JEBEL HAFFIT SURVEY REPORT

FOR

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(Location: Al Ain, Abu Dhabi, United Arab Emirates)

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THE MAMMAL FAUNA OF JEBEL HAFFIT

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Of the thirty nine mammal species recorded as occurring, or having occurred, in the United Arab Emirates (excluding the cetaceans), an amazing eighteen species have been observed on, or in close proximity to, the great "whale-back" inselberg known as Jebel Haffit. Of these eighteen species, three are certainly extinct here, namely the wolf (*Canis lupus*), the striped hyaena (*Hyaena hyaena)* and the leopard (*Panthera pardus)*. Two others, the Arabian gazelle (*Gazella gazella)* and the Arabian tahr (*Hemitragus jayakari)*, may still be present but in such critically low numbers that their survival is in grave doubt. However, during the survey recently undertaken by the authors three mammals were recorded on Jebel Haffit for the first time, although their presence was suspected, these are Blanford's fox (*Vulpes cana)*, Egyptian spiny mouse (*Acomys cahirinus)* and Wagner's gerbil (*Gerbillus dasyurus).*

Complete list of mammals recorded on Jebel Haffit- Past & Present

Name	**Scientific name**	**Status**
Brandt's hedgehog	*Paraechinus hypomelas*	Rare
Egyptian fruit-bat	*Rousettus aegyptiacus*	Unknown
Muscat mouse-tailed bat	*Rhinopoma muscatellum*	Common
Naked bellied tomb bat	*Taphozous nudiventris*	Unknown
Trident leaf-nosed bat	*Asellia tridens*	Unknown
Persian leaf-nosed bat	*Triaenops persicus*	Unknown
Kuhl's pipistrelle	*Pipistrellus kuhlii*	Common
Wolf	*Canis lupus*	**Extinct**
Red fox	*Vulpes vulpes*	Common
Blanford's fox	*Vulpes cana*	Uncommon (**New record)**
Striped hyaena	*Hyaena hyaena*	**Extinct**
Leopard	*Panthera pardus*	**Extinct**

Arabian tahr	*Hemitragus jayakari*	**Verge of Extinction**
Mountain gazelle	*Gazella gazella*	**Verge of Extinction**
Cape hare	*Lepus capensis*	Uncommon
Lesser jerboa	*Jaculus jaculus*	Uncommon
Egyptian spiny mouse	*Acomys cahirinus*	Common (**New record)**
Wagner's gerbil	*Gerbillus dasyurus*	Uncommon (**New record)**

Before presenting a species by species account of the mammal fauna of Jebel Haffit and its immediate surrounds, it is appropriate to give mention of the form of the inselberg, the threats facing its fauna and the methods used to assess its species richness. Jebel Haffit, lying just to the south of the town of Al Ain within the Emirate of Abu Dhabi, extends over a length of some ten kilometres and rises to a maximum height above-sea-level of 1180 metres. The inselberg is an anticline dating from the late Miocene that is overlain by a mantle of limestone and marls that date from the Lower Tertiary. The surrounding alluvial plain is heavily "scratched" by numerous shallow dry water courses, resulting from the rapid off-flow of water during the erratic periods of rainfall. The eastern face of the jebel is steep-sided and dominated by high cliffs, whereas the western slopes are more gentle but even here there are numerous steep cliffs and deeply gouged water-courses. The vegetation is of generally low diversity and density, which is aggravated by uncontrolled grazing and browsing by domestic animals, in particular camels and goats. Although the former are restricted to the surrounding plains and the low inter-hill valleys, goats are to be found at all levels. The impact of domestic animals on the sparse vegetation has almost certainly had a negative influence on the two wild ungulates associated with the mountain, namely the Arabian tahr and the mountain gazelle. Evidence of hunting by man, in the form of spent rifle and shotgun cartridges, was also found in association with the mountain and surrounding plains of Jebel Haffit. Other negative impacts, such as the construction of water retaining walls and the sealing of caves and potholes and the erection of buildings, roads and floodlights in the Emirates sector of the inselberg, are covered in the species accounts that follow. The inselberg straddles the border between the United Arab Emirates and the Sultanate of Oman.

The authors followed non-invasive survey methods for the mammals, using box-traps for capture, and following examination and taking of photographs of specimens these were released. Other methods used included direct observation where feasible, setting of scent-posts, as well as the noting of tracks and other signs of passage where the substrate allowed this. The pellets of a pair of little owls (*Athene noctua),* as well as the scats of red fox (*Vulpes vulpes)* and Blanford's fox (*Vulpes cana)* were collected for later analysis as this could reveal the presence of small mammals overlooked in the survey.

Systematic annotated list of the mammals of Jebel Haffit

Order *Insectivora*
Family *Erinaceidae*

Brandt's Hedgehog *Paraechinus hypomelas*

This dark-coloured hedgehog has an apparently patchy distribution in southern Arabia but this is probably more a measure of under-recording than fact. It is frequently found in arid, sparsely vegetated mountainous areas, and it has been located by the authors to occur throughout the mountainous and hilly regions of the northern United Arab Emirates. Harrison & Bates (1991) have shown it to occur widely in the adjacent mountains of Oman, including Jebel Haffit. During the present survey no specimens were trapped or observed but the characteristic tracks of hedgehogs were found in fine, soft, soil under several overhangs in the lower zone of Jebel Haffit. It seems likely that this is the species involved, although the Ethiopian hedgehog (*Hemiechinus aethiopicus)* is known to occur in the sands located just to the west of the inselberg. Unconfirmed reports also indicate its presence around Al Ain, therefore it is possible that this species may extend into the inter-hill valleys of Jebel Haffit. In our opinion Brandt's hedgehog would be rare on the inselberg but we are unaware of any direct threats to its survival.

Order *Chiroptera*

Six species of bat, five insect-eating and one fruit-eating, have been recorded on, or in close proximity to Jebel Haffit. During the course of this survey the presence of only two species was confirmed. The inselberg is an ideal roosting site, particularly on its lower slopes, for cave and crevice-retreating bats. However, recent developments pose a major threat to the continued importance of the northern sector of the massif as a retreat for bat populations, probably one of the most important for at least one species, the Muscat mouse-tailed bat (*Rhinopoma muscatellum)*, in the Emirates. The construction of water retention walls around Jebel Haffit within the Emirates sector has resulted in a policy of filling in a large number of cave and pothole openings along its lower edge. It is known that several of these underground caverns were important bat roosts. It is our opinion that the northern part of the mountain is by far the most important for most bats as it offers the greatest diversity of potential roost sites and because its proximity to the well-vegetated gardens, cultivations and parks in and around the town of Al Ain, provides an extremely rich food source. The Omani sector of the massif has fewer large roost possibilities and more limited sources of insect food. The authors descended into several potholes that were slated for closure (several of which have since been sealed) and several hundred Muscat mouse-tailed bats were counted. Judging by the presence of quantities of bat guano in at least three underground caverns bat numbers were probably higher during different months, or seasons. One pothole, considered to be too dangerous to access, gave off an aroma that immediately reminded the authors of caves in Africa that are occupied by Egyptian fruit-bats (*Rousettus aegyptiacus)*. It is deemed likely by the authors that further surveys, in different seasons, will increase the number of bat species known from the Jebel Haffit and Al Ain areas.
Family *Pteropodidae*

Egyptian fruit-bat *Rousettus aegyptiacus*

No evidence was obtained that this fruit-eating bat was present in, or around, Jebel Haffit during the period of the survey, which was during the winter and therefore no trees were bearing suitable fruit. One pothole was suspected of having housed fruit-bats at some time, based on the slight aroma eminating from its entrance, but no other evidence of presence was obtained. The entrance to this pothole has since been closed by the authorities. It is deemed to be highly unlikely that Egyptian fruit-bats form a permanent component of the local fauna but small numbers may move into the area during the period when suitable soft-fruits are available to them in the plantations. Unconfirmed reports indicate that "large bats" have been observed flying in the Al Ain area during the summer months. Harrison and Bates (1991) record the only proven record of this bat from the Emirates (Ras al Khaimah), with a second specimen having been taken in the same general area by the current authors. There are a number of records of this bat to the south-east of Jebbel Haffit in the better-watered Jebel Akhdar massif of Oman (Harrison & Bates 1991). Although over much of this bat's extensive range they tend to live in large colonies of up to several thousand individuals, we believe that much smaller numbers would be associated with an area such as Jebel Haffit and then only on an erratic basis.

Sub-Order *Microchiroptera*
Family *Rhinopomatidae*

Muscat mouse-tailed bat *Rhinopoma muscatellum*

This is the common bat associated with Jebel Haffit, distinguished from other bats in the area by its long, thin and mouse-like tail. Within Arabia it has a very limited range being found only in association with the mountains of the south-east, in particular the Ru'us-al-Jebal, Jebel Haffit, the Hajar ranges and the Jebel Akhdar massif. Within the Emirates the roosts on Jebel Haffit would appear to be by far the most important for the country. During the survey this bat was found to occupy a number of underground caverns (many of which have since been sealed), deep overhangs, clefts and crevices. Although impossible to determine with accuracy, several thousands of these mouse-tailed bats were estimated to have been present on Jebel Haffit at the time of the survey, but it is likely, judging by findings elsewhere (Harrison & Bates 1991), that such numbers may not be present throughout the year.

Family *Emballonuridae*

Naked-bellied tomb bat *Taphozous nudiventris*

Harrison (1977) recorded the presence of this widespread bat for Al Ain without giving further details. As this tomb bat favours crevices and cracks, particularly on steep mountain slopes (at least in parts of its range), for roosting it is likely that it occurs, at least seasonally, on Jebel

Haffit. This species was not located during the present survey.

Family *Hipposideridae*

Trident leaf-nosed bat *Asellia tridens*

Persian leaf-nosed bat *Triaenops persicus*

Both the trident leaf-nosed and the Persian leaf-nosed bats have been recorded in the vicinity of Al Ain (Harrison & Bates 1991), and as they frequently roost in caves and deep caverns suitable habitat on Jebel Haffit would indicate that they are at least seasonally present. The authors are familiar with the habitat and flight patterns of both species within their African range and it is fairly certain that none were present in the vicinity of Jebel Haffit at the time of the survey.

Family *Vespertilionidae*

Kuhl's pipistrelle *Pipistrellus kuhlii*

Kuhl's pipistrelle is the common bat of the Northern Emirates and it is frequently commensal with man, occupying crevices, cracks in walls, and roofs of buildings. One roost known to the authors (not on Jebel Haffit) is estimated to hold more than 5000 individuals. Harrison & Bates (1991) noted its occurrence in the Buraimi Oasis and in a falaj in Al Ain; with it being noted in the northern sector of Jebel Haffit in the present survey but in small numbers.

Order *Carnivora*

Wolf *Canis lupus*

The wolf once had a wide distribution over the Arabian Peninsula, including the vicinity of Jebel Haffit, however, it is almost certainly extinct now within the survey area. Thesiger (1949) recorded the presence of wolves on the massif, and according to local informants the wolf survived in the area up until 1994, using the near impenetrable mountain as a retreat. During that year, apparently, a poisoning campaign eradicated this, Arabia's largest canid, from the area.

Red fox *Vulpes vulpes*

By far the most common and widespread of the canids occurring in Arabia, despite poisoning

campaigns and direct persecution in many areas. This is the common carnivore in and around Jebel Haffit. They were found to occur on the open plains around Jebel Haffit and at all levels of the inselberg, although on the higher ridges evidence was minimal. Evidence of their occurrence during the survey included calling at night, tracks where suitable substrate existed and at scent-posts, and droppings. The remains of a dead fox was located in a low overhang in the south-west and evidence indicated that it had been shot. A total of 56 red fox droppings were collected on and around the mountain and their content indicated the wide ranging diet that allows survival in such an inhospitable environment. In summary, remains identified in the sample included numerous date seeds and skins; rodent hair and bones- *Gerbillus dasyurus*, *Gerbillus nanus* and *Acomys cahirinus-;* lagomorph (*Lepus capensis),* insect fragments included grasshopper, beetle and praying mantid; solifugid and scorpion; reptile- jaws of agamids and geckos; goat hair. The fact that dates were not available on the mountain but only within three kilometres, and that *Gerbillus nanus* is a sand-dweller, indicates that red foxes were foraging widely onto the open plains and using Jebel Haffit as a retreat during the day.

Blanford's fox *Vulpes cana*

Until 1995 (Stuart & Stuart, in prep.) this small fox was not know to occur in south-eastern Arabia but after its discovery in the Shimaliyah range of the north-eastern United Arab Emirates, it was also recorded from the Ru'us al Jebal (Musandam) and the Hatta region. During the course of this survey it was also found to be present along the length of Jebel Haffit but at low densities, thus constituting a first record for the Emirate of Abu Dhabi. Two animals were captured in cage-traps, examined, photographed and released, one individual was sighted during the late afternoon ,tracks located at several sites and a total of 32 droppings were collected and analysed as to content. Unlike those of the red fox, none of the droppings contained date pips or skin, or the remains of the sand-dwelling *Gerbillus nanus,* thus indicating that Blanford's fox is much more closely allied to the mountain. Insect fragments, including those of grasshoppers and beetles, were abundant in the droppings, and identified rodent remains included those of rock-dwelling *Acomys cahirinus* and *Gerbillus dasyurus*. The full results of the diet analysis of the red and Blanford's foxes occurring on Jebel Haffit are to be published elsewhere. Evidence indicates that Blanford's fox utilizes all levels of the mountain but surprisingly most activity, and both live captures, were at the lowest levels just above the surrounding plain.

Family *Hyaenidae*

Striped hyaena *Hyaena hyaena*

The only literature record of the occurrence of the striped hyaena on and around Jebel Haffit (Thesiger 1949), is backed up by local tradition. In interviews with people living to the west of the inselberg (relayed by Moaz Sawaf to the authors) it was indicated that the last hyaenas lived on Jebel Haffit more than ten years ago and none have been seen in the region since. No sign of this large carnivore was found during the course of the survey and it is almost certainly extinct here.

Family *Felidae*

Although no signs were found of the occurrence of **caracal (***Felis-Caracal- caracal)* or **wild cat** *(Felis silvestris)* in, or in the vicinity of, Jebel Haffit, it is possible that both may survive in the area. In other similar habitats in both the United Arab Emirates and Oman the authors have located signs of both of these cats but always at very low densities. In the case of the wild cat, a number of apparently "pure" animals have been caught within the grounds of Al Ain Zoo in recent years (eg.M.Jongbloed pers. comm.) but high levels of hybridisation with domestic cats can make identification difficult.

Leopard *Panthera pardus*

The leopard has a very precarious hold on survival in the Arabian Peninsula and it is unlikely that any of these magnificent cats are resident in the United Arab Emirates (Stuart & Stuart 1995), despite occasional press reports to the contrary. The remnant leopard population in the Ru'us-al-Jebal (Musandam, Oman) is estimated by the authors to number less than six adults, with individuals occasionally making marginal incursions into Emirates territory. Occasional reports of leopard presence in the Al Hijr al Gharbi mountains of adjoining Oman have not to date been confirmed by the authors but should these be accurate they would constitute the distribution closest to Jebel Haffit. No local informants (conveyed by Moaz Sawaf) indicated the past or present occurrence of leopards on Jebel Haffit, and no evidence of this cats' presence was located during the course of this survey. In fact, given the nature of the mountain it is held to be unlikely that leopard were ever a permanent feature of Jebel Haffit.

Order *Artiodactyla*

Family *Bovidae*

Arabian tahr *Hemitragus jayakari*

The Arabian tahr, a rare wild goat that has a total population size of less than 2000 individuals, is endemic to the mountains of northern Oman and the eastern United Arab Emirates. Its remaining stronghold lies within and adjacent to the Jebel Akhdar massif of Oman but in 1995 (Stuart & Stuart 1995) a remnant population was discovered in the Shimaliyah (Al Hajr) mountains lying adjacent to the east coast of the United Arab Emirates. In 1949 Thesiger recorded the tahr's presence on Jebel Haffit, and Dickinson *et al* (1983) believed that the population numbered less than 20 individuals in 1980. Specimens from the massif are deposited in the collections of the British Museum of Natural History and the Harrison Zoological Museum. However, as a result of hunting pressure and an apparent decrease in the quantity of accessible surface water (tahr must drink on a regular basis) it was generally believed that the tahr had drifted into extinction on Jebel Haffit. However, occasional apparent sightings have been reported over the years. Although several such sightings seem to have been of misidentified domestic/feral goats viewed from a distance, one record from 1997 (Colin Richardson pers.comm.) would appear to have been accurate. Surprisingly, the sighting was made from the parking lot on the Emirates side of the mountain, an area where there has been, and is ongoing, construction work and development. In interviews with local pastoralists (conveyed by Moaz Sawaf) all stated that none had seen tahr for some years and most believed it to be extinct, or at best only a few animals survived. In the past it had been hunted but several interviewees cited the decrease in permanent surface water, as a result of pumping by Omani and Emirates authorities, as the major reason for the demise of the tahr. Competition for the sparse graze/browse with domestic goats could well be a critical factor in the case of any tahr surviving. During the course of the survey, despite covering most of the traversible areas of the massif on foot and examining the terrain through binoculars during all daylight hours, no sighting of Arabian tahr was made. Domestic/feral goats were observed in most locations, even on the highest ridges but not on sheer cliffs, and inexperienced, casual observers could easily mistake brown-pelaged goats for tahr at a distance. Although the presence of shallow troughs dug by the fore-hoofs of tahr within their home ranges has been documented (Munton 1988), no such obvious sign was discovered on Jebel Haffit. Numerous shallow resting scrapes were located close to ridges and saddles with non-rocky substrate but as far as could be established these were associated with domestic/feral goats. It is the opinion of the authors that if the tahr is not already extinct on Jebel Haffit, it is certainly on the verge of extinction!

Mountain gazelle *Gazella gazella*

An endemic Arabian antelope, the mountain gazelle, or idmi, has declined greatly both in numbers and range in recent decades. Two lying-up scrapes located under rock overhangs and distinctive dung pellet piles were located in the low western outer ridge of Jebel Haffit, within the Omani territory. According to locals interviewed (conveyed by Moaz Sawaf),

gazelles are now very rare and those that survive to not venture far from the inter-hill valleys of the massif. No sign of the idmi was found in the Emirates sector.

Order *Lagomorpha*

Cape hare *Lepus capensis*

The Cape hare occurs at low densities on the gravel plains surrounding Jebel Haffit, and it penetrates into the mountain along the vegetated inter-hill valleys and dry water courses in the west and south. Remains (hair, claws and bone fragments) of hares were found in several of the red fox droppings examined.

Order *Rodentia*

Lesser jerboa *Jaculus jaculus*

One set of tracks of this unusual bipedal rodent was recorded in the bed of a sandy dry water-course adjacent to the south-western outer ridge of Jebel Haffit. Although it probably occurs on the plains around the massif and in the inter-hill valleys in the west and south, densities would appear to be very low.

Egyptian spiny mouse *Acomys cahirinus*

Live-trapping amongst rock scree and in overhangs with crevices and cracks on the lower western slopes of Jebel Haffit revealed that the Egyptian spiny mouse was widespread in the west and south. Densities, although relatively low, were higher than for other areas in the United Arab Emirates trapped/surveyed by the authors. This constitutes the first proof of occurrence of this rodent on Jebel Haffit, as well as the first record for the Emirate of Abu Dhabi.

Wagner's gerbil *Gerbillus dasyurus*

The trapping of Wagner's gerbil on Jebel Haffit constitutes a first record for the massif , and the Emirate of Abu Dhabi, of this little known, and probably under-trapped rodent. It occurs at low densities, with most animals having been trapped in the same overhangs as spiny mice but burrowing into the soft substrate rather than using the crevices as shelters. Individuals

were also trapped in boulder piles and amongst rock scree but it is not known whether they also had burrows in the vicinity.

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REPTILES OBSERVED/COLLECTED DURING THE JEBEL HAFFIT SURVEY

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Although not in the survey brief, but covered by the collecting permit issued by the Omani authorities, sightings of all reptiles were recorded and in the case of three species specimens were collected. Where feasible photographs were taken to serve as voucher material. As the survey was undertaken in December and temperatures were generally low, reptile activity was greatly reduced and therefore the following annotated list is probably not complete.

Lizards
Family *Agamidae*

Pseudotrapelus sinaitus

There is only one previous record of this rock-dwelling agamid from Jebel Haffit (El Din 1996) from the western flank of the inselberg. During the current survey three sightings were noted, two on open, exfoliating rock plates at middle altitudes and the third amongst a boulder cluster just above the level of the western plain. A single specimen was collected on the lower western slope (WGS 84- 24° 01.29'N; 55° 46.16'E).

Family *Gekkonidae*

Bunopus spatalurus

A single specimen was collected from under a stone in the bed of a gravel-bottomed dry water course (WGS 84- 24° 01.29'N; 55° 46.16'E). This is apparently the first record of this species for Jebel Haffit. *Bunopus tuberculatus* has been recorded in the general area of Jebel Haffit but not on, or close to, the massif itself.

Pristurus rupestris

Several specimens, almost certainly of this species, were observed on boulders in shallow, dry water courses along the western and southern flanks of Jebel Haffit. The authors are familiar with this species from other parts of its range and have handled and photographed numerous specimens.

Ptyodactylus hasselquisti

One published record exists of this rock-climbing gecko from the northern point of Jebel Haffit (see references). During the present survey a single sighting was recorded in the west-central area of the massif, the individual clinging to the under-surface of a large boulder, some two

metres above the ground.

Family *Lacertidae*

Mesalina adramitana

Previously recorded on the gravel plain and associated dry water-courses surrounding Jebel Haffit, during the present survey this small, slender lacertid was found to be common. Apart from the fringing plains, they were also observed on the beds of the small inter-hill valleys on the west of the massif. Four specimens were collected.

Snakes

Carpet viper *Echis carinatus*

Previously recorded from the vicinity of Al Ain, the single specimen caught and photographed in the present survey constitutes the first proven record for Jebel Haffit. The snake was located in a strata-crack with loose rocks and sand; both Egyptian spiny mice and Wagner's gerbils had been trapped in this same locality, on the west-central outer slope of the mountain.

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VEGETATION OVERVIEW OF JEBEL HAFFIT

Chris & Mathilde Stuart

The *inselberg* of Jebel Haffit, lying just to the south of the town of Al Ain, straddles the international boundary between the United Arab Emirates and the Sultanate of Oman. The rock *massif* is aligned in a north to south direction and it has a length of approximately ten kilometres, with its greatest altitude reached at 1180 metres above-sea-level. The mountain is classified as a foreland anticline that dates from the late Miocene and it is overlaid with a limestone and marl mantle. The plain that surrounds Jebel Haffit is made up of Alluvial detritus and is heavily "scratched" by numerous shallow and narrow dry water-courses that radiate from the base of the *massif*. The plain in the west extends to the fringe of the quartzite sand expanses of the *"Empty Quarter"* and in the east on to the Jaww Plain. Low reefs of Oligocene origin extend from the northern point of Jebel Haffit for several kilometres.

Given the desert nature of the area in which Jebel Haffit is located, plant diversity and densities are in general very low, particularly on its higher reaches. The state of the vegetation has been greatly modified, and this continues, by uncontrolled access by large numbers of camels, goats and to a lesser extent by sheep and donkeys. During the course of the general survey camels were encountered on the plains surrounding the mountain and up to one third up parts of its western slopes. Goats, or their signs, were observed at all levels and on all but the most inaccesible cliffs. Many perennial plant species palatable to domestic animals have been virtually destroyed or individual plants (mainly bushes and small trees) greatly modified by continuous browzing. Impacts on production of annual plant species is not known but could be considerable in the case of all palatable species, thus impacting massively on future seed production. A further problem results from trampling by hoofs, increasing vegetation destruction and aggravating already marked natural erosion. An aspect that has received little, or no attention, has been the impact on the vegetation of increased water extraction by pumping by both the Emirates and Omani authorities for domestic and horticultural/agricultural use. Woody plants, most notably *Acacia tortilis*, are heavily utilised by local people as fuel-wood, and also during dry periods branches, or even whole trees, are felled to provide food for domestic livestock.

Western (1989) has broadly divided desert vegetation into three principal categories, each of which is identifiable within the Jebel Haffit environment, **Ephemerals (therophytes)**- that is the herbaceous, non-woody, species that occur as annuals that usually emerge following rain but at other times survive as seed-stock; the **succulent perennials**- those plant species that "stand" throughout the year, surviving the harsher months by storing moisture usually in the leaves, that normally have a waxy coating to prevent water loss, and the **woody perennials**- these include trees such as *Acacia tortilis* and *Ziziphus spina-christi* and larger shrubs, that are slow growing and have extensive root systems that can tap into underground water sources. In general the summer months are unfavourable for plant growth in the area, with autumn and winter being most favourable but this is to a large extent dependant of the incidence of the meagre and unreliable rainfall. As an adaptation to the short periods when favourable conditions may be in force, many annuals known to be associated with Jebel Haffit and its

environs germinate, flower and set seed,within a few weeks. Should germination take place during a period of "moisture stress" , some plants in desert conditions are able to conserve growth energy by completing flower to seeding stage in "dwarf" form.

In its broadest context the vegetation associated with Jebel Haffit can be divided into three principal groupings: 1. The *Acacia tortilis- Lycium shawii* association on the gravel plains fringing the mountain; 2. The *Acacia tortilis- Euphorbia larica - Tephrosia apollinea* complex of the inner-hill valleys and lower dry water-courses and 3. The *Euphorbia larica-Gymnocarpos decandrum* associations of the upper slopes and gorges. Obviously this is an oversimplification but many species extend into all three broad associations and it is difficult to separate and define clearly plant communities on the mountain.

Annotated list of selected plant species growing on Jebel Haffit:

Trees and Bushes:

Acacia tortilis
This is by far the most abundant and widespread tree species occurring on and around Jebel Haffit. It dominates the landscape along the fringing dry water-courses, the inner-hill valleys, extending to the upper reaches as a low bush, with some specimens as little as 50cm high but this has been aggravated by heavy cropping by goats. The largest specimens observed were approximately four metres tall. Highest densities are reached along the western aspect of the massif.

Ziziphus spina-christi
A few specimens of this small to medium-sized tree are found in association with the dry water-courses on the nearby fringing plain, and in the inner-hill valleys in the south west of Jebel Haffit and in the extreme north. A few stunted specimens grow in the deeply incised gorges on the western aspect of the *massif*. None of those *zidr* trees associated with Jebel Haffit reach their maximum potential height, with must specimens being under five metres.

Moringa peregrina
On Jebel Haffit this short, distinctive, tree is largely restricted to deep gorges, not infrequently growing from crevices on steep rock faces. It is uncommon and most specimens are stunted and deformed.

Ficus carica
A few gnarled and stunted specimens of this wild fig are located in some steep gorges and runnels, most particularly on the western aspect of Jebel Haffit, although a few grow on the steep eastern slopes.

Dodonaea angustifolia
Relatively short, most specimens less than 1.5 metres, bush that grows at most levels of Jebel Haffit but most particularly along higher lying but generally shallow "water courses" and depressions.

Lycium shawii
A spiny, stiff-stemmed, bush or shrub, that may reach a height of up to three metres and occurs widely but sparsely along the water-courses that radiate from Jebel Haffit, those associated with the western and southern inter-hill valleys and higher lying areas. In the latter situation they are generally uncommon and tend to be smaller than those at lower altitudes.

Other Perennials:

Capparis cartilaginea
This stocky, woody shrub is generally encountered as a flattened, sprawling plant on Jebel Haffit, mainly along the edges of the dry water-courses at most altitudes. They also grow from ledges on a number of the steep cliff-faces. Their fairly large, ovate, thick and leathery leaves, distinctive white flowers and large green to reddish cucurbid-type fruits are distinctive.

Salsola rubescens
Shrub reaching up to 30cm with a short, stout and usually gnarled stem found in narrow water-courses and clefts, mainly at higher altitudes on Jebel Haffit.

Euphorbia larica
This evergreen shrub, with its many erect, yellow-green coloured stems, is one of the most distinctive plants growing on and around Jebel Haffit. It grows at all altitudes but is most abundant on the lower to middle slopes and along the dry water-courses. When the stems are broken they "spill" droplets of white, latex-like liquid that is toxic. Although generally unpalatable domestic stock nibble the new growth shoots and flowers from the stem tips.

Ephedra foliata
This shrub, growing or creeping to two metres, is distinguished by its numerous, slender almost leafless stems and occurs at low densities at higher and median altitudes on the *massif.*

Tephrosia apollinea
A common to very common densely-leaved and "bushy" shrub, averaging 50cm in height, with distinctive but small deep red to purple flowers. On Jebel Haffit it is strongly associated with the dry water-courses at all levels but becomes less common with increasing altitude.

Taverniera cuneifolia

This relatively low shrub (30cm to 70cm) was located along inter-hill dry water-courses and in some of the higher altitude runnels on Jebel Haffit.

Crotalaria aegyptiaca
A rather uncommon erect, woody, shrub found in association with the lower dry water-courses of Jebel Haffit.

Argyrolobium roseum
This very low, creeping perennial herb was located in close proximity to the *massif,* in the inter-hill valleys and at a very few locations at higher altitudes in shelter crevices.

Reseda aucheri
This low, biennial herb was found to be in flower at the time of the survey and located sparsely but widely on Jebel Haffit.

Ochradenus arabicus
This many-branched and sprawling plant was found in flower and mainly in association with the inter-hill valleys and the lower dry water-courses.

Fagonia indica
Although mostly reaching a height of 40cm, can reach up to 80cm, this spined, small-leafed shrub, was found growing at all altitudes but those along the ridge tops tended to be smaller than those at lower altitudes.

Zygophyllum qatarense
A common, succulent-leaved shrub up to 80cm but most specimens shorter in association with Jebel Haffit. Although most abundant in the dry water-courses radiating from Jebel Haffit, it was not uncommon in the inter-hill valleys of the west, south and north but much more uncommon as altitude increased and then usually associated with runnels and flattened saddles.

Corchorus depressus
A prostrate, many stemmed plant that was found to occur on gravel in the inter-hill valleys, between boulder clusters and on the more gentle slopes of Jebel Haffit.

Helianthemum kahiricum
Up to 30cm high shrub with woody stem and distinctive greyish-green leaves. Widely but sparsely distributed on Jebel Haffit.

Aerva javanica
A distinctive tall (may reach more than one metre) shrub with long spikes of small, tightly packed white, woolly flowers, only located in a few of the lower inter-hill dry water-courses on Jebel Haffit.

Boerhavia elegans
This erect, multi-stemmed shrub is at its most distinctive when in flower, as the stem and upper branches turn red at this time. In this state it has been likened to a "wisp of red smoke"- a most apt description. It grows in low to very low densities over much of Jebel Haffit.

Glossonema varians
A rather uncommon, low-growing herb, with greyish-green leaves and distinctive ovate swollen fruits that have a number of long, curved hooks growing from them.

Periploca aphylla
A distinctive plant, with numerous long, thin and green erect stems that are almost leafless. The small but characteristic flowers give off a pungent smell that attracts flies- the presumed pollinating agent. Sparsely but widely distributed in the rocky dry water-courses on the lower slopes and inter-hill valleys of Jebel Haffit, with some growing at high altitudes in deep, sheltered gorges and runnels. Many of these plants have been heavily browzed by goats.

Pseudogaillonia hymenostephana
Seldom reaching 30cm in height, this multi-stemmed, bushy shrub is characterized for much of the year by pink-white "bonnet-like" structures that are associated with the fruiting bodies. Found sparsely but throughout Jebel Haffit, particularly in the north and west-central regions.

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