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Vegetation Zonation Along an Altitudinal Gradient between Sea Level and 3000 Meters in Southwestern Saudi Arabia

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Abstract. Vegetation of the southwestern region of Saudi Arabia is of temperate, semi-tropical, and desert to semi-desert affinites. Along altitudinal gradient the climate plays a major role on the vegetation distribution, and the vegetation can be divided into six major zones: coastal plains (0-300m), foothills (300-1000m), lower escapments (1000-1600m), upper escarpments (1600-2200),high mountains (2200-3000m), and rainshadow slopes (1700-2200m). Each zone is further divided into smaller units according to topography, soil type, rock substrate, water system, and salinity. Plant species of these ecological units or communities were recorded. In each zone plant habit (tree, shrub, herb, sclerophyllous, etc.) was noted and is listed for some representative species of each community.

Introduction

A series of publications on the vegetation of southwestern Saudi Arabia were found to be of value in the course of this study. Vesey-Fitzgerald [1] had given an overall view of the vegetation of the lowland area. Various vegetational aspects of the high mountains were dealt with by a number of authors: Mandaville [2] and Boulos [3] provide a list of common plant species found over the high mountains of Asir; Chaudhary and El-Sheikh [4] recorded the plant species of the Raidah escarpment which is located west of Abha; Brook and Mandil [5] discuss the role of mountain aspect on the distribution of Juniper trees and the common associated species; Frey and Kurschner [6] and Kurschner [7] evaluated the distribution of bryophytes on the Asir mountains. General information on the flora and vegetation of Saudi Arabia, exist in the publications by Migahid [8], Zahran [9], Collenette [10], Chaudhary [11, 12, 13], and Hassan and Farraj [14]. The publication on the vegetation of Yemen by Al-Hubaishi and Muller-Hohenstein [15] was also of great assistance in the process of orientation of the subject material of this article.

Preliminary studies by the author and various collaborators, Abulfatih [16], Abulfatih and Al-Khalili [17], Abulfatih [18, 19, 20], Abulfatih and Emara [21],

Abulfatih, Emara and Hashish [22], Abulfatih and Nasher [23] also provided experience of various aspects of the flora and vegetation of southwestern Saudi Arabia. In the present study, an attempt has been made to describe the species composition of the communities which occur along the altitudinal zonation between sea-level and 3000 m in southwestern Saudi Arabia.

Materials and Methods

The altitude at which the prominent plant species found in the southwestern region of Saudi Arabia were recorded during numerous field trips made in the past fourteen years. The vegetation distribution in general is continuous. However, in the process of grouping the plant species, collected along the elevation gradient, it was possible to distinguish six major plant groups which consequently enabled me to define six vegetation zones between sea level and 3000 meters (Fig. 1). These vegetation zones were as follows:

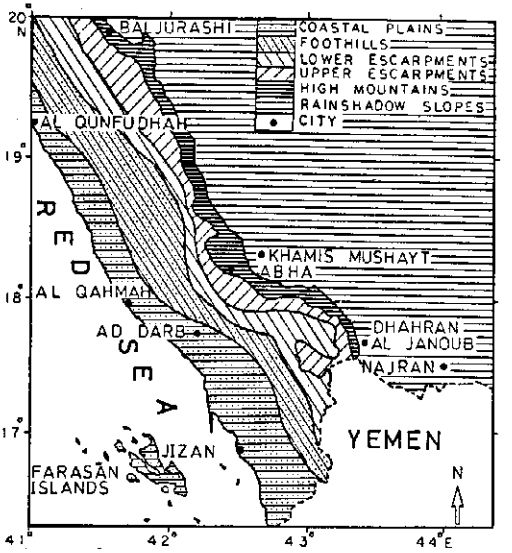


Fig. 1. Map showing the six vegetation zones of southwestern Saudi Arabia

1) Coastal Plains: 0-300m
2) Foothills: 300-1000m
3) Lower Escarpments: 1000-1600m

4) Upper Escarpments: 1600-2200m
5) High Mountains: 2200-3000m
6) Rainshadow Slopes: 1700-2200m,

Each zone was considered as further consisting of a number of plant communities. Plant identification was based on the publications by Abulfatih [20], Chaudhary [11, 13], Collenete [10], Migahid [8], and with some assistance from the staff of the Botany Department, the Natural History Museum, London. Voucher specimens of many of the species listed in this article were deposited in the herbarium of the College of Education, King Saud University, Abha Branch, Abha.

Climate

The climate of the southwestern region of Saudi Arabia is affected by the prevailing southwesterly wind and the monsoon rains which fall mainly during winter and summer. The climate of each vegetation zone is unique with regard to temperature, rainfall, and relative humidity (Fig. 2). The coastal plains zone is generally characterized by lower rainfall, high temperature and high relative humidity. Proceeding eastward towards the high mountains a gradual increase in rainfall and decrease in air temperature and relative humidity are observed. The rainshadow slopes zone is characterized by lower annual rainfall and relative humidity, warmer summer and cooler winter compared with the neighboring western high mountains zone. The complex terrain in the foothill, lower and upper escarpments and high mountain zones create a wide range of micro-environments. Such broad spectrum of micro-environments available in each zone makes it possible for the plants of different ecological affinities and different growth forms to thrive and reproduce.

Results

Plant distribution along the elevation gradient between sea level and 3000m showed that there are six major vegetation zones (Fig. 1). General features of the landscape and the plant communities belonging to each vegetation zone are described below. An appendix containing families, genera, species and their authors arranged in alphabetical order is also added at the end of this article.

Coastal Plains (0-300m)

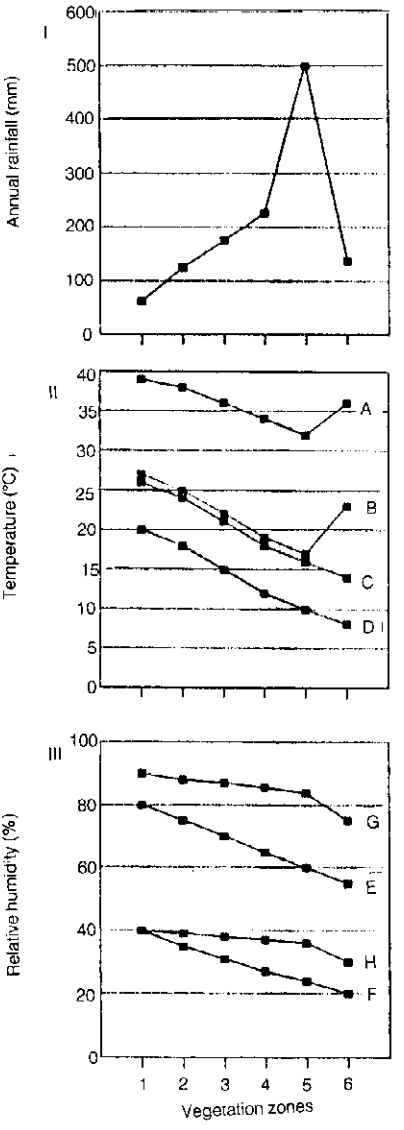
The coastal plains is regarded as a semi-tropical desert and its vegetation is highly affected by water table, water salinity, texture and mobility of soils. Vegetation concerned in this study were surveyed along the coasts of mainland and the Fara-

Fig. 2. Climatic information of the six vegetation zones of the southwestern region of Saudi Arabia, for the years 1975-1984, extracted from the Climatic Atlas of Saudi Arabia (1988). Vegetation zones 1,2,3,4,5, and 6 correspond consequently with the altitudes 0-300, 300-1000, 1000-1600, 1600-2200, 2200-3000, and 2200-1700 meters above sea level.

Part I. Average total annual rainfall.

Part II. July average daily maximum (A) and minimum (B) air temeprature. December average daily maximum (C), and minimum (D) air temperature.

Part III. July average daily maximum (E), and minimum (F) relative humidity. December average daily maximum (G), and minimum (H) relative humidity.



san islands in the Red Sea as well. Species composition were recorded in each of the following plant communities: intertidal zone, saline soil, fossil corals and lava rocks, sand dunes and hummocks, hard sandy-silty soil of alluvial deposits, rocky hillsides of aeolian deposits, water courses, and disturbed grounds.

Intertidal zone community

The plant community of the intertidal zone of the Red Sea is occupied by large patches of mangrove swamps, especially in a relatively calm water. Such forest is comprised mainly of two species:

Avicennia marina *Rhizophora mucronata*

Saline soil community

Halophytic vegetation stretches along the beaches of the Red Sea, on saline hard sandy soil. Such vegetation is composed of the following species:

Aeluropus lagopoides
Arthocnemum glaucum
Atriplex sp.
Cressa cretica
Desmostachya bipinnata
Halopeplis perfoliata
Halothamnus bottae
Limonium axillare
Limonium cylindrifolium
Salsola spinescens
Suaeda monoica
Zygophyllum coccineum
Zygophyllum simplex

Fossil corals and lava rocks community

Along the beaches of the mainland and Farasan Islands fossil coral and lava fields were observed to be inhabited by the following species:

Acacia tortillis
Aloe vera var. *officinalis*
Caralluma russeliana
Euphorbia sp. aff.
Fractiflexa
Ficus populifolia
Indigofera caerulea
Indigofera semitrijuga
Pancratium tenuifolium
Rhynchosia minima var *minima*

Sand dunes and hummocks community

In the Farasan Islands, sand dunes and hummocks are inhabited by various types of plants, such as:

Lasiurus scindicus
Panicum turgidum
Salvadora persica
Suaeda fruticosa
Tamarix nilotica

Hard sandy-silty soil of alluvial deposits community

The down hill movement of water coming from the mountainous region to the east carries along a large amount of fine soil particle. Such mineral rich soil is deposited over vast areas in the coastal plain, allowing the following plants to thrive:

Acacia ehrenbergiana
Acacia mellifera
Acacia oerfota
Acacia seyal
Aerva javanica
Aloe vera var. *officianalis*
Alternanthera sessilis
Aristida adscensionis
Aristida funiculata
Aristida mutabilis
Boerhavia repens
Cadaba rotundifolia
Calotropis procera
Caralluma deflersiana
Caralluma edulis
Carraluma russeliana
Cassia senna
Coelachyrum brevifolium
Duvalia velutina
Ecbolium viride
Eragrostis ciliaris
Euphorbia arabica
Euphorbia fractiflexa
Euphorbia sp. aff. *parciramulosa*
Heliotropium longiflorum
Hyphaene thebaica
Indigofera spinosa
Jatropha pelargoniifolia
Leptadenia pyrotechnica
Maerua crassifolia
Mollugo cerviana
Moringa peregrina
Pandanus odoratissimus
Pavonia arabica
Pavonia triloba
Ricinus communis
Salvia aegyptiaca
Tephrosia sp. aff. *quartiniana*
Tephrosia subtriflora
Tragus berteronianus
Trianthema crystallina
Ziziphus spina-christi

Rocky hillsides of aeolian deposits community

Air born sandy soil carried by the prevailing southwesterly wind is accumulated on the granite rocky hillsides of the coastal plain where many plant species are thriving. These plants include the followings:

Abrus bottae
Acacia asak
Acacia ehrenbergiana
Acacia oerfota
Commiphora opobalsamum
Commiphora sp.
Cucumis melo var. *agrestis*
Dobera glabra

Acacia tortilis
Adenium obesum
Blepharis ciliaris
Capparis decidua
Combretum molle
Commiphora myrrha
Euphorbia cuneata
Euphorbia triaculeata
Lasiurus scindicus
Maerua crassifolia
Sansevieria ehrenbergii

In places of relatively high air humidity climbing plants were common over *Acacia* trees. Such plants included:

Ceropegia devecchii
Ceropegia tihamana
Cocculus hirsutus
Combretum aculeatum
Merremmia tridentata var. *angustifolia*

Water courses community

Drainage gullies and temporary water ways (wadis) are common in the lowland area (Tihama). They receive their water from the Asir Mountains (Sarawat Mountains) to the east and north east, and allow numerous plant species to thrive here, such as:

Abutilon sp.
Abutilon sp. aff. *bidentatum*
Acacia ehrenbergiana
Acacia tortilis
Calotropis procera
Cissus quadrangularis
Clitoria ternatea
Delonix elata
Desmostachya bipinnata
Euphorbia cuneata
Grewia tenax
Hyphaene thebaica
Jatropha glauca
Lasiurus scindicus
Leptadenia pyrotechnica
Panicum turgidum
Phragmites australis
Salvadora persica
Seddera latifolia
Seddera virgata
Suaeda monoica
Tamarix nilotica
Typha domingensis
Ziziphus spina-christi

Disturbed ground community

On disturbed ground near farms one might come across any of the following species:

Amaranthus spinosus
Convolvulus arvensis
Heliotropium longiflorum
Sida spinosa
Striga hermonthica (parasite on sorghum)
Vigna aconitifolia

Foothills (300-1000m)

The foothills zone is a semi-tropical to a semi-desert zone, and characterized by a rolling landscape which rises gradually to the east and consists of the following plant communities:

Hillside community

Many plant species are found on the slopes of the foothills zone over a wide range of habitats, such as granite rocky slopes, cliffs, and crevices. The main component of the soil is granite sand. The common plants found in this type of community are:

Abrus bottae
Acacia abyssinica var. *macroloba*
Acacia asak
Acacia ehrenbergiana
Acacia etbaica
Acacia hamulosa
Acacia mellifera
Acacia tortilis
Actiniopteris semiflabellata
Adenium obesum
Aerva javanica
Anisotes trisulcus
Barleria bispinosa
Becium filamentosum
Boerhavia repens
Cadaba glandulosa
Capparis tomentosa
Caralluma russeliana
Celosia polystachya
Cheilanthes vellea
Commiphora kataf
Commiphora myrrha
Commiphora sp. aff. *erythraea*
Desmodium gangeticum
Dorstenia foetida
Euphorbia cuneata
Euphorbia inarticulata
Gomphocarpus sinaicus
Grewia tenax
Grewia velutina
Justicia odora
Kalanchoe lanceolata
Maerua crassifolia
Monsonia senegalensis
Peristrophe paniculata
Premna resinosa
Pupalia lappacea var. *velutina*
Sansevieria abyssinica

Water course community

This community includes various types of habitats such as ravines, valleys, pools, ponds, which receive an immense amount of water from the neighboring highlands during the monsoon rains in winter and summer. The ground is made of boulders, rocks, stones, and sand. Water is seasonally abundant. The common plant species found in this type of community are:

Aloe sabaea
Aloe sp. aff. *niebuhriana*
Argemone mexicana
Aristolochia bracteolata
Caralluma penicillata
Caralluma quadrangula
Combretum molle
Commelina forsskahlei
Convolvulus prostratus
Corallocarpus epigeus
Cordia ovalis
Datura fastuosa
Euphorbia triaculeata
Evolvulus alsinoides
Ficus salicifolia
Ficus vasta
Fimbristylis spathacea
Mimusops laurifolia
Orthosiphon pallidus
Selaginella imbricata
Senra incana
Tamarindus indica
Tapinanthus globiferus (parasite on *Ficus)*
Zaleya pentandra

Plain community

The term plain refers to basins bordered by hills, which occur in various sizes. Soil consists of hard sandy deposits mixed with rocks. Common plants found in this type of community include the followings:

Aloe vera var. *officinalis*
Ammannia auriculata
Blepharis ciliaris
Caralluma commutata
Caralluma shadhbana
Caralluma subulata
Cassytha filiformis (parasitic on on various hosts)
Ceropegia mansouriana
Corallocarpus schimperi
Cucumis figarei
Cyperus rubicundus
Dactyloctenium scindicum
Duvalia sulcata var. *semi-nuda*
Endostemon tenuiflorus
Euphorbia fractiflexa
Fagonia indica
Indigofera phillipsiae
Leucas urticifolia
Limeum arabicum
Limeum obovatum
Polygala senensis
Ruellia prostrata
Salvadora persica
Trianthema triquetra
Ziziphus spina-christi

Disturbed ground community

Many plants were seen on disturbed ground on the fringes of farms, roadside, near villages, and wasteland. Such plants are:

Abutilon bidentatum
Calotropis procera
Cassia italica
Cassia occidentalis
Heliotropium longiflorum
Pulicaria jaubertii
Ricinus communis
Sida ovata

Cassia senna
Cassia tora
Commicarpus plumbagineus
Solanum incanum
Striga gesnerioides

Lower Escarpments (1000-1600m)

The lower escarpments zone is a semi-tropical to a semi-desert zone, and comprises of the following communities:

Hillside community

The land surface of this type of community is composed of various kinds of microhabitats which appear in the forms of rocky or sandy cliffs and crevices. Various kinds of plant species are found in these microhabitats. Such plants are:

Acacia asak
Acacia etbaica
Acacia tortilis
Acalypha racemosa
Adenia venenata
Adenium obesum
Andropogon distachyos
Anisotes trisulcus
Barleria bispinosa
Barleria trispinosa
Blepharis ciliaris
Bromus fasciculatus
Buddleja polystachya
Cenchrus ciliaris
Ceropegia sp. aff. *variegata*
Chrysopogon aucheri var. *quinqueplumis*
Commiphora kataf
Commiphora myrrha
Cymbopogon schoenanthus
Danthoniopsis barbata
Dichrostachys cinerea
Eragrostis papposa
Euclea schimperi
Euphorbia cactus
Ficus sycamorus
Hyparrhenia hirta
Kalanchoe citrina
Kalanchoe crenata
Kalanchoe sp. aff. *glaucescens*
Kalanchoe sp. aff. *laciniata*
Kleinia odora
Leucas glabrata
Lindenbergia indica
Macrotyloma axillare var. *axillare*
Maytenus heterophylla
Pegolettia senegalensis
Pennisetum setaceum
Phyllanthus tenellus var. *arabicus*
Plectranthus asirensis
Polygala tinctoria
Pulicaria arabica
Pulicaria somalensis ssp. *somalensis*
Rhynchosia sp. aff. *minima* var. *minima*
Sansevieria ehrenbergii
Stipagrostis obtusa
Tephrosia pumila
Teramnus labialis ssp. *arabicus*

Grewia tenax
Grewia villosa
Hibiscus deflersii
Huernia saudi-arabica
Terminalia brownii
Tetrapogon villosus
Vigna ambacensis

Water course community

This type of community includes different habitats such as ravines, streams, gullies, pools and wadis. Water is very likely to be seen in such habitat during or shortly after the rain, or in some cases might continue throughout the year. Common plant species found in this type of community are:

Acacia laeta
Adenia venenata
Aloe fleurentinorum
Aloe sabaea
Alternanthera pungens
Anagallis arvensis ssp. *arvensis*
Annona squamosa
Astragalus corrugatus
Blumea bovei
Cadia purpurea
Caralluma sp.
Centaurea pseudosinaica
Cissus rotundifolia
Coccinea grandis
Combretum molle
Commelina albescens
Commicarpus plumbagineus
Crossandra wissmannii
Datura stramonium
Euphorbia sp. aff. *schimperi*
Ficus salicifolia
Ficus vasta
Frankenia pulverulenta
Geranium ocellatum
Hibiscus vitifolius
Hippocrepis ciliata
Kanahia laniflora
Lactuca sp. aff. *sativa*
Lasiopogon muscoides
Lepidagathis scariosa
Linderbergia sp. aff. *indica*
Nuxia oppositifolia
Ocimum basilicum
Pavonia patens
Plectranthus arabicus
Plectranthus cylindraceus
Plectranthus tenuiflorus
Plumbago zeylanica
Portulaca quadrifida
Securinega virosa
Selaginella yemensis
Tamarindus indica
Themeda triandra
Verbascum bottae
Withania somnifera
Ziziphus spina-christi

Disturbed ground community

Disturbed ground is found on the edges of farms, near villages, and on roadsides. The soil is mainly of sandy rocky texture. The following plants can be seen in such community:

Abutilon bidentatum
Alhagi maurorum
Astragalus atropilosulus
Boerhavia elegans
Crotalaria quartiniana
Cucumis prophetarum var. *prophetarum*
Euphorbia heterophylla
Hibiscus trionum
Lotus corniculatus
Malva parviflora
Mentha longifolia ssp. *schimperi*
Plantago major
Pulicaria jaubertii
Sonchus oleraceus

Upper Escarpments (1600-2200m)

The upper escarpments zone is a semi-tropical to a semi-desert zone, and consists of the following plant communities:

Hillside community

Slopes in the upper escarpments zone are generally steep and appear in the forms of cliffs, ridges, sharp peaks, and consist of granite boulders, sandstone and limestone rocks. Soil is commonly sandy stony. Common plants found in cracks and crevices are:

Abutilon bidentatum
Acacia albida
Acacia etbaica ssp. *uncinata*
Acacia negrii
Acacia seyal
Acokanthera schimperi
Aizoon canariense
Alkanna orientalis
Aloe castellorum
Aloe fleurentinorum
Aloe sheilae
Aloe vacillans
Argyrolobium arabicum
Arnebia hispidissima
Asparagus falcatus
Astripomoea malvacea
Barleria acanthoides
Barleria parviflora
Barleria proxima
Barleria sp. aff. *hochstetteri*
Juniperus excelsa = *J. procera*
Justicia flava
Justicia odora
Kalanchoe glaucescens
Kleinia odora
Kleinia pendula
Launaea massauensis
Lotus lanuginosus
Lycium Shawii
Maerua triphylla
Maytenus somalensis
Monsonia heliotropioides
Moringa peregrina
Nepeta deflersiana
Olea chrysophylla
Oncocalyx schimperi
Orobanche minor
Osteospermum vaillantii
Otostegia fruticosa
Paronychia chlorothyrsa

Barleria trispinosa
Berchemia discolor
Blepharis ciliaris
Cadia purpurea
Campanula edulis
Campylanthus pungens
Caralluma eremastrum
Caralluma shadhbana var. *barhana*
Carex divisa
Centaurea pseudosinaica
Ceropegia arabica
Ceropegia sp. aff. *arabica*
Ceropegia superba
Cheilanthes pteridioides
Chenopodium ambrosioides
Cicer cuneatum
Cienfuegosia welshii
Cluytia myricoides
Cocculus hirsutus
Cometes surattensis
Commicarpus grandiflorus
Commicarpus sinuatus
Commicarpus squarrosus
Cordia africana
Crassocephalum bojeri
Crotalaria aegyptiaca
Dichrostachys cinerea
Diospyros mespiliformis
Dodonaea viscosa
Dolichos trilobus
Epilobium hirsutum
Euclea schimperi
Eulophia petersii
Euphorbia ammak
Ficus carica forma
Geranium trilophum
Gomphocarpus fruticosus
Heliotropium longiflorum
Hibiscus somalensis
Huernia lodarensis
Pelargonium alchemilloides
Pergularia daemia
Pergularia tomentosa
Periploca aphylla
Phagnalon scalarum
Phragmanthera sp. aff. *rufescens*
Plectranthus marrubioides
Plicosepalus curviflorus
Polygala subaphylla
Polygonum setulosum
Psiadia punctulata
Pteris vittata
Pulicaria glutinosa
Pulicaria schimperi
Pupalia lappacea var. *velutina*
Reseda sphenocleoides
Rhus retinorrhoea
Rhynchosia buramensis
Rhynchosia sp.
Rhynchosia sp. aff. *schimperi*
Rhytidocaulon sp. aff. *macrolobum*
Rosa abyssinica
Ruellia patula
Sarcostemma sp. aff. *viminale*
Scabiosa columbaria
Scadoxus multiflorus
Senecio asirensis
Senecio hadiensis
Silene schimperiana
Solanum macracanthum
Solanum sepicula
Stylosanthes fruticosa
Tapinunthus globiferus (parasitic)
Tarchonanthus camphoratus
Teclea nobilis
Telephium sphaerospermum
Trichodesma calathiforme
Trichodesma ehrenbergii
Trifolium fragiferum
Verbascum yemense

Indigofera schimperi
Jasminum grandiflorum var. *floribundum*
Jatropha spinosa
Vernonia cinerascens
Viscum schimperi
Xanthium cf. *pungens*
Zehneria scabra

Water course community

Different kinds of microhabitats are found here, such as water streams, ravines, gullies, and wadis. Most of these microhabitats are characterized by their steepness and water is seen running in them during most parts of the year. Soil is mainly of granite sandy type. The following plant species are found in this type of community:

Acacia etbaica
Adiantum capillus-veneris
Adiantum incisum
Aerva lanata
Andrachne aspera
Caralluma sinaica
Clematis incisodentata
Clematis simensis
Commelina africana var. *villosior*
Crinum yemense
Cyperus rigidifolius
Cyperus schimperianus
Datura stramonium
Equisetum ramosissimum
Erica arborea
Ficus ingens
Ficus salicifolia
Ficus vasta
Geranium arabicum
Hibiscus micranthus
Hypericum annulatum
Hypericum hircinum
Iris albicans
Lablab purpureus
Lemna gibba
Lythrum hyssopifolia
Maesa lanceolata
Meriandra benghalensis
Myrica salicifolia
Pluchea dioscoridis
Polygonum amphibium
Potomogeton nodosus
Pulicaria vulgaris
Ranunculus multifidus
Ricinus communis
Senecio deltoideus
Silene conoidea
Trifolium campestre
Trigonella anguina
Vigna membranacea
Woodfordia fruticosa
Xanthium strumarium

Disturbed ground community

Disturbed ground is found near farms and villages, on roadsides, and on wastlands. Soil is mainly of sandy-gravelly type. Common plant species are:

Aerva javanica
Allium pseudocalyptratum
Ammi majus
Onopordon heteracanthum
Oxygonum sinuatum
Polygonum aviculare

Drimia maritima
Endostemon gracile
Enicostemma axillare
Eruca sativa
Indigofera articulata
Salix subserrata
Silene vulgaris
Verbascum longibracteatum
Xanthium spinosum

High Mountains (2200-3000m)

The high mountains zone is of temperate climate and consists the following plant communities:

Hillside community

Slopes are generally steeply sheared to the west and decline to the east, and appear in various formations such as rocky cliffs, rocky ridges, granite boulders, granite outcrops, granite sandstones and crevices. Soil is generally of granite sandy type. Common plants are:

Acacia negrii
Achyranthes aspera
Aloe rubroviolacea
Aloe sp. aff. *tomentosa*
Aloe sp. nov. aff. *vacillans*
Anarrhinum orientale
Andropogon distachyos
Arabidopsis kneuckeri
Asparagus africanus
Asplenium aethiopicum
Barbeya oleoides
Biserrula pelecinus
Bromos pulchellus
Buddleja polystachya
Caralluma petraea
Caralluma plicatiloba
Caralluma wissmannii
Caylusea hexagyna
Celtis africana
Cenchrus ciliaris
Centaurea schimperi
Centaurothamnus maximus
Ceterach officinarum
Lavandula dentata
Lepidium sativum
Lonicera etrusca
Malva neglecta
Marrubium vulgare
Maytenus undata
Micromeria imbricata
Minuartia filifolia
Monechma debile
Myrsine africana
Nepeta deflersiana
Nuxia oppositifolia
Ochradenus baccatus
Olea chrysophylla
Ononis reclinata
Orobanche cernua var. *cernua*
Orobanche oxyloba var. *oxyloba*
Otostegia fruticoca ssp. *schimperi*
Panctarium maximum
Paronychia chlorothyrsa
Pennisetum setaceum
Pennisetum villosum
Phragmanthera sp. aff. *rufescens.*

Cheilanthes coriacea
Cheilanthes marantae
Chenopodium schraderianum
Cluytia myricoides
Coelachyrum poiflorum
Crassula alba
Crinum yemense
Cynodon dactylon
Delosperma harazianum
Dianthus zonatus
Dichondra repens
Digitaria abyssinica
Dipcadi viride
Dodonaea viscosa
Dracaena serrulata
Echinops sp.
Ephedra intermedia
Erodium moschatum
Euphorbia schimperi
Euphorbia schimperiana
Geranium molle
Holothrix arachnoidea
Huernia saudi-arabica
Hyparrhenia hirta
Juniperus excelsa = *J. procera*
Kalanchoe alternans
Lavandula citriodora
Pistacia falcata
Plantago cylindrica
Plectranthus asirensis
Psiadia arabica
Pteris dentata spp. *dentata*
Rhamnus oleoides
Rosa abysinnica
Sarcostemma sp.
Scadoxus multiflorus
Sedum hispanicum
Senecio hadiensis
Silene macrosolen
Silene sp. aff. *burchellii*
Silene yemensis
Solanum grossedentatum
Solanum incanum
Solanum schimperianum
Tetrapogon villosus
Teucrium yemense
Themeda triandra
Tragia pungens
Trifolium tomentosum
Umbilicus horizontalis var. *intermedius*
Usnea sp.
Verbascum longibracteatum
Volutaria albicaulis

Water course community

Water might be seen running through streams, ravines, gullies, valleys, and waterfalls, or gathered in small pools. Soil is generally sandy-loamy rich with humus. Common plants are:

Achillea biebersteinii
Adiantum capillus-veneris
Adiantum incisum
Ajuga bracteosa
Anagallis arvensis ssp. *arvensis*
Anthemis pseudocotula
Arabis alpina
Hypericum revolutum
Juncus punctorius
Kanahia laniflora
Lathyrus pratensis
Lavandula stricta
Maesa lanceolata
Malva verticillata

Artemisia abyssinica
Asplenium aethiopicum
Asplenium trichomanes
Beta vulgaris
Buddleja polystachya
Cadia purpurea
Campanula edulis
Capsella bursa-pastoris
Carex distans
Celtis africana
Ceterach officinarum
Cheilanthus coriacea
Cheilanthus marantae
Cichorium bottae
Cirsium vulgare
Conyza hochstetteri
Conyza incana
Crepis ruepellii
Euphorbia helioscopia
Felicia abyssinica
Ficus carica forma
Glycine wightii spp. *longicauda*
Helichrysum forsskahlei
Medicago lupulina
Moricandia sinaica
Pentas lanceolata
Plectranthus barbatus
Potomogeton pusillus
Primula verticillata
Pycreus elegantulus
Ranunculus aquatilis
Ranunculus multifidus
Ranunculus trichophyllus
Rhus retinorrhoea
Rumex nervosus
Ruta chalepensis
Samolus valerandi
Sauromatum venosum
Scirpus holoschoenus
Scirpus setaceus
Scutellaria peregrina
Senecio schimperi
Senecio sumarae
Swertia sp. aff. *polynectaria*
Tagetes minuta
Veronica anagallis-squatica

Plain community

Plain areas of various sizes were found among hills. Soil in general appear in the forms of sand pans or gravel pans of granite origin. Common plants are:

Amaranthus hybridus
Arenaria leptoclados
Argyrolobium confertum
Arnebia decumbens
Asparagus fistulosus
Citrullus colocynthis
Craterostigma pumilum
Dianthus uniflorus
Falkia oblonga
Herniaria hirsuta
Indigofera arabica
Lavandula pubescens
Lotus sp. aff. *quinatus*
Ophioglossum polyphyllum
Plantago albicans
Plantago lanceolata
Rumex steudelii
Rumex vesicarius
Salvia merjamie
Salvia schimperi

Disturbed ground community

Disturbed grounds are common at farm edges, wastland, and around villages. Common plant species are:

Anagyris foetida
Asphodelus fistulosus
Astragalus sparsus
Lactuca serriola
Lotus sp. aff. *arabicus*
Marrubium vulgare
Medicago polymorpha
Papaver dubium
Polygala abyssinica
Pterocephalus pulverulentus

Rainshadow Slopes (1700-2000m)

The rainshadow slopes zone is a moderate desert, located to the east of the high mountains. It declines gradually toward the east and consist of the following plant communities:

Hillside community

Sporadic hills which are found in the area range in height between a few to 20 meters above the general slope surface. They are made of rocky granite, rocky outcrop, or sand stone. Soil is either of white sand or of granite sand. Common plants are:

Acacia ehrenbergiana
Acacia gerardii spp. *negevensis* = *A. iraquensis*
Acacia seyal
Acacia tortilis
Adenium obesum
Aloe vacillans
Caralluma petraea
Commiphora sp.
Cordia sinensis
Ecbolium gymnostachyum
Ecbolium violaceum
Echinops sp.
Euphorbia balsamifera ssp. *adenensis*
Ficus carica forma
Kalanchoe lanceolata
Kleinia odora
Lycium shawii
Oncocalyx schimperi (parasitic)
Phoenix caespitosa
Phragmanthera sp. aff. *rufescens* (parasitic)
Plicosepalus curviflorus (parasitic)
Rumex nervosus
Salvadora persica
Withania somnifera

Sand dune community

Sand dunes are sporadic and cover small areas in the rainshadow slopes zone. Their soil is of white sandy type. Common plants are:

Calligonum polygonoides ssp. *comosum*
Salvadora persica
Tamarix aphylla

Panicum turgidum *Tamarix nilotica*
Rhazya stricta

Water course community

Wadis are the major water courses in this area and they look like rivers when they receive the water from the western mountains after the brief periods of the monsoon rain. However, they appear dry during most parts of the year. Soil is white sandy. Common plants:

Calotropis procera *Phragmites australis*
Cocculus pendulus *Ricinus communis*
Datura stramonium *Tamarix aphylla*
Fagonia sp. *Tamarix nilotica*
Lavandula pubescens *Typha domingensis*
Leptadenia pyrotechnica *Ziziphus spina-christi*
Mentha longifolia ssp. *schimperi*

Plain community

The plain habitat covers a vast area, and it is made mostly of hard sand, hard saline sand, or soft sand. Fine soil particles and mineral are usually deposited in such areas after the rains. Common plants are:

Aerva javanica *Indigofera spinosa*
Aizoon canariense *Plantago ciliata*
Arnebia hispidissima *Pulicaria crispa*
Dipterygium glaucum *Salsola imbricata*
Farsetia longisiliqua *Suaeda monoica*

Disturbed ground community

Disturbed grounds are found near farms and villages, on wastlands and roadsides. Soil is sandy. Common plants are:

Citrullus colocynthis *Verbecena encelioides*
Fagonia indica *Xanthium spinosum*
Solanum incanum

Plant Growth Forms

Each of the six vegetation zones is characterized by a variety of plant growth forms. These growth forms reflect the kind of adaptation found in these plants in

response to the environment in which they exist. Such growth forms are summarized in the following paragraphs with some representative plant species:

The coastal plains zone (semi-tropical desert) is characterized by the following plant growth forms: evergreen sclerophyllous mangal vegetation *(Avicennia marina, Rhizophora mucronata)*, evergreen broad-leaved shrubs *(Calotropis procera)*, perennial dwarf shrubs *(Aerva javanica, Indigofera spinosa)*, Climbing plants *(Ceropegia* spp.), microphyllous trees *(Tamarix nilotica)* or leafless shrubs *(Leptadenia pyrotechnica, Capparis decidua)*, halophytic plants *(Suaeda fruticosa* and *S. monoica)*, and succulents *(Caralluma* spp., *Duvalia velutina, Euphorbia* spp., *Pavonia* spp.), drought deciduous trees *(Acacia* spp., *Commiphora myrrha)*, perennial halophytic grasses *(Aeluropes lagopoides)*, tropical evergreen trees *(Hyphaene thebaica)*, and tussock and dune-forming plants *(Panicum turgidum, Cassia senna, Cadaba rotundifolia, Salvadora persia, Tamarix nilotica)*.

The foothills zone (semi-tropical, semi-desert) is characterized by the following plant growth forms: drought deciduous trees *(Acacia* spp., *Commiphora* spp.), succulents *(Caralluma* spp., *Euphorbia* spp., *aloe* spp.), bottle-like trees *(Adenium obesum)*, short stemmed and multi-branched shrubs *(Aerva javanica, Abrus bottae, Abutilon bidentatum, Justicia odora, Maerua crassifolia, Solanum incanum)*, herbs *(Cassia senna, Ruellia prostrata, Blepharis ciliaris)*, evergreen trees *(Ficus salicifolia, F. vasta, Ziziphus spina-christi), and climbing plants (Aristolochia bracteolata)*.

The lower escarpments zone (semi-tropical, semi-desert) maintain the following plant growth forms: drought deciduous submontane woodland *(Acacia* spp., *Cadia purpurea, Commiphora* spp., *Ficus sycamorus)*, evergreen broad-leaved trees *(Ficus salicifolia, F. vasta, Tamarindus indica, Ziziphus spina-christa)*, succulents *(Aloe sabaea, Euphorbia* spp., *Huernia saudi-arabica, Kalanchoe* spp.), bottle-like trees *(Adenium obesum, Adenia venenata)*, herbs *(Barleria* spp., *Blepharis ciliaris, Pulicaria* spp.), shrubs *(Abutilon hirtum, Alhagi maurorum, Withania somnifera, Anisotes trisulcus, Grewia* spp., *Buddleja polystachya)*, grasses *(Andropogon distachyus, Aristida* spp., *Pennisetum setaceum, Stipagrostis obtusa, Bromus fasciculatus)*, and climbing plants *(Cissus rotundifolia, Coccinia grandis)*.

The upper escarpments zone (semi-tropical, semi-desert) maintain the following plant growth forms: drought decidous montane woodland *(Acacia* spp.), hemiparasitic plants *(Phragmanthera* sp. aff. *rufescens, Plicosepalus curviflorus, Tapinanthus globiferus)*, xerophyllous trees and shrubs *(Acacia negrii, Cadia purpurea, Hibiscus somalensis, Dodonaea viscosa, Barleria* spp., *Plectranthus marrubioides, Lycium*

shawii, Withania somnifera, Kleinia odora), hygrophyllous trees and shrubs *(Juniperus excelsa, Olea chrysophylla, Ficus* spp., *Rosa abyssinica, Commicarpus* spp.), succulents *(Aloe* spp., *Aizoon canariense, Euphorbia* spp.), ferns *(Adiantum incisum),* and climbing plants *(Asparagus falcatus, Ceropegia* spp.).

The high mountains zone (temperate) maintain the following plant growth forms: evergreen woodlands *(Juniperus excelsa, Olea chrysophylla),* drought deciduous woodlands *(Acacia negrii),* succulents *(Aloe* spp., *Caralluma* spp., *Delosperma harazianum, Euphorbia* spp.), shrubs *(Dodonaea viscosa, Withania somnifera, Lycium shawii, Salvia merjamie, Lavandula dentata, Psiadia arabica, Rhamnus oleoides, Rosa abyssinica, Solanum incanum, Rumex nervosus,* herbs *(Cichorium bottue, Teucrium yemense, Campanula edulis, Crassula alba, Primula verticillata, Micromeria imbricata, Dianthus zonatus),* grasses *(Pennisetum* spp., *Andropogon distachyos, Bromus pulchellus, Themeda triandra, Tetrapogon villosus),* Ferns *(Ceterach officinarum, Cheilanthus* spp.), epiphytes *(Usnea articulata),* hemiparasitic plants *(Phragmanthera* sp. aff. *rufescens),* and climbing plants *(Asparagus africanus, Lonicera etrusca).*

The rainshadow slopes (moderate desert) included the following plant growth forms: drought deciduous trees *(Acacia* spp., *Ficus carica, Ziziphus spina-christi),* evergreen microphyllous trees *(Tamarix aphylla, T. nilotica),* succulents *(Aloe vacillans, Kalanchoe lanceolata, Euphorbia schimperi, Caralluma petraea),* dune-forming plants *(Calligonum polygonoides* ssp. *comosum, Leptadenia pyrotechnica, Panicum turgidum, Salvadora persica),* shrubs *(Lycium shawii, Euphorbia balsamifera, Withania somnifera, Rhazya stricta, Calotropis procera, Arnebia hispidissima),* herbs *(Plantago ciliata, Fagonia* spp.), halophyte *(Suaeda monoica),* hemiparasitic plants *(Phragmanthera* sp. aff. *rufescens, Oncocalyx schimperi, Plicosepalus curviflorus),* grass *(Phragmites australis), and climber (Cocculus pendula).*

Conclusion

Intensive excursions for the purpose of vegetation studies and plant collection along altitudinal gradient between sea level and 3000 meters in the southwestern region of Saudi Arabia lead to the recognition of six major vegatation zones. They are: coastal plains (0-300m), foothills (300-1000m), lower escarpments (1000-1600m), upper escarpments (1600-2200m), high mountains (2200-3000m) and rainshadow slopes (1700-2200m).

The primary factors controlling the distribution of the plant species in the region are temperature, moisture, and soil types. The flora of the region is of temperate,

tropical to semi-tropical, and arid to semi-arid affinities. These three plant groups are intermingled with each other with regard to their distribution. Yet, a simplified correlation between these plant groups and the vegetation zones was possible. Temperate plants are common over the high mountain and upper escarpments. Tropical to semi-tropical plants are common on coastal plain, foothills, lower escarpments, and upper escarpments. Arid to semi-arid plants are common on the rain-shadow slopes and coastal plains.

Different growth forms were found among the plants of the southwestern region of Saudi Arabia. Under the environments of less water and high temperature which prevailed in most parts of the region the drought deciduous, leafless, microphyllous, perennial grasses, and succulent plants were the most common types of growth forms. Halophytes and sclerophyllous plants were most adapted to sea-shore. Evergreen trees and their associates appeared to be well adapted over the summits of the high mountains. Annuals were distributed in various zones and their presence were highly dependant upon the intensity and the frequency of the rainfall.

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Appendix

Anisotes trisulcus (Forssk.) Vahl
Barleria acanthoides Vahl
Barleria bispinosa (Forssk.) Vahl
Barleria parviflora R. Br.
Barleria proxima Lindau
Barleria sp. aff. *hochstetteri* Nees
Barleria trispinosa (Forssk.) Vahl
Blepharis ciliaris L.
Blepharis ciliaris (L.) B.L. Burtt
Crossandra wissmannii O. Schwartz
Ecbolium gymnostachyum (Nees) Milna-Redh.
Ecbolium violaceum J.R.I. Wood & Hillcoat
Ecbolium viride (Forssk.) Alston
Justicia flava (Vahl) Vahl
Justicia odora (Forssk.) Lam.
Lepidagathis scariosa Nees
Monechma debile (Forssk.) Necs
Peristrophe paniculata (Forssk.) Brummitt
Ruellia patula Jacq.
Ruellia prostrata T. Anders.

Agavacea

Dracaena serrulata Bak.
Sansevieria abyssinica N. E. Br.
Sansevieria ehrenbergii Schweinf. ex Bak.

Agavacea

Dracaena serrulata Bak.
Sansevieria abyssinica N. E. Br.
Sansevieria ehrenbergii Schweinf. ex Bak.

Aizoaceae

Aizoon canariense L.
Delosperma harazianum (Defl.) Popp. & Ihl.
Limeum arabicum Friedr.
Limeum obovatum Vicary
Mollugo cerviana L.
Trianthema crystallina (Forssk.) Vahl
Trianthema triquetra Willd.
Zaleya pentandra (L.) Jeffr.

Amaranthaceae

Achyranthes aspera L.
Aerva javanica (Burm. f.) Juss. ex J. A. Schultes (Forssk.)
Aerva lanata (L.) Juss. ex J. A. Schultes
Alternanthera pungens Kunth
Alternanthera sessilis (L.) R. Br.
Amaranthus hybridus L.
Celosia polystachya (Forssk.) C.C. Townsend
Pupalia lappacea (L.) Juss. var. *velutina* (Moq.) Hook. f.

Amaryllidaceae

Crinum yemense Defl.
Pancratium tenuifolium Hochst. ex A. Rich
Panctarium maximum (Forssk.)
Scadoxus multiflorus (Martyn) Raf.

Anacardiaceae

Pistacia falcata Mart.
Rhus retinorrhoea Steud. ex Oliv.

Annonaceae

Annona squamosa L.

Apocynaceae

Acokanthera schimperi (A. DC.) Benth.
Adenium obesum (Forssk.) Roem. & Schult.
Rhazya stricta Decne.

Araceae

Sauromatum venosum (Ait.) Kunth

Aristolochiaceae

Aristolochia bracteolata Lam.

Asclepiadaceae

Calotropis procera (Ait.) Ait. f.
Caralluma commutata Benger
Caralluma deflersiana Lavr.
Caralluma edulis (Edgew.) Benth.
Caralluma eremastrum Schwartz
Caralluma penicillata (Defl.) N. E. Br.
Caralluma petraea Lavr.
Caralluma plicatiloba Lavr.
Caralluma quadrangula (Forssk.) N. E. Br.
Caralluma russeliana (Courb. ex Brongn.) Cufod
Caralluma shadhbana Lavr.
Caralluma shadhbana Lavr. var. *barhana* Lavr.
Caralluma sinaica (Decne.) var. *haradii* Lavr.
Caralluma sp.
Caralluma subulata (Forssk.) Decne.
Caralluma wissmannii Schwartz
Ceropegia arabica Huber
Ceropegia devecchii Chiov.
Ceropegia mansouriana Chaudhary & Lavr.
Ceropegia sp. aff. *arabica* Huber
Ceropegia sp. aff. *variegata* Decne.
Ceropegia superba D.V. Field & Collenette
Ceropegia tihamana Chaudhary & Lavr.
Duvalia sulcata N. E. Br. var. *semi-nuda* Lavr.
Duvalia velutina Lavr.
Gomphocarpus fruticosus (L.) R. Br. & Ait. f.
Gomphocarpus sinaicus Boiss.
Huernia lodarensis Lavr.
Huernia saudi-arabica D. V. Field
Kanahia laniflora (Forssk.) R. Br.
Leptadinia pyrotechnica (Forssk.) Decne.
Pergularia daemia (Forssk.) Chiov.
Pergularia tomentosa L.
Periploca aphylla Decne.
Rhytidocaulon sp. aff. *macrolobum* Lavr.
Sarcostemma sp. aff. *viminale* (L.) R. Br.

Barbeyaceae

Barbeya oleoides Schweinf.

Boraginaceae

Alkanna orientalis (L.) Boiss.
Cordia sinensis Lam.

Arnebia decumbens (Vent.) Coss. & Kval
Arnebia hispidissima (Lehm.) DC.
Cordia africana Lam.
Cordia ovalis R. Br. ex DC.
Heliotropium longiflorum Hochst. & Steud.
Trichodesma calathiforme Hochst.
Trichodesma ehrenbergii Schweinf.

Burseraceae

Commiphora kataf (Forssk.) Engl.
Commiphora myrrha (Nees) Engl.
Commiphora opobalsamum (L.) Engl.
Commiphora sp.
Commiphora sp. aff. *erythraea* (Ehrenb.) Eng.

Campanulaceae

Campanula edulis Forssk.

Capparaceae

Cadaba glandulosa Forssk.
Cadaba rotundifolia Forssk.
Capparis decidua (Forssk.) Edgw.
Capparis tomentosa Lam.
Dipterygium glaucum Decne.
Maerua crassifolia Forssk.
Maerua triphylla Rich.

Caprifoliaceae

Lonicera etrusca Santi

Caryophyllaceae

Arenaria leptaclados (Reichenb.) Guss. (forma)
Cometes surattensis L.
Dianthus uniflorus Vahl
Dianthus zonatus Fenzl.
Herniaria hirsuta L.
Minuartia filifolia Forssk.
Schweinf. ex Mattf.
Paronychia chlorothyrsa Murb.
Silene conoidea L.
Silene macrosolen Steud. ex A. Rich.
Silene schimperiana Boiss.
Silene sp. aff. *burchellii* Otth.
Silene vulgaris (Moench) Garcke
Silene yemensis Defl. P. P.
Telephium sphaerospermum Boiss.

Celastraceae

Maytenus heterophylla (Eklon & Zeyher) N. Robson
Maytenus somalensis (Loes.) Cufod.
Maytenus undata (Thunb.) Blakelock

Chenopodiaceae

Arthocnemum glaucum (Del.) Ung.-Sternb.
Atriplex sp.
Beta vulgaris L.
Chenopodium ambrosioides L.
Chenopodium schraderianum Schultes
Halopeplis perfoliata (Forssk.) Binge
Salsola bottae (Jaub. & Spach) Boiss.
Salsola imbricata Forssk.
Salsola spinescens Moq.
Suaeda fruticosa Forssk. ex Gmel
Suaeda monoica Forssk. ex J. F. Gmel.

Combretaceae

Combretum aculeatum Vent.
Combretum molle R. Br. ex D. Don
Terminalia brownii Fresen.

Commelinaceae

Commelina africana L. var. *villosior* (C. B. Cl.) Benan
Commelina albescens Hassk.
Commelina forsskahlei Vahl

Compositae

Achillea biebersteinii Afan.
Anthemis pseudocotula Boiss.
Artemisia abyssinica Sch. Bip.
Blumea bovei (DC.) Vatke
Centaurea pseudosinaica Czerep.
Centaurea schimperi DC.
Centaurothamnus maximus Wagenitz & Dittr.
Cicer cuneatum Hochst. ex Rich.
Cichorium bottae Defl.
Cirsium vulgare L.
Conyza hochstetteri Sch. Bip.
Conyza incana Willd.
Crassocephalum bojeri DC.
Crepis ruepellii Sch. Bip.
Echinops sp.
Pegolettia senegalensis Cass.
Phagnalon scalarum Schwartz
Pluchea dioscoridis DC.
Psiadia arabica Jaub. & Spach.
Psiadia punctulata DC.
Pulicaria arabica (L.) Cass.
Pulicaria crispa (Forssk.) Benth. & Hook.
Pulicaria glutinosa Jaub. & Spach.
Pulicaria jaubertii Gamel-Eldin
Pulicaria schimperi DC.
Pulicaria somalensis O. Hoffm. ssp. *somalensis*
Pulicaria vulgaris Gaertn.
Senecio asirensis Boulos

Felicia abyssinica A. Rich.
Helichrysum forsskahlei (Gmel.) Hilliard & Burtt
Kleinia odora (Forssk.) DC.
Kleinia pendula (Forssk.) Sch. Bip.
Lactuca serriola L.
Lactuca sp. aff. *Sativa* L.
Lasiopogon muscoides (Desf.) DC.
Launaea massauensis (Fresen.) Sch. Bip. ex Kuntze
Onopordon heteracanthum C. A. Mey.
Osteospermum vaillantii (Decne.) Nor 1. & J. R. I. Wood
Senecio deltoideus Less.
Senecio hadiensis Forssk.
Senecio schimperi Sch. Bip.
Senecio sumarae Defl.
Sonchus oleraceus L.
Tagetes minuta L.
Tarchonanthus camphoratus L.
Verbecena encelioides Gaertn.
Vernonia cinerascens Sch. Bip.
Volutaria albicaulis (Defl.)
Xanthium cf. *pungens* Wallr.
Xanthium spinosum
Xanthium strumarium L.

Convolvulaceae

Astripomoea malvacea (Klotzsch) Meuse
Convolvulus arvensis L.
Convolvulus prostratus Forssk.
Convolvulus spp.
Cressa cretica (L.)
Evolvulus alsinoides L.
Falkia oblonga Krauss
Merremmia tridentata (L.) Hall f. var. *angustifolia* (Jacq.) Van Ooststr.
Seddera latifolia Hochst. & Steud.
Seddera virgata Hochst. & Steud.
Dichondra repens J. R. & G. Forst.

Crassulaceae

Crassula alba Forssk.
Kalanchoe alternans (Vahl) Pers.
Kalanchoe citrina Schweinf.
Kalanchoe crenata (Andr.) Haw.
Kalanchoe glaucescens Brit.
Kalanchoe lanceolata (Forssk.) Pers.
Kalanchoe sp. aff. *glaucenscens* Brit.
Kalanchoe sp. aff. *laciniata* DC.
Sedum hispanicum L.
Umbilicus horizontalis Boiss. var. *intermedius* Boiss.

Cruciferae

Arabis alpina L.
Capsella bursa-pastoris (L.)
Farsetia longisiliqua Decne.
Lepidium sativum L.

Medic.
Eruca sativa Mill.
Moricandia sinaica (Boiss.) Boiss.

Cucurbitaceae

Arhidopsis kneuckeri (Bornm.) O.E. Schulz
Citrullus colocynthis (L.) Schrad.
Coccinea grandis (L.) J.O. Voigt
Corallocarpus epigeus (Roettl.) C. B. Cl.
Corallocarpus schimperi (Naud.) Hook. f.
Cucumis figarei Del. ex Naud.
Cucumis melo L. var. *agrestis* Naud.
Cucumis prophetarum L. var. *prophetarum*
Zehneria scabra (L.) Sond.

Cupressaceae

Juniperus excelsa M. Bieb.
= *J. procera* Hochst. ex Endl.

Cyperaceae

Carex distans L.
Carex divisa Huds.
Cyperus rigidifolius Steud.
Cyperus rubicundus Vahl
Cyperus schimperianus Steud.
Fimbristylis spathacea Roth
Pycreus elegantulus (Steud.) C. B. Cl.
Scirpus holoschoenus L.
Scirpus setaceus L.

Dipsacaceae

Pterocephalus pulverulentus Boiss. & Bal. ex Boiss.
Scabiosa columbaria L.

Ebenaceae

Diospyros mespiliformis Hochst. ex DC.
Euclea schimperi Presl
Euclea schimperi (A. DC.) dandy

Ephedraceae

Ephedra intermedia Schrenk & C. A. Mey.

Equisetaceae

Equisetum ramosissimum Desf.

Ericaceae

Erica arborea L.

Euphorbiaceae

Acalypha racemosa Baill.
Andrachne aspera Spreng.
Cluytia myricoides Jaub. & Spach.
Euphorbia ammak Schweinf.
Euphorbia arabica (Hochst. & Steud.) Boiss.
Euphorbia balsamifera Ait. ssp. *adenensis* (Defl.) Bally
Euphorbia cactus Ehrenb.
Euphorbia cuneata L.
Euphorbia fractiflexa S. Carter & J. R. I. Wood
Euphorbia helioscopia L.
Euphorbia heterophylla L.
Euphorbia inarticulata Schweinf.
Euphorbia schimperi Presl
Euphorbia schimperiana Scheele
Euphorbia sp. aff. *fractiflexa* S. Carter & J.R.I. Wood
Euphorbia sp. aff. *parciramulosa* Schweinf.
Euphorbia sp. aff. *schimperi* Presl
Euphorbia triaculeata Forssk.
Jatropha glauca Vahl
Jatropha pelargoniifolia Courb.
Jatropha spinosa (Forssk.) Vahl
Phyllanthus tenellus Muell. Arg. var. *arabicus* Muell. Arg.
Ricinus communis L.
Securinega virosa (Roxb. ex Willd.) Bail
Tragia pungens (Forssk.) Muell. Arg.

Frankeniaceae

Frankenia pulverulenta L.

Gentianaceae

Enicostemma axillare (Lam.) A. Raynal
Swertia sp. aff. *polynectaria* (Forssk.) Gilg

Geraniaceae

Erodium moschatum (L.) L'Her
Monsonia heliotropioides

Geranium arabicum Forssk.
Geranium molle L.
Geranium ocellatum Camb.
Geranium trilophum Boiss.
Monsonia senegalensis Guill. & Perr.
Pelargonium alchemilloides (L.) L'Her. ex Ait.

Gramineae

Aeluropus lagopoides (L.) Trin. ex Thw.
Andropogon distachyos L.
Aristida adscensionis L.
Aristida funiculata Trin. & Rupr.
Aristida mutabilis Trin. & Rupr.
Bromus fasciculatus C. Presl.
Bromus pulchellus Fig. & DeNot
Cenchrus ciliaris L.
Chrysopogon aucheri (Boiss.) Stapf var. *quinqueplumis*
Coelachyrum brevifolium (Hochst.) Nees
Coelachyrum poiflorum Chiov.
Cymbopogon schoenanthus (L.) Spreng.
Cynodon dactylon (L.) Pers.
Dactyloctenium scindicum Boiss.
Danthoniopsis barbata (Nees) C. E. Hubbard
Desmostachya bipinnata (L.) Stapf
Digitaria abyssinica (A. Rich.) Stapf
Eragrostis ciliaris (L.) R. Br.
Eragrostis papposa (Roemer & Schultes) Steudl
Hyparrhenia hirta (L.) Stapf
Lasiurus scindicus Hernard
Panicum turgidum Forssk.
Pennisetum setaceum (Forssk.) Chiov.
Pennisetum villosum R. Br. ex Fresen.
Phragmites australis (Cav.) Trin. ex Steud.
Stipagrostis obtusa (Del.) Nees
Tetrapogon villosus Desf.
Themeda triandra Forssk.
Tragus berteronianus Schultes

Hypericaceae

Hypericum annulatum Moris
Hypericum hircinum L.
Hypericum revolutum Vahl

Iridaceae

Iris albicans Lange

Juncaceae

Juncus punctorius L.

Labiatae

Ajuga bracteosa Wall.
Becium filamentosum (Forssk.) Chiov.
Endostemon gracile (Benth.) Ashby
Endostemon tenuiflorus (Benth.) Ashby
Lavandula citriodora A. G. Miller
Lavandula dentata L.
Lavandula pubescens Decne.
Lavandula stricta Del.
Leucas glabrata (Vahl) R. Br.
Leucas urticifolia (Vahl) R. Br.
Marrubium vulgare L.
Mentha longifolia L. ssp. *schimperi* (Briq.) Briq.
Meriandra benghalensis Benth.
Micromeria imbricata (Forssk.) Christen
Nepeta deflersiana Schweinf. ex Hedge
Ocimum basilicum L.
Orthosiphon pallidus Royle
Otostegia fruticosa (Forssk.) Schweinf. ex Penzig ssp. *schimperi* (Benth.) Sebald
Plectranthus asirensis J. R. I. Wood
Plectranthus barbatus Andr.
Plectranthus cylindraceus Hochst. ex Benth.
Plectranthus marrubioides Hochst. & Benth.
Plectranthus tenuiflorus (Vatke) Agnew
Salvia aegyptiaca L.
Salvia merjamie Forssk.
Salvia schimperi Benth.
Scutellaria peregrina L.
Teucrium yemense Defl.

Lauraceae

Cassytha filiformis L.

Leguminosae

Abrus bottae Defl.
Acacia abyssinica Hochst. ex Benth. var. *macroloba* Schweinf.
Acacia albida Del.
Acacia asak (Forssk.) Willd.
Acacia ehrenbergiana Hayne
Acacia etbaica Schweinf.
Acacia etbaica Schweinf. ssp. *uncinata* Brenan
Acacia gerrardii Benth.
Indigofera arabica Jaub. & Spach.
Indigofera articulata Gouan
Indigofera caerulea Roxb. var. *Caerulea*
Indigofera phillipsiae Bak. f.
Indigofera schimperi Jaub. & Spach.
Indigofera semitrijuga Forssk.
Indigofera spinosa Forssk.
Lablab purpureus (L.) Sweet

ssp. *negevensis* Zoh.
= *A. iraquensis* Rech. f.
Acacia hamulosa Benth.
Acacia laeta R. Br. ex Benth.
Acacia mellifera (Vahl) Benth.
Acacia negrii Pichi-Sermolli
Acacia oerfota (Forssk.) Schweinf.
Acacia seyal Del.
Acacia tortilis (Forssk.) Hayne
Alhagi maurorum Medic.
Anagyris foetida L.
Argyrolobium arabicum (Decne.) Jaub. & Spach.
Argyrolobium confertum Polhill
Astragalus atropilosulus (Hochst.) Bunge
Astragalus corrugatus Bert.
Astragalus sparsus Decne.
Biserrula pelecinus L.
Cadia purpurea (Picciv.) Ait.
Cassia italica (Mill.) Lam. ex Steud.
Cassia occidentalis L.
Cassia senna L.
Cassia tora L.
Clitoria ternatea L.
Crotalaria aegyptiaca Benth.
Crotalaria quartiniana A. Rich.
Delonix elata L. Gamble
Desmodium gangeticum (L.) DC.
Dichrostachys cinerea (L.) Wight & Arn.
Dolichos trilobus L.
Glycine wightii (Wight & Arn.) *Verdc.* ssp. *longicauda* (Schweinf.) Verdc.
Hippocrepis ciliata Willd.
Lathyrus pratensis L.
Lotus corniculatus L.
Lotus lanuginosus Vent.
Lotus sp. aff. *arabicus* L.
Lotus sp. aff. *quinatus* (Forssk.) Gillett
Macrotyloma axillare (E. Mey.) Verdc. var. *axillare*
Medicago lupulina L.
Medicago polymorpha L.
Ononis reclinata L.
Rhynchosis buramensis Hutch. & Bruce
Rhynchosia minima (L.) DC. var. *minima*
Rhynchosia sp.
Rhynchosia sp. aff. *minima* (L.) DC. var. *minima*
Rhynchosia sp. aff. *schimperi* Boiss.
Stylosanthes fruticosa (Retz.) Alston
Tamarindus indica L.
Tephrosia pumila (Lam.) Pers.
Tephrosia sp. aff. *quartiniana* Cuf.
Tephrosia subtriflora Hochst. ex Bak.
Teramnus labialis (L.f.) Spreng. ssp. *arabicus* Verdc.
Trifolium campestre Schreb.
Trifolium fragiferum L.
Trifolium tomentosum L.
Trigonella anguina Del.
Vigna aconitifolia (Jacq.) Marechal
Vigna ambacensis Welw. ex Bak.
Vigna membranacea A. Rich.

Lemnaceae

Lemna gibba L.

Liliaceae

Allium pseudocalyptratum Mouterde
Aloe castellorum J. R. I. Wood
Aloe fieurentinorum Lavr.
Aloe rubroviolacea Schweinf.
Aloe sabaea Schweinf.
Aloe sheilae Lavr.
Aloe sp. aff. *niebuhriana* Lavr.
Aloe sp. aff. *tomentosa* Defl.
Aloe sp. nov. aff. *vacillans* Forssk.
Aloe vacillans Forssk.
Aloe vera (L.) Burm. f. var. *officinalis* Forssk.
Asparagus africanus Lam.
Asparagus falcatus L.
Asparagus fistulosus L.
Asphodelus fistulosus L.
Dipcadi viride (L.) Moench
Drimia maritima (L.) Stearn

Loganiaceae

Buddleja polystachya Fres.
Nuxia oppositifolia Hochst.

Loranthaceae

Oncocalyx schimperi (Hochst. ex A. Rich.) M. Gilbert
Phragmanthera sp. aff. *rufescens* (DC.) Balle
Plicosepalus curviflorus (Benth. ex Oliv.) Tiegh
Tapinunthus globiferus (A. Rich.) Tiegh
Viscum schimperi Engl.

Lythraceae

Ammannia auriculata Willd.
Lythrum hyssopifolia L.
Woodfordia fruticosa (L.) S. Kurz

Malvaceae

Abutilon bidentatum Hochst. ex A. Rich.
Hibiscus vitifolius L.
Malva neglecta Wallr

Abutilon sp.
Abutilon sp. aff. *bidentatum* Hochst. ex A. Rich.
Cienfuegosia welshii (T. Anders.) Garcke
Hibiscus deflersii Schweinf.
Hibiscus micranthus L. f.
Hibiscus somalensis Franch.
Hibiscus trionum L.
Malva parviflora L.
Malva verticillata L.
Pavonia arabica Hochst.
Pavonia patens (Andre.) Chiov.
Pavonia triloba Hochst.
Senra incana Cav.
Sida ovata Forssk.
Sida spinosa L.

Menispermaceae

Cocculus hirsutus (L.) Diels.
Cocculus pendulus (J. R. & G. Forst.) Diels.

Moraceae

Dorstenia foetida (Forssk.) Schweinf. & Engl.
Ficus carica L. *forma*
Ficus ingens (Miq.) Miq.
Ficus populifolia Vahl
Ficus salicifolia Vahl
Ficus sycamorus L.
Ficus vasta Forssk.

Moringaceae

Moringa peregrina (Forssk.) Fiori

Myricaceae

Myrica salicifolia Hochst. ex A. Rich.

Myrsinaceae

Maesa lanceolata Forssk.
Myrsine africana L.

Myctaginaceae

Boerhavia elegans Choisy
Boerhavia repens L.
Commicarpus grandiflorus (A. Rich.) Standl.
Commicarpus plumbagineus (Car.) Standle.
Commicarpus sinuatus Meikle
Commicarpus squarrosus (Heimerl) Standl.

Oleaceae

Jasminum grandiflorum L. var. *floribundum* (R. Br. ex Fresen.) P. S. Green

Olea chrysophylla Lam.

Ornagraceae

Epilobium hirsutum L.

Ophioglossaceae

Ophioglossum polyphyllum A. Br.

Orchidaceae

Eulophia petersii (Rchb. f.) Rchb. f

Holothrix arachnoidea Rchb.

Orobanchaceae

Orobanche cernua Loefl. var. *cernua*

Orobanche minor Sm.

Orobanche oxyloba (Reuter) Beck var. *oxyloba*

Palmae

Hyphaene thebaica (L.) Mart.

Phoenix caespitosa Chiov.

Pandanaceae

Pandanus odoratissimus L.

Papaveraceae

Argemone mexicana L.

Papaver dubium L.

Passifloraceae

Adenia venenata Forssk.

Plantaginaceae

Plantago albicans L.
Plantago ciliata Desf.
Plantago cylindrica Forssk.
Plantago lanceolata L.
Plantago major L.
Plectranthus arabicus E. A. Bruce

Plumbaginaceae

Limonium axillare (Forssk.) O. Kuntze
Limonium cylindrifolium (Forssk.) Verdc.
Plumbago zeylanica L.

Polygalaceae

Polygala abyssinica R. Br.
Polygala senensis Klotzsch
Polygala subaphylla Swartz
Polygala tinctoria Vahl

Polygonaceae

Calligonum polygonoides L. ssp. *comosum* (L'Her.) Sosk.
Oxygonum sinuatum (Meissn.) Dam.
Polygonum amphibium L.
Polygonum aviculare L.
Polygonum setulosum A. Rich.
Rumex nervosus Vahl
Rumex nervosus Vahl
Rumex steudelii Hochst.
Rumex vesicarius L.

Polypodiaceae

Actiniopteris semiflabellata Pic.-Ser.
Adiantum capillus-veneris L.
Adiantum incisum Forssk.
Asplenium aethiopicum (Burm.) Bech.
Asplenium trichomanes L.
Ceterach officinarum DC.
Cheilanthes coriacea Decne.
Cheilanthes marantae (L.) Domin
Cheilanthes pteridioides (Reichard) C. Chr.
Cheilanthes vellea (Ait.) F. Mueller
Cheilanthus coriacea Decne.
Cheilanthus marantae (L.) Domin
Pteris dentata Forssk. ssp. *dentata*
Pteris vittata L.

Portulacaceae

Portulaca quadrifida L.

Potamogetonaceae

Potamogeton nodosus Poir.
Potamogeton pusillus L.

Primulaceae

Anagallis arvensis L. ssp. *arvensis*
Primula verticillata Forssk.
Samolus valerandi L.

Ranunculaceae

Clematis incisodentata A. Rich.
Clematis simensis Fresen.
Clematis eightiana
Ranunculus aquatilis L.
Ranunculus multifidus Forssk.
Ranunculus trichophyllus Chaix

Resedaceae

Caylusea hexagyna (Forssk.) M. L. Green
Ochradenus baccatus Del.
Reseda sphenocleoides Defl.

Rhamnaceae

Berchemia discolor (Klotzsch) Hemsl.
Rhamnus oleoides L.
Ziziphus spina-christi (L.) Willd.

Rhizophoraceae

Rhizophora mucronata Lam.

Rosaceae

Rosa abysinnica R. Br.

Rubiaceae

Pentas lanceolata (Forssk.) K. Schum.

Rutaceae

Ruta chalepensis L.
Teclea nobilis Del.

Salicaceae

Salix subserrata Wildd.

Salvadoraceae

Dobera glabra (Forssk.) Poir.
Salvadora persica L.

Sapindaceae

Dodonaea viscosa L.

Sapotaceae

Mimusops laurifolia (Forssk.) Friis

Scrophulariaceae

Anarrhinum orientale Benth.
Campylanthus pungens Swartz
Craterostigma pumilum Hochst.
Lindenbergia indica (L.) Kuntze
Linderbergia sp. aff. *indica* L. Kuntze
Striga gesnerioides (Willd.) Vatke ex Engl.
Striga hermonthica (Del.) Benth.
Verbascum bottae Defl.
Verbascum longibracteatum Defl.
Verbascum longibracteatum Defl.
Verbascum yemense Defl.
Veronica anagallis-aquatica L.

Selaginellaceae

Selaginella imbricata (Forssk.) Spring
Selaginella yemensis Spring

Solanaceae

Datura fastuosa L.
Datura stramonium L.
Lycium Shawii Roem. & Schult.
Solanum grossedentatum A. Rich.
Solanum incanum L.
Solanum macracanthum A. Rich.
Solanum schimperianum Hochst. ex A. Rich.
Solanum sepicula Dun.
Withania somnifera (L.) Dun.

Tamaricaceae

Tamarix aphylla (L.) Karst. *Tamarix nilotica* (Ehrenb.) Bge

Tiliaceae

Grewia tenax (Forssk.) Fiori *Grewia villosa* Willd.
Grewia velutina Vahl

Typhaceae

Typha domingensis Pers.

Ulmaceae

Celtis africana Burm. f.

Umbelliferae

Ammi majus L.

Usneaceae

Usnea articulata

Verbenaceae

Avicennia marina (Forssk.) Vierh. *Premna resinosa* Schauer

Vitaceae

Cissus quadrangularis L. *Cissus rotundifolia* (Forssk.) Vahl

Zygophyllaceae

Fagonia indica Burm. f. *Zygophyllum coccineum* L.
Fagonia sp. *Zygophyllum simplex* L.

نطاقات الغطاء النباتي بين مستوى سطح البحر وارتفاع ٣٠٠٠ متر في الجنوب الغربي من المملكة العربية السعودية

حسين علي أبو الفتح

قسم علوم الحياة، كلية التربية، جامعة الملك سعود، فرع أبها

ص.ب ٩٣٢، المملكة العربية السعودية

(استلم في ٢١ شعبان ١٤١٠هـ، قُبل للنشر في ٢٧ ذي القعدة ١٤١١هـ)

ملخص البحث. تختلف النباتات التي يتكون منها الغطاء النباتي لجنوب غرب المملكة العربية السعودية اختلافًا كبيرًا من حيث أشكالها وأحجامها وأنماط نموها، وذلك بسبب وجودها في بيئات مختلفة، وانتمائها إلى مناطق جغرافية متنوعة، تشتمل على المنطقة المعتدلة، والمنطقة الصحراوية، والمنطقة شبه الصحراوية ـ شبه الاستوائية.

تم خلال هذه الدراسة تقسيم نباتات المنطقة الجنوبية الغربية للمملكة العربية السعودية حسب مواقعها على مدرج الارتفاع إلى ست نطاقات هي: السهل الساحلي (صفر ـ ٣٠٠ متر)، (التلال ٣٠٠ ـ ١٠٠٠ متر)، والجرف السفلي (١٠٠٠ـ١٦٠٠ متر)، والجرف العلوي (١٦٠٠ـ٢٢٠٠ متر)، والجبال العالية (٢٢٠٠ـ٣٠٠٠ متر)، ومنحدرات ظل المطر (١٧٠٠ـ٢٢٠٠ متر).

كذلك تم تقسيم النطاق الواحد إلى عدد من المجتمعات النباتية على أساس طبيعة سطح الأرض، والتربة، وحجم الصخور، والنظام المائي، ونسبة الأملاح، مع ذكر أسماء النباتات التي تتميز بها هذه المجتمعات.

إضافة إلى ذلك تم تمييز النباتات الموجودة في كل نطاق على أساس أنماط نموها إلى المجموعات التالية: أشجار دائمة الخضرة، وأشجار نافضة الأوراق أثناء فترة الجفاف، وشجيرات، وأعشاب، وحشائش، وعصاريات، وملحيات، ومتسلقات، وأشباه متطفلات، ومعلقات (من أشنات)، وذوات أوراق سميكة، وذوات أوراق دقيقة، وعديمة الأوراق، وسرخسيات، ونباتات تساهم في بناء الكثبان الرملية.