CHAPTER 1

INTRODUCTION

The demise of the Arabian oryx *Oryx leucoryx* (Pallas, 1777) in the Arabian Peninsula, and the subsequent rescue effort which led to the reintroduction of the species in Oman in 1982 has been well documented (Chapter 3). This rescue effort and the resulting reintroduction of the Arabian oryx into Oman has been hailed as one of the conservation success stories of the 20th century (Dixon & Jones 1988; Stanley-Price 1989; Spalton 1993).

Developments in Oman during the late 1990's have, however, indicated the susceptibility of such reintroduction projects even after nearly 20 years into a reintroduction project's life-span (Spalton, Lawrence & Brend 1999). If anything, these developments underline the need for involving various sectors, including the local communities in all conservation efforts. It also emphasises the need for long-term monitoring of the reintroduced populations and the establishment of various free-living populations of an animal type within any particular country, given that there are sufficient areas containing enough suitable habitat of sufficient quality for such populations.

The National Commission for Wildlife Conservation and Development (NCWCD) of the Kingdom of Saudi Arabia initiated this study on the reintroduction of the Arabian oryx into the unfenced 'Uruq Bani Ma'arid Protected Area of that Kingdom. This reintroduction was the next step, after a successful captive-breeding programme, for the National Commission for Wildlife Conservation and Development in fulfilling its mandate as specified by Royal Decree. This decree directed them to develop and restore the wildlife and natural resources of the Kingdom of Saudi Arabia (Joubert 1994). If successful, this reintroduction would give rise to only the second free-living Arabian oryx population in the Arabian Peninsula, and the only such population within the Kingdom of Saudi Arabia.

Concurrently with the Arabian oryx reintroduction project there were also reintroductions of two of the Arabian gazelle types into the 'Uruq Bani Ma'arid Protected Area. These reintroductions included in excess of 200 sand gazelles *Gazella subgutturosa marica* (Güldenstaedt, 1780) and more than 20 mountain gazelles *Gazella gazella gazella* (Pallas, 1766), thereby confirming the National Commission for Wildlife Conservation and Development's commitment to restoring the Kingdom's wildlife to its former glory.

The reintroduction of the Arabian oryx into the 'Uruq Bani Ma'arid Protected Area was not a mere replication of the process in Oman. Although much was learned from the Oman reintroduction, the approach taken in the present study was not to make any assumptions in advance on aspects of Arabian oryx ecology. No assumptions were for example made on the social organisation and the herd composition or the size of the "ideal" Arabian oryx herd. In addition no management action was taken to influence group composition, cohesion, dispersal from the release site, or even range size.

The title of this thesis states that it is an ecological study. This title is quite broad. In finalising the title the author was guided by the immediate needs and concerns of the National Commission for Wildlife Conservation and Development as far as the reintroduction of the Arabian oryxes was concerned. The fact that such a large proportion of the animals was fitted with radio-collars (Chapter 3) contributed to the collection of data on a wide range of topics. The aim of this study was not to re-write the books on Arabian oryx ecology. Rather, the aim was to assess the performance of a group of captive-bred animals, including some hand-reared individuals, that were mixed with wild born individuals from the Mahazat as Sayd Protected Area and then were reintroduced into their native, hyper-arid habitat in the Kingdom of Saudi Arabia.

In the following chapters some background information on the Arabian oryx and the Kingdom of Saudi Arabia are presented first, as it is considered essential for understanding the ecology of the species fully. The main part of this thesis, however, deals with the various aspects of the ecology of the reintroduced Arabian oryxes and includes chapters on the Arabian oryx range use, habitat use, feeding, activity, and productivity. In addition, population viability analysis is used to assess the reintroduction process and to predict the future of this population, given the assumptions made. Some management recommendations aimed at the effective management of the Arabian oryx in the Kingdom of Saudi Arabia are also made.

CHAPTER 2

STUDY AREA

Location and topography

The Kingdom of Saudi Arabia has a surface area of approximately 2.2 million km², and it occupies 80% of the surface area of the Arabian Peninsula. The country extends from 32° 15' N on the Jordanian border to 16° 30' S on the Yemen border. In the east and west the Arabian Gulf and the Red Sea respectively (Child & Grainger 1990) bound it.

The Arabian Peninsula is a huge crustal plate that is composed of ancient sedimentary and volcanic rocks. During Precambrian*[1] times long before the formation of the Red Sea, the Arabian Peninsula was still attached to Africa as part of the African (Nubian) Shield. Some 30 million years ago in the middle Tertiary* Period the Arabian plate split away from the African Shield along the Red Sea Trough. This separation of Arabia from Africa was accompanied by extensive volcanism along the western edge of the Arabian Peninsula (Chapman 1978a).

Today the Arabian Peninsula can be divided into two structural provinces. A western province, known as the Arabian Shield, is part of the Precambrian crustal plate and is composed of igneous and metamorphic rocks. Volcanism was widespread in western Arabia from the Tertiary Period to the recent past. Floods of basic lava poured out onto the surface of the shield (Chapman 1978a). The Arabian Shelf is the second of the two structural provinces. It lies east of the Arabian Shield and forms about two-thirds of the peninsula. Its foundation is part of the same Precambrian plate that makes up the Arabian Shield. When the crystalline rocks of the eastern extension of the Shield tilted progressively towards the northeast, they were inundated by a series of shallow seas that led to successive sedimentary deposits. These sedimentary rocks mostly consist of limestone, sandstone and shale, which dip gently eastward into a number of sedimentary basins ranging in age from the Cambrian* to the Pliocene* (Child & Grainger 1990).

[1] * Refers to terms that are included in the glossary.

Biogeography

The present position of the Arabian Peninsula dates back to 25 million years ago from the Miocene* Period. From the Precambrian to the Paleocene* Eras the peninsula was attached to Africa as part of the Nubian Shield (Child & Grainger 1990). From the end of the Cretaceous* Period until the end of the Oligocene* the fauna and flora of this landmass evolved their distinctive forms in relative isolation over a period of approximately 45 million years.

Until the Paleocene the African-Arabian landmass had been separated from Europe and Asia by the Tethys Sea. During the Eocene* and the Oligocene, however, this sea regressed and the Levantine land bridge formed between Eurasia and Africa through the Middle East. This land bridge formed one of five biogeographical filters that separated the terrestrial biogeographical* regions of the world. The Levantine land bridge is considered to be the most important nodal point in the distribution history of modern terrestrial species of the globe (Child & Grainger 1990).

The global fauna and flora are divided into eight terrestrial biogeographical realms, their provinces and lesser subdivisions. Portions of the Palearctic (Europe and Asia) and Afrotropical (Africa south of the Sahara) Terrestrial Realms are within the boundaries of Saudi Arabia. Elements of the Indo-Malayan Terrestrial Realm are also present in Saudi Arabia. In addition, the Kingdom of Saudi Arabia includes the Indo-Pacific Marine Realm. Saudi Arabia is therefore an area of great international biogeographic significance (Child & Grainger 1990).

The fauna and flora of the Arabian Peninsula are therefore a unique assemblage of elements with African, Eurasian and Indo-Malaysian affinities. There are also a number of endemic forms and passage migrants which further enrich the area. The resident biological complex is a product of the geological evolution of the peninsula and its more recent history of climatic change (Child & Grainger 1990). Several mammals from Saudi Arabia now occur, or have recently occurred, in all three of the Terrestrial Realms mentioned above. These include the honey badger *Mellivora capensis* (Schreber, 1776), the striped hyaena *Hyaena hyaena* (Linnaeus, 1758), the leopard *Panthera pardus* (Linnaeus, 1758), the cheetah *Acinonyx jubatus* (Schreber, 1775), the golden jackal *Canis aureus* Linnaeus, 1758 and the lion *Panthera leo* (Linnaeus, 1758). Other species like the Arabian oryx and the Cape hyrax *Procavia capensis* (Pallas, 1766) have an African origin. The presence of the Arabian tahr

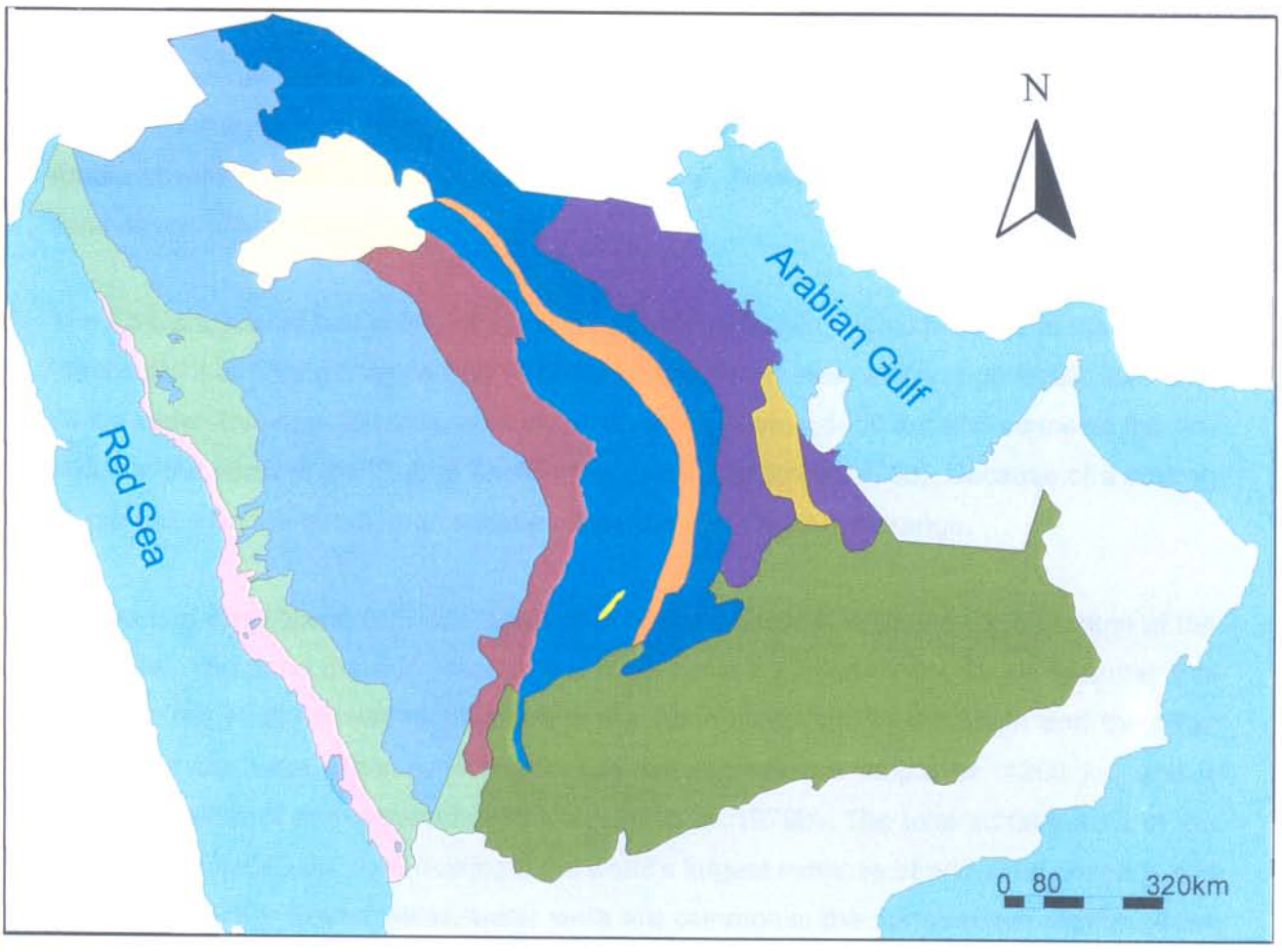
Hemitragus jayakari Thomas, 1894 in the northern mountains of Oman confirms that there has been a land connection between Arabia and Asia in the past (Child & Grainger 1990). The vegetation of the Arabian Peninsula has been studied less intensively than that of all the other areas of southwest Asia (Kaul & Thalen 1979). General compilations, which include part of this area, are those by Mc Ginnies (1967), UNESCO-FAO (1969) and Zohary (1973). Some specific area studies have also been done by Vesey-Fitzgerald (1955, 1957 a, b), Popov and Zeller (1963) and Mandaville (1986; 1990).

The flora of Saudi Arabia has affinities with the Saharo-Arabian and the Sudano-Zambesian Floristic Regions (Takhtagan 1986 In: Child & Grainger 1990). The Saharo-Arabian Region with its desert and semi-desert forms is characterised by a low species diversity with ca.1500 plant species. The Saharo-Arabian Region is divided into the Saharan and the Egyptian-Arabian Floral Provinces. The latter province covers the largest part of extra-tropical Saudi Arabia. The Sudano-Zambesian Floral Region covers a vast area of Africa and Arabia and consists mainly of open woodland and savanna grassland.

Physiographic regions

According to Child and Grainger (1990) Saudi Arabia divides naturally into seven terrestrial physiographic* regions with 30 subregions, and two marine regions (Figure 1). The main terrestrial physiographic regions are the Tihama Coastal Plain and adjacent foothills, the Western Highlands, the Arabian Hinterland, the Cuesta Region, the Aeolian Sands, the As-Summan and Widyan Plateaus, and the Arabian Gulf Coastal Region. The two marine regions are the Red Sea and the Arabian Gulf.

The physiographic region that is of particular importance to the current study, and which includes the traditional distribution of the Arabian oryx in the Kingdom of Saudi Arabia, is the Aeolian Sands. Wind-blown sand covers 38% (855 000 km²) of the Arabian Peninsula. The main areas of such sand are in the great basins of the Nafud and the 'Rub al Khali and in the low-lying areas between the cuestas of the sedimentary Najd (Child & Grainger 1990). In the north of the country the term Nafud refers to areas of deep sand and wind-built dunes and includes the Great Nafud (an-Nafud), Al Jafurah, the Ad-Dahna sand belt and a group of sand bodies along the western side of the Tuwayq escarpment (Chapman 1978b).



LEGEND

- Red Sea Coast
- Western Highlands
- Arabian Hinterland
- Cuesta

Aeolian sands

- An-Nafud
- Ad-Dahna
- Central Nafud
- Al-Jafura
- Ar-Rub Al-Khali
- Uruq Ar-Rumaylah

- As-summan and Widyan (Plateau)
- Gulf Coast
- Unclassified

Figure1: The seven main terrestrial physiographic regions of the Kingdom of Saudi Arabia (Child and Grainger).

The sparsely vegetated An-Nafud Basin in the northwestern part of the peninsula is characterised by sands that are stained red-orange by iron oxide and occur in closely spaced crescentic dune ridges and linear dunes. This sand desert in the north of Saudi Arabia covers a surface area of some 57 000 km². No oases occur in the interior of this sand desert (Chapman 1978b)

The Ad-Dahna sand belt is one of the most distinctive physiographic features of the Arabian Peninsula. It is a long, narrow belt of shifting sand and dunes, which is generally less than 50 km wide. This area extends in an arc over approximately 1300 km and connects the An-Nafud in the north to the 'Rub al Khali in the south (Chapman 1978b). Because of a coating of iron oxide on the quartz grains these sands are also bright red-orange.

The 'Rub al Khali Basin or Empty Quarter as it is also called, is situated in the south of the peninsula. The sand there is present in a huge basin bounded by the Oman Mountains in the east, the Hadhramawt Highlands and the Aden Hinterland in the south and the Hijaz Plateau in the west. This sand region has an approximate length of 1200 km and a maximum width of approximately 650 km (Chapman 1978b). The total surface area of the 'Rub al Khali is 640 000 km² making it the world's largest expanse of arid sand desert (Child & Grainger 1990). Nevertheless, water wells are common in the northeastern section of the 'Rub al Khali.

The dunes of the 'Rub al Khali illustrate the variety of shapes present in all the sand areas of Saudi Arabia. The dunes in this area are crescent-shaped, dome-shaped, hook-shaped or star-shaped. Many of these dunes form long, single or parallel ridges also known as *'uruq* with a height of 100 m or more and a length of 20 to 200 km. Many of these dunes are also huge complex pyramids or sand mountains, which attain heights of up to 300 m (Chapman 1978b). The sands are red-orange in colour and have a medium to fine grain like those of the Great Nafud and the Ad-Dahna sand areas.

The sources of sand for the 'Rub al Khali have always been numerous. The primary source is from crystalline rocks exposed in the uplands of the peninsula. From there, the wadis* or river courses carry alluvium to the flood plains and the deltas in the lowlands of the peninsula, where aeolian processes winnow out the sand and transport it to the 'Rub al Khali Basin (Holm 1960). Shorelines of lakes and the sea are other potential primary sources of sand. Secondary sources of sand are the outcrops of sandstone which are found upwind from the dune fields, and the gravel plains in which unconsolidated clastic sediments are

partly protected by a veneer of gravel, which often is a rich source of sand (Holm 1960). It is believed that the 'Rub al Khali Basin derives its sand from the highlands on three sides of it, as well as from the coastal dunes and beach deposits of the southern Persian Gulf (Holm 1960).

The prevailing wind therefore plays a major role in the distribution of the aeolian sand and its concentration in the Kingdom of Saudi Arabia. The wind regime of the Arabian Peninsula is complex in detail but rather simple in broad view. The region lies within the trade-wind belt of the Northern Hemisphere. Westerly winds from the Mediterranean Sea enter the region in the northwest, travel toward the Persian Gulf, and then swing south and southwest through the 'Rub al Khali Basin (Holm 1960).

There are several striking characteristics of the plant life in the 'Rub al Khali basin. The first is that the vegetation in the 'Rub al Khali Basin is widespread. Another characteristic is the close association of the vegetation with the sand. Approximately 90% of the 'Rub al Khali Basin is covered with sand. This sand has relatively good textural and moisture-storing properties when compared with some of the other desert soils in the world. These properties provide niches for at least a few hardy psammofiles throughout most of the basin. It is also notable that there is limited floristic diversity in the area with only approximately 20 plant species known from the main body of the sands (Mandaville 1986) and another 17 species which mostly occur on the outer margins of the sands.

Based on the present knowledge of the 'Rub al Khali, only a broad tentative classification of the vegetation of the area is possible. Mandaville (1986) described three basic plant communities (Figure 2). The first is the *Cornulaca arabica* community, which is distinguished by the presence of the endemic chenopodiaceous bush *Cornulaca arabica*. The next is the *Calligonum crinitum-Dipterygium glaucum* community, which is a rather poorly defined and variable complex that is mapped over large areas where other dominant plant species such as *Cornulaca arabica* and *Haloxylon persicum* are absent. The last is the *Haloxylon persicum* community, which is a rather clear-cut and conspicuous unit with a restricted, patchy distribution in a broad belt across the northern and northwestern edges of the sands.

In physiognomic* terms the vegetation of the 'Rub al Khali basin can be described as a diffuse but fairly evenly distributed sandy shrubland, which is interrupted in some parts by

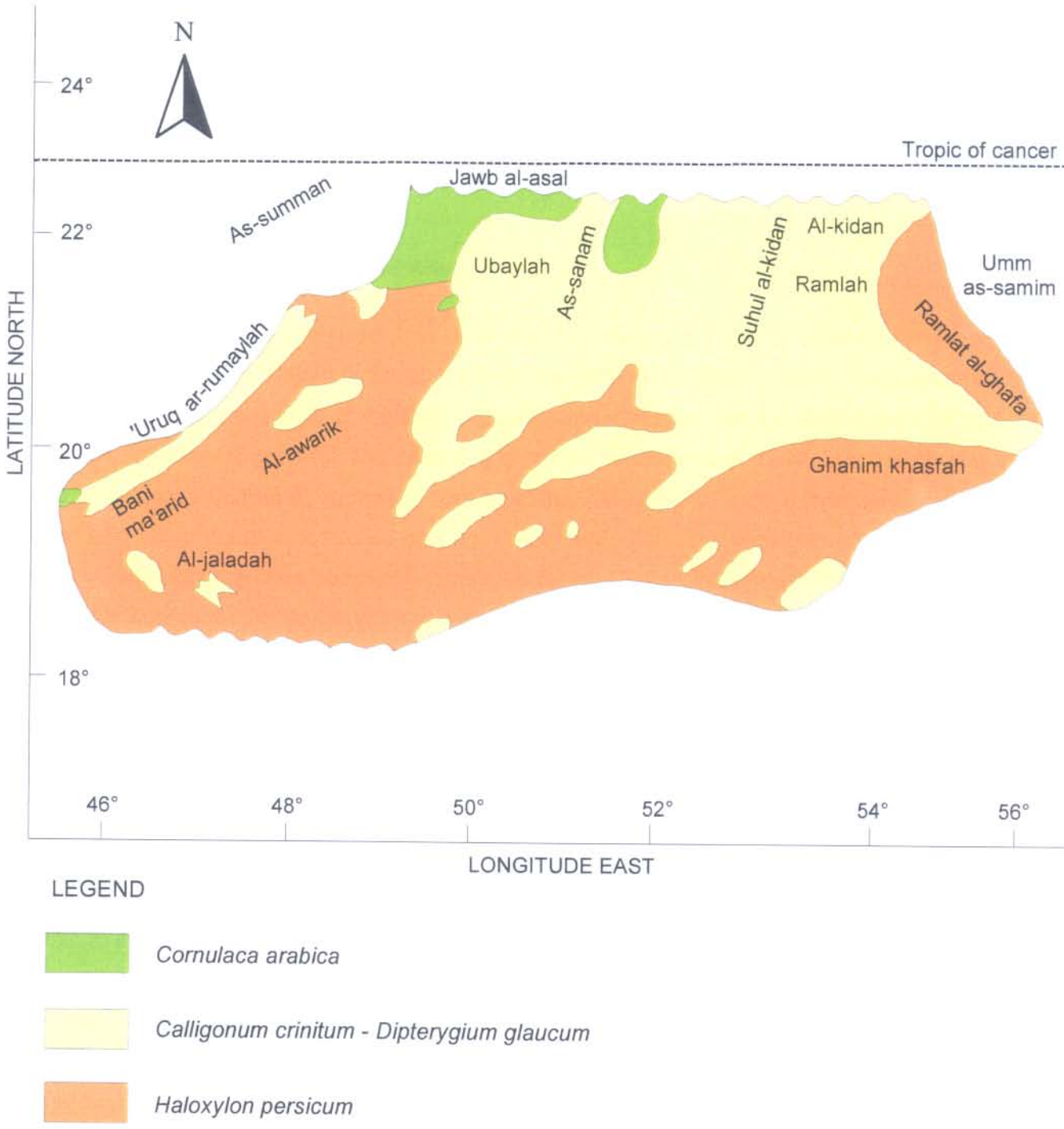


Figure 2: The major plant communities of the Rub' al-Khali (Mandaville 1986).

near-sterile inter-dune valleys. Trees are virtually absent except for a few individuals along the outer sand margins. It has also been noted that there is little seasonal variation in the general aspect of the plant cover. The main growth period for plants in the 'Rub al Khali is from March to June, but such growth depends on the amount of rain received. No spring annuals are found in the 'Rub al Khali basin (Mandaville 1986) because the infrequent rains do not seem to meet the cyclical moisture requirements of even these desert-adapted annual plants.

The 'Uruq Bani Ma'arid Protected Area

The 'Uruq Bani Ma'arid Protected Area is located approximately halfway between the cities of Wadi D'Awasir and Najran in Saudi Arabia. It lies within the Aeolian Sands Physiographic Region on the western edge of the Empty Quarter and it has the Tuwayq Escarpment as its western boundary (Figure 3). The protected area was proclaimed in 1994, and it is divided into three zones (Figure 4), namely a core protected area of 2400 km², a managed grazing zone of 5500 km² and a controlled hunting area of 4400 km². The core protected area and the managed grazing area corresponds with the Special Nature Reserve and Resource Use Reserve categories respectively, as defined by Child and Grainger (1990), while the controlled hunting area corresponds with the Controlled Hunting Reserve category.

The western edge of the 'Uruq Bani Ma'arid Protected Area is a limestone plateau which rises approximately 900 m above sea level and slopes gently to the east. A number of large wadis are incised into this plateau. The largest part of the protected area is covered by parallel sand dunes with a northeast-southwest orientation. These dunes are often more than 1 km wide and may be up to 152 m high. They merge at times to form mobile dunes close to the escarpment edge. The area between the parallel dunes consists of gravel plains interspersed with sand belts over the first 30 to 40 km, whereafter the gravel plains are replaced by sand. This produces a continuous undulating sand mass some 40 km or more away from the escarpment edge (Bothma & Strauss 1995).

Climate

An analysis of climatic data on a scale smaller than the whole Arabian Peninsula is difficult because insufficient data are available on the climatic conditions of any of the countries of

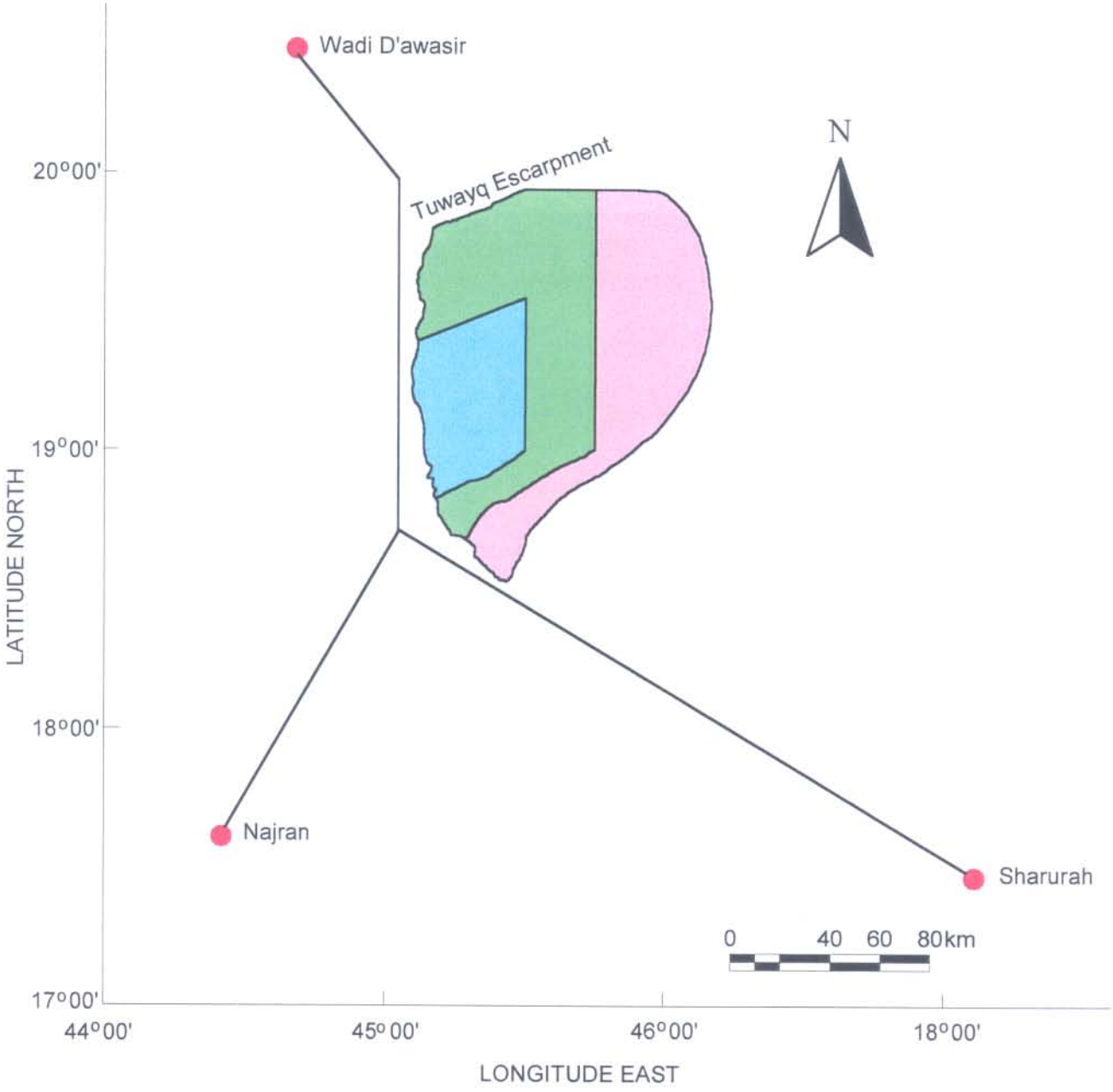


Figure 3: The location of the 'Uruq Bani Ma' arid Protected Area in the Kingdom of Saudi Arabia, in relation to three major towns (red dots). The different zones of the 'Uruq Bani Ma'arid Protected Area as indicated by the different colours above are explained in Figure 4.

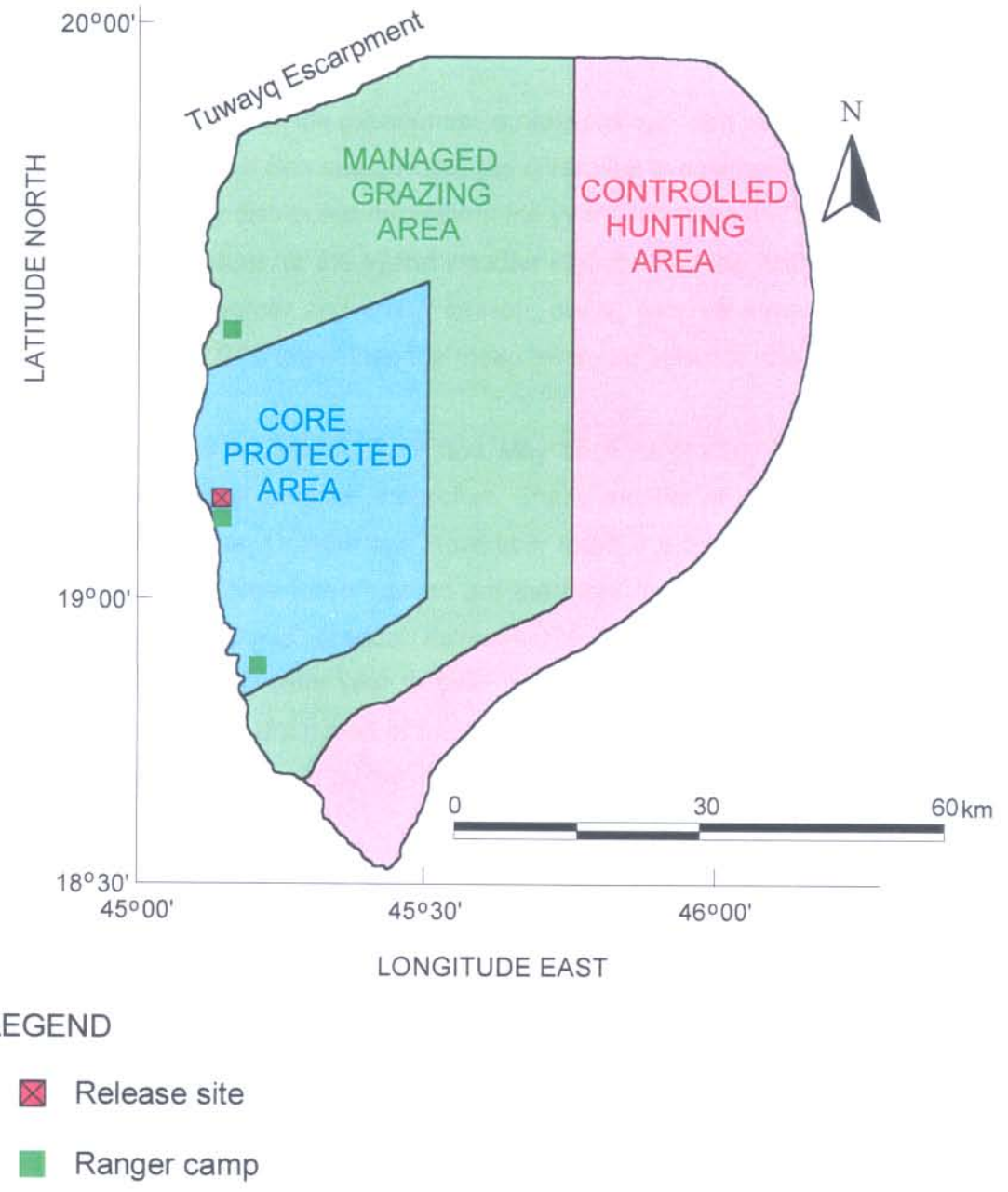


Figure 4: The 'Uruq Bani Ma' arid Protected Area of the Kingdom of Saudi Arabia showing some prominent features and the original release site of the reintroduced animals.

the peninsula (Taha, Harb, Nagib &Tartauny 1981). The climatic description that follows is therefore largely based on that given by Child and Grainger (1990). From this description it is clear that the subtropical high-pressure ridge which is part of the tropical circulatory system known as the Hadley Cell dominates the climate of Saudi Arabia. In the Equatorial Tropical Convergence Zone, this cell is characterised by rising air and clouds, with rain coming from the north. After rising to a height of 1400 m the air returns to the north, sinking as it does so to complete the Hadley Cell and to give rise to an extensive subtropical high pressure ridge which circles the globe (Child & Grainger 1990).

In general the Arabian Peninsula experiences a rapid change from summer to winter, except for the area along the Red Sea coast where the difference is small and the relative humidity of the air is more evenly distributed throughout the year (Schyfsma 1978). The ranges of the mean monthly temperature for the inland weather stations and the Arabian Gulf area show that there is a clear summer and winter season, during which the mean maximum winter temperature is about 7.5 °C lower than the mean minimum summer one.

In the Arabian Peninsula, March, April and May show a gradual increase in the mean monthly temperature until summer is reached. These months are therefore recognised as spring. During September, October and November there is a gradual decrease in the mean monthly temperature. These three months are therefore recognised as autumn (Schyfsma 1978). The timing of these gradual increases and decreases in the mean monthly temperature varies slightly from year to year, but when taken over a long period there is sufficient evidence for the distinction of the four seasons in the peninsula. The identification of the four seasons is confirmed by the changes in the relative humidity of the air (Schyfsma 1978).

Rainfall

Saudi Arabia lies within the subtropical ridge. This is an area of dry, stable and subsiding air. This ridge gives rise to hot, dry and near cloudless conditions, with 355 to 365 physiologically dry days per year (Child & Grainger 1990). During the summer the ridge is weaker than in the winter when it is displaced to the north. Disturbed tropical monsoon weather may then also occasionally reach the Kingdom of Saudi Arabia, bringing rain to the south of the country during the summer (Child & Grainger 1990).

The variability of the rainfall in deserts is well known. A way to measure this variability is to calculate the relative inter-annual variability (Wallén 1966). This is done by calculating the

difference between the year-to-year mean rainfall figures, and expressing it as a percentage of the mean annual rainfall. For the majority of the weather stations in the Eastern Province of Saudi Arabia this figure ranges from 70 to 90%, which shows that this high degree of variation approaches the value of the mean itself (Mandaville 1990).

The annual rainfall in eastern Saudi Arabia declines from the north to the south, as does the annual rainfall in the 'Uruq Bani Ma'arid Protected Area, where the mean annual rainfall probably is less than 47 mm per year (Dunham, Robertson & Wacher 1995). Many parts of the 'Rub al-Khali may have several years without any rain. For example, during the early 1930's Philby reported that no rain had fallen in the northern margin of the sands near Wadi D'Awasir for several years (Carruthers 1935).

Temperature

The ambient temperatures in Saudi Arabia show considerable diurnal and seasonal fluctuations. The winters are cool to warm, with frost not being uncommon at night. Occasionally, snow falls in the north of the country at higher altitudes. The maximum summer temperatures tend to be above 40° C in general, while occasionally exceeding 50° C. The relative humidity of the air is generally low, except along the coasts where the days may be excessively hot and humidly oppressive (Child & Grainger 1990).

The 'Uruq Bani Ma'arid Protected Area is a new protected area in the Kingdom of Saudi Arabia. Therefore much climatic data are not available for the area (Bothma & Strauss 1995). Data are, however, available for the three towns surrounding the area.[2] These are the towns of Wadi D'Awasir, Sharurah and Najran. Following Walther (1979) the climatic data for these towns can be used to create a composite display of the expected monthly rainfall and the mean temperatures of each town (Figure 5) and consequently the study area. This display gives a useful impression of the seasonal march of aridity (Mandaville 1990). The ratio of temperature to rainfall is chosen so that the area between the curves provides an approximate indication of the water balance (excess or deficit) (Mandaville 1990).

The three diagrams show that the mean annual temperature of the three towns involved range from 25.5 to 29.4 °C, while the mean annual rainfall ranges from as low as 30 mm per

[2] Climatic data for a 5-year period (1989 to 1993) as supplied by the Meteorological and Environmental Protection Administration, Jeddah, Saudi Arabia.

year in Sharurah to 54 mm per year in Najran. It is also apparent that there is a water deficit in all three of these towns throughout the year. According to Mandaville (1986) the evapo-transpiration in as-Sulayil, a town approximately 150 km north of the protected area, was 5250 mm per year over a 9-year period. This evapo-transpiration rate strongly supports the current climatic data available for the three towns used.

Vegetation

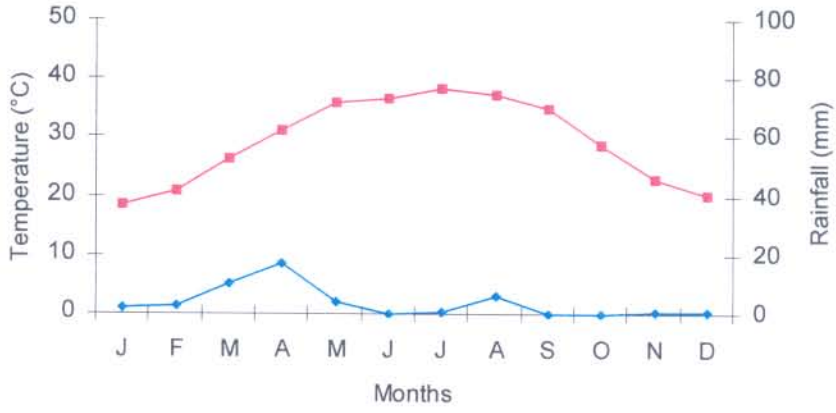
Based on the topography of the 'Uruq Bani Ma'arid Protected Area, several vegetation associations are distinguished (MEPA 1986; NCWCD 1987; NCWCD 1990), of which the sand and the escarpment associations are the two basic types (MEPA 1986; NCWCD 1987). The sand association can be divided into the vegetation of the dunes and the *shiquats*, the latter also being known as dune corridors. The *shiquats* consist of hard, compact lacustrine* deposits, lag* gravels adjacent to run-off sites, and fringing plains. The escarpment association can be subdivided into the escarpment gravel plains, which are mostly void of vegetation, the escarpment sand sheets, and the vegetation-rich wadis.

Various *Acacia* tree species dominate in the 'Uruq Bani Ma'arid Protected Area with *Acacia tortilis*, and *Acacia ehrenbergiana* especially abundant and *Acacia hamulosa*, *Acacia oerfota*, *Ziziphus spina-christi* and *Maerua crassifolia* also present. The shrub and herb layer consists of species such as *Calligonum crinitum*, *Leptadenia pyrotechnica*, *Tribulus arabicus*, and *Dipterygium glaucum*. Grass species commonly found in the protected area include *Panicum turgidum, Lasiurus scindicus*, *Stipagrostis plumosa, Centropodia fragilis* and *Pennisetum divisum* (Bothma & Strauss 1995).

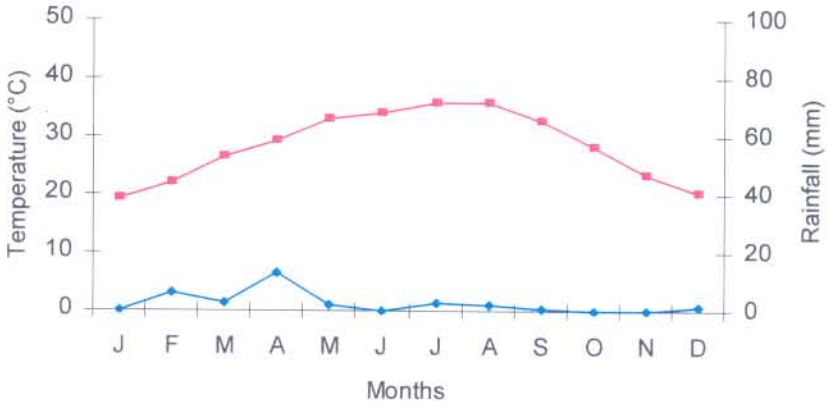
Based on the location of the 'Uruq Bani Ma'arid Protected Area and the vegetation in the area, this protected area is located mainly within the *Calligonum crinitum - Dipterygium glaucum* plant community, as defined by Mandaville (1986). The *Haloxylon persicum* and *Cornulaca arabica* communities also occur within the protected area (Figure 2).

Previous surveys conducted in the 'Uruq Bani Ma'arid Protected Area (MEPA 1986, NCWCD 1987; NCWCD 1990) concluded that the protected area has an appreciable habitat diversity, a vegetation that is less degraded than in other areas of Saudi Arabia, and that the protected area lies within the historical range of the Arabian oryx, all three of the native gazelle types and the ibex *Capra ibex nubiana* Linnaeus, 1758 (Büttiker &

Wadi D'awasir (701.02 m) 29.4°C 45.6 mm



Sharurah (724.65 m) 28.4°C 30.0 mm



Najran (1212.33 m) 25.5°C 54.0 mm

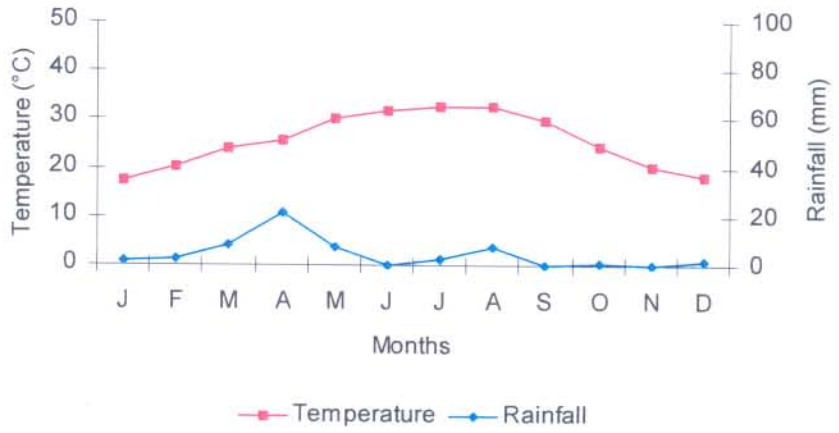


Figure 5: Walther diagram for three towns surrounding the 'Uruq Bani Ma'arid Protected Area in the Kingdom of Saudi Arabia. Figures at right of station name are, from left to right: station elevation in metres above mean sea level, mean annual temperature and mean annual rainfall. The red line depicts the mean monthly temperature and the blue line the mean monthly rainfall. The area in-between the graphs represent the period of moisture deficit.

Grainger 1989). There is therefore no question about the suitability of these herbivores for their reintroduction* into the 'Uruq Bani Ma'arid Protected Area.