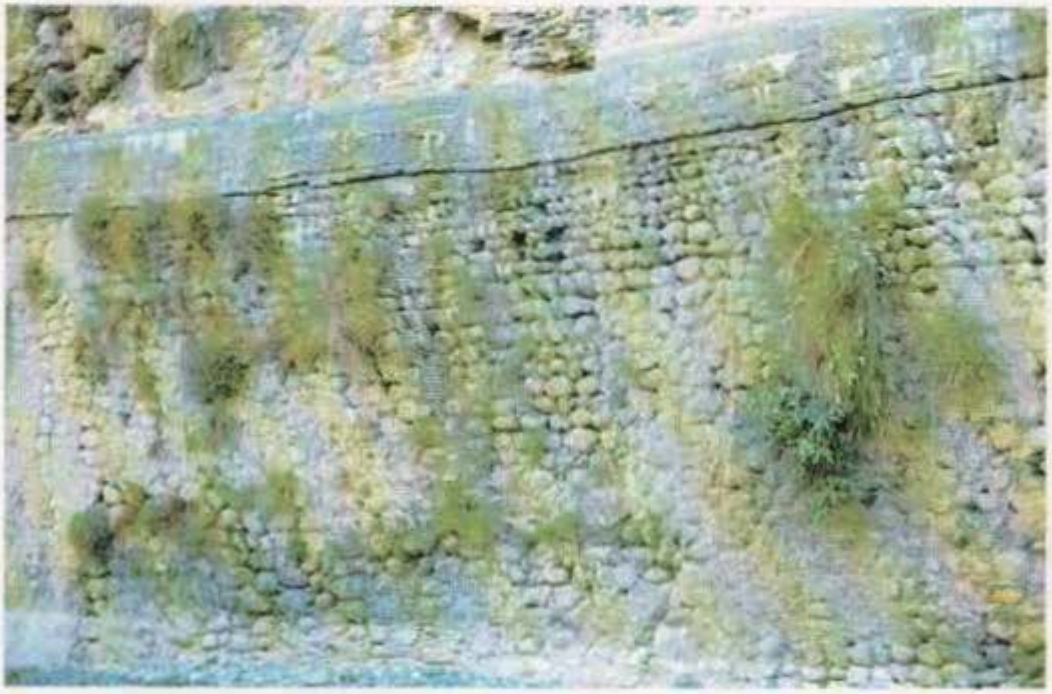

Photo 10. Chasmophytes growing on the wall supporting a canal of a falaj.

PLATE VI

Photo 11. *Fagonia indica* community along the road from Nizwa to Bahla.

Photo 12. *Zygophyllum mandavilli* community in the gravelly plains between Nizwa and Bahla.

PLATE VII

Photo 13. *Zygophyllum mandavilli* Hadidi.

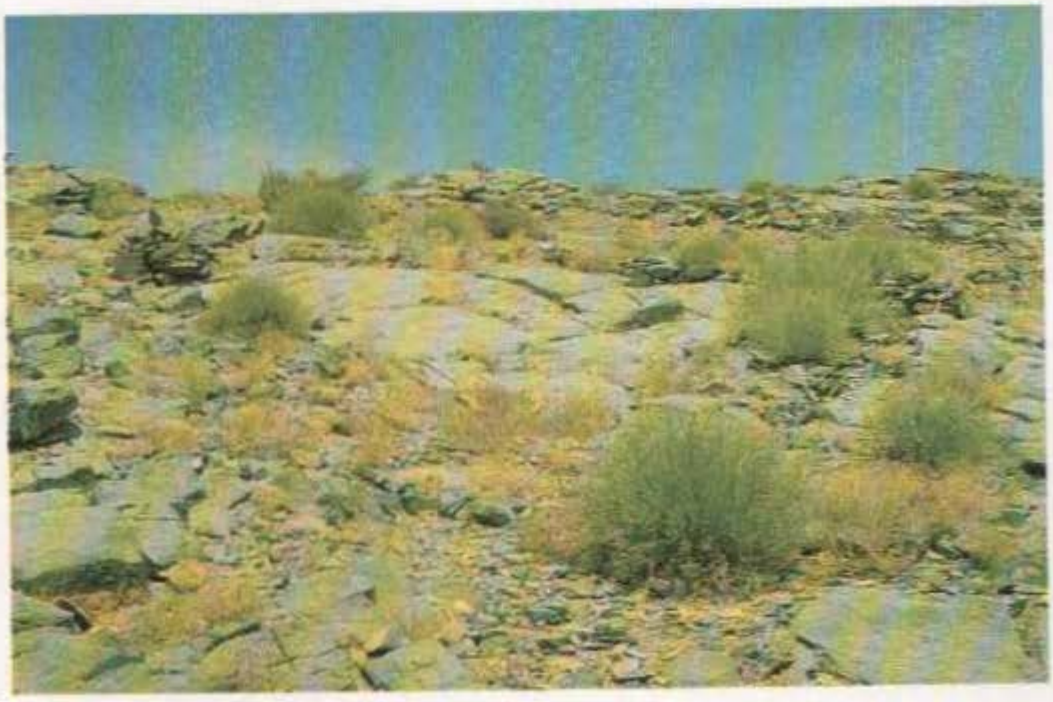

Photo 14. *Euphorbia larica* community on the rocky slopes near Al-Misfat.

PLATE VIII

Photo 15. Collection of *Euphorbia larica* as a firewood for pottery.

Photo 16. A dense growth of *Arundo donax* along a canal in Sumayil.

PLATE IX

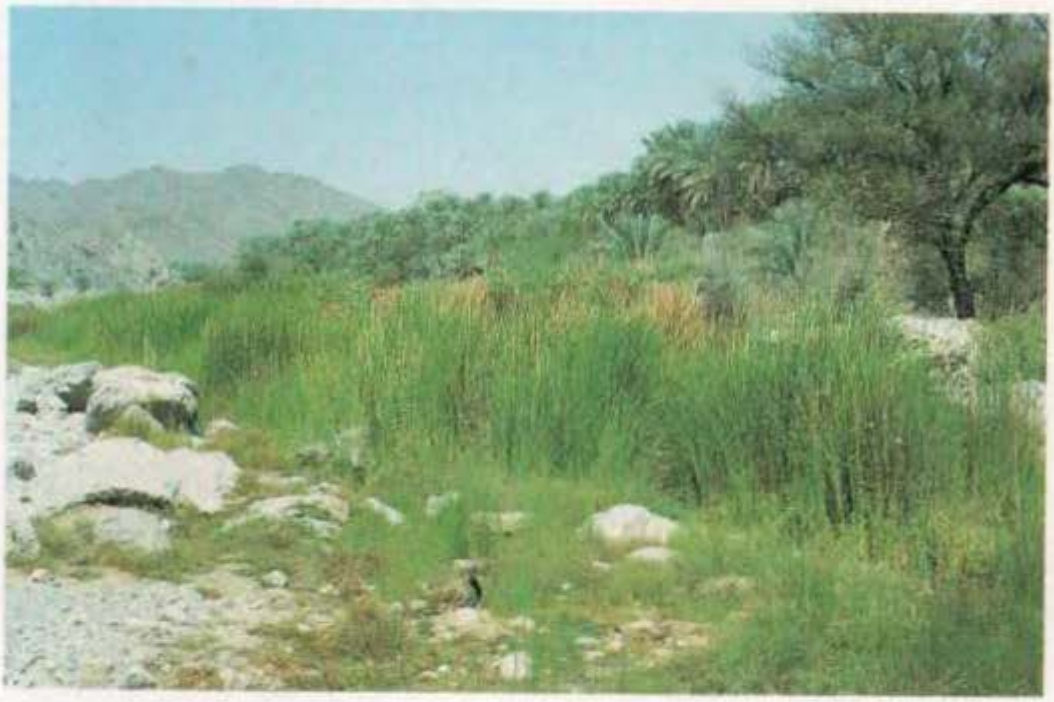

Photo 17. *Typha domingensis* in the main course of wadi Bahla.

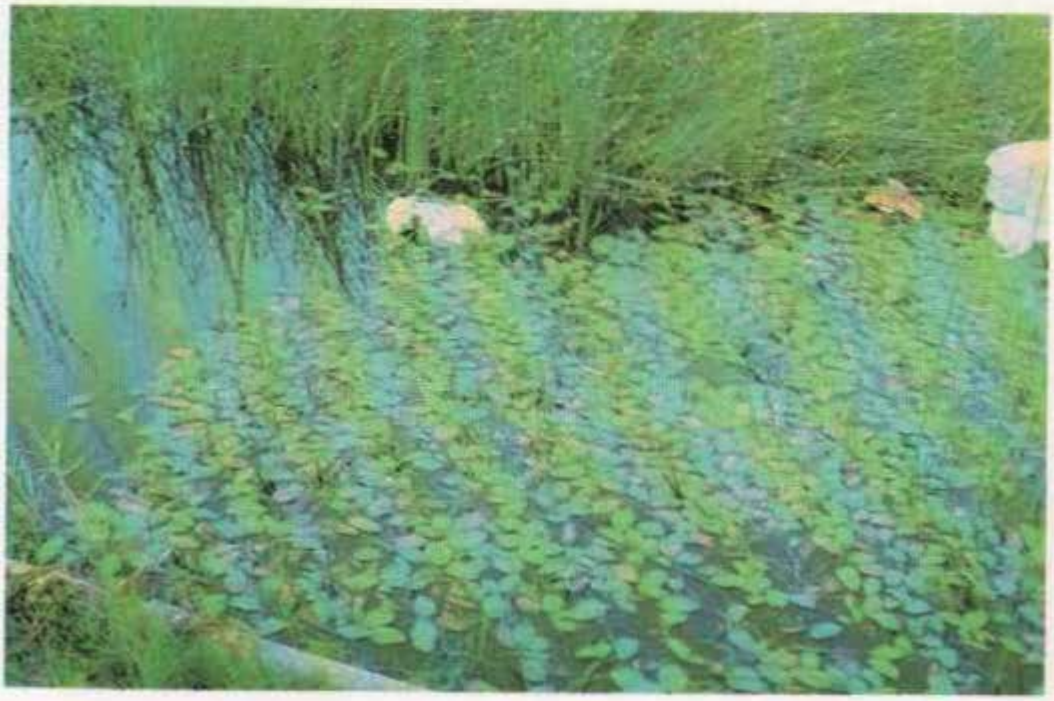

Photo 18. *Potamogeton nodosus* dominating a plant growth in the stream of wadi Bahla. *Cyperus laevigatus* grows in the background.

PLATE X

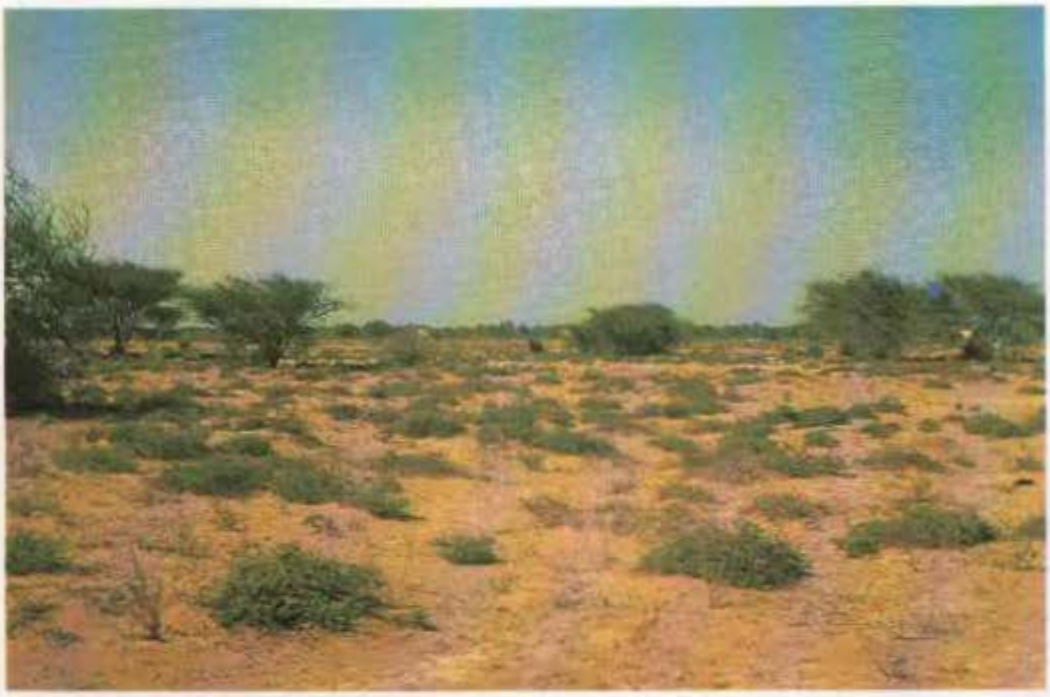

Photo 19. *Zygophyllum qatarense* community in Batinah desert coastal plain.

Photo 20. *Pteropyrum scoparium* community in wadis along the road from Batinah to Ar-Rustaq.

PLATE XI

Photo 21. *Pteropyrum scoparium*

Photo 22. Date-palm plantation at Al-Hazm.

PLATE XII

Photo 23. *Aristolochea bracteolata* Lam. growing in the date-palm plantations at Al-Hazm.

Photo 24. *Flaveria trinervia*, a common weed in Nizwa farms.

PLATE XIII

Photo 25. *Solanum incanum* L., a weed in Nizwa farms.

Photo 26. *Calotropis procera* (Ait.) Ait. f. growing along the roads.

PLATE XIV

Photo 27. *Desmostachya bipinnata* (L.) Stapf. growing along a canal of Falaj Dares near Nizwa.

Photo 28. *Tecomella undulata* growing along a canal of Falaj Dares, near Nizwa.

PLATE XV

Photo 29. *Salsola rubescens* growing in a waste land, 10 km before Nizwa.

Photo 30. *Dierophytum indicum* growing along the hedges of farms.

كما تضمنت الدراسة قائمة تضم ٦٢ نوعاً نباتياً تنمو في المزارع والحقول في أنحاء متفرقة من منطقة الدراسة . وعرضاً لبعض الأنواع التي تنمو في الأراضي المهملة . وتضم الدراسة ثلاثين صورة ملونة تبين بعض البيئات والأنواع النباتية في منطقة الدراسة .

دراسة بيئية نباتية شمال سلطنة عمان

كمال الدين حسن البتانوني و احمد محمد إسماعيل

رغم أن هذه الدراسة أجريت أثناء زيارة قصيرة لسلطنة عمان ، وفي مساحة محدودة ، مقارنة بالمساحة الشاسعة للسلطنة ، إلا أنها أول دراسة تعطى نتائج أكثر تفصيلاً عن الكساء النباتي وبيئته في منطقة الدراسة ، التي تمتد من مسقط حتى القريات ، ومن مسقط حتى سمايل والحمراء ونزوى وجبرين ، ومن مسقط حتى الرستاق متضمنة ساحل الباطنة ووادي معاول . وقد استعرضت الدراسة تاريخ الدراسات البيئية والنباتية في المنطقة ، مؤيدة الحاجة إلى المزيد من الدراسات التفصيلية .

وتبين الدراسة الدور الرئيس للمطر ، وما يبديه من اختلاف وتذبذب من حيث الزمان والمكان ، ودور التَّضَرُّس الموضعي في إثراء الموارد المائية وتَرَسُّب التربة في المنخفضات . ودور الإنسان وأثر مناشطه في الكساء النباتي .

ويوجد بالمنطقة عديد من النظم البيئية مثل الجبال والوديان والسهول والسبخات والأراضي المنزرعة وبرك وقنوات المياه . وكل منها يضم عدداً من البيئات التي يمكن تمييزها حسب التضاريس الموضعية وخصائص التربة وطبيعة الكساء النباتي والنبات السائد . وتقطن كل بيئة عشيرة نباتية تُعَرَّفُ باسم النبات الذي يسودها ، ويُعْطيها مظهرها العام . وتضمنت الدراسة عرضاً للعشائر النباتية في المنطقة وللأنواع النباتية الشائعة في كل عشيرة ولخصائص بيئاتها . وتتمثل باثنتي وعشرين عشيرة ، قسمت حسب طبيعة النبات السائد كالآتي :

١ ـ أربع عشائر تسودها أشجار صحراوية هي السَّمُر والسِّدر والغاف والسَّرْح .
٢ ـ ثلاث عشائر تسودها شجيرات صحراوية هي الأراك والقَفَص والسَّيداف .
٣ ـ عشيرة تسودها شجيرة ملحية هي الطَّرْفاء .
٤ ـ ثلاث عشائر تسودها نباتات معمرة غير عصيرية هي الضَّفْراء والظَّفْرَة والمشكاع .
٥ ـ عشيرة يسودها نبات عصيري لَبَنِيّ هو العَشْبق .
٦ ـ ثلاث عشائر تسودها نباتات عصيرية تجمع الأملاح في أنسجتها هي الهَرْم والهَرْم القطري والمُلَيِّح .
٧ ـ عشيرة يسودها نبات نجيلي مُعَمِّر هو الإذخر .
٨ ـ ثلاث عشائر تسودها نباتات مائية هي سِلق الماء والحُرَّيش والبردي .