

An Introduction to: The Plant Ecology of Tihamah Plains of Jizan Region, Saudi Arabia

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ABSTRACT. Jizan region is located on the Red Sea coast in the South Western corner of Saudi Arabia. This region is situated in the tropical arid zone of the Arabian desert. Seventy stands, representing the physiographic and physiognomic variations in the area of study, were selected. From an ecological and geomorphological point of view, five distinct habitat types are recognizable in Tihamah coastal plains namely: shore-line, sand formations, salt marshes, wadis and rocky hills. A total of 153 plant species belonging to 46 families occupied the different habitat types of the Tihamah plains. Gramineae attaining 25.7% of the total recorded species. The chamaephytes and therophytes life-forms are the most dominant life-form in the study area. Soil conditions, water availability, as well as, anthropozoogenic influences, play a leading role in the distribution of the various plant communities and their composition.

Several ecological studies have been done dealing with different features of some phytogeographical regions of Saudi Arabia, (e.g. Vesey-Fitzgerald 1955, Popov and Ziller 1963, Batanouny 1979, Zahran *et al.* 1980, Zahran 1982, Younes *et al.* 1981, Batanouny and Baeshin 1983), dealing with different features of some phytogeographical regions of Saudi Arabia and have been reported in the literature. Among all the investigated regions, Jizan has received the least attention. According to Al-Sheriff (1984) the region of Jizan is divided, physiographically, into three main provinces: a) Mountains; El-Sarwat mountains, b) Coastal Plains; "Tihamah" plains, and c) Islands; including those between Jizan city and Farsan islands.

The region occupies the south western part of the kingdom of Saudi Arabia (16° 54' lat N and 42° 33' long E). The coast of Jizan on Red Sea stretches for about 300 km in South-North direction and for 80 km in West-East direction, covering an approximate area of about 24,000 km² (Fig. 1).

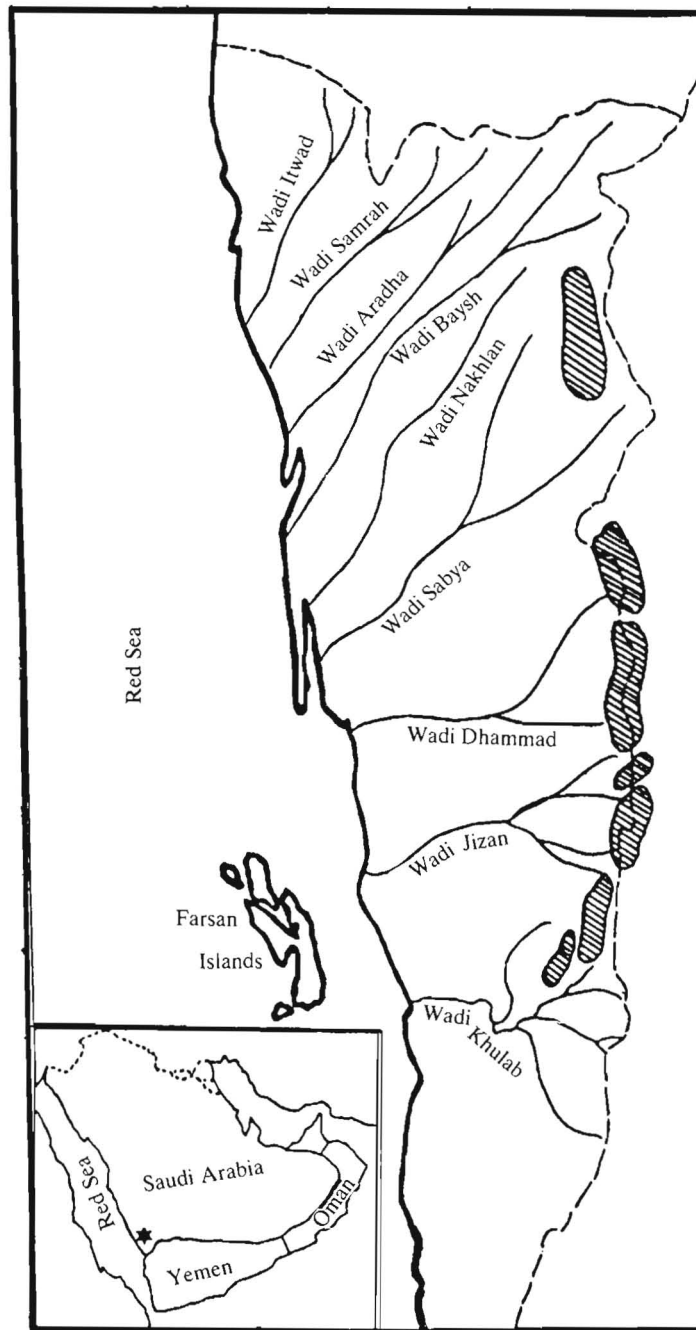


Fig. 1. Location map of the study area.

In the Precambrian times, the Arabian Peninsula was a part of the African or Nubian shield and has split away along the Red Sea trough during the middle Tertiary times. The area considered in this study belongs geologically to the greater Afro-Arabian shield which was a part of the Precambrian crustal plate. It is generally exposed to and locally covered by Tertiary volcanic rocks (Schmidt *et al.* 1978).

According to the available climatic data (1964-1990), the Jizan area has a long hot season (April- October) and a short mild one (November-March), with a mean maximum air temperature varying from 30.5° C during January to 38.4° C during July, and from 21.4° C as a mean minimum air temperature during January to 29.7° C during July. The annual mean relative humidity of the study area is 64.2% , with a maximum value of 95.4% in December, and a minimum value of (31.4%) in October. The total annual rainfall is 88.2 mm. The wind speed varies within a narrow range (10.6-12.2 km/h). During July and August a north - western stormy wind, with fine aeolian particles, prevails and it is locally called "El-Gohbera".

The Saudi National Commission for Wildlife Conservation and Development concentrates on two main objectives: a) taking urgent measures to protect wildlife in immediate danger of extinction and to learn, quickly, about the needs of these threatened species; and b) conducting field and laboratory research in order to catalogue and understand the Kingdom's wild organisms, their habitats and their life histories. In this respect this study will be directed towards outlining an ecological description of the "Tihamah" coastal plain of the Jizan region, and recording more detailed information about vegetation as well as the other environmental parameters.

Methods

The present work was initiated in September 1988 and continued until March 1992. Seventy stands distributed in the "Tihamah" coastal plains, covering the main physiographic variations of the region, were selected for the study. In selecting individual stands, care was taken to ensure a reasonable degree of physiographic and physiognomic homogeneity. A floristic list was recorded out for each stand. Identification of the plant specimens are according to: Täckholm (1974), Migahid (1978), Al-Hubaishi and Hohenstein (1984) and Mandaville (1990).

In each of the seventy stands, soil samples were taken to a depth of: 0-50 cm. These soil samples were air dried and sieved through 2 mm sieve before being analyzed. Soil texture was determined by sieve method according to Jackson (1962). The percentage of CaCO₃ was estimated by titration against IN HCl (Jackson 1962). Oxidizable organic carbon was estimated using the Walkely and Black rapid titration method (Black 1979). Estimation of soil pH, electrical conductivity (E.C.), HCO₃⁻, were carried out in 1:5 soil/water extract. The extractable cations (Na⁺, K⁺, Ca⁺⁺ and Mg⁺⁺) were extracted using ammonium acetate solution at pH 7 and estimated

using a spectrophotometer (Allen *et al.* 1976). Means of the soil variables in each recognized major habitat were used to describe its soil characteristics.

Results

The reconnaissance study indicated that, ecologically, five distinct habitat types are recognizable in the Tihamah coastal plains namely: shore-line, sand formations, salt marshes, wadis and rocky hills. In these habitat types, 153 plant species, belonging to 46 botanical families, were recorded. Of these 32.7% are monocots and 66.6% are dicots and 0.7% gymnosperms. Families of Gramineae (25.7%) Leguminosae (10.1%) and Zygophyllaceae (6.1%) were the highly represented families in the study area. Results of the life-form analysis indicated that the chamaephytes attained 39.2% followed by therophytes (32.0%). Phanerophytes and cryptophytes attained almost comparable figures (12.2 & 11.9), whereas hemicryptophytes attained the lowest value (4.7%). The recognized habitat types varied in their environmental features (topography, soil conditions and the degree of human and animal impacts), and consequently in their vegetational composition. In this respect, the soil variables of each of the five habitats are presented in Table 1; the different life-form and dominant plant species in each habitat are indicated in Table 2; whereas their main features outlined below:

1- The shore-line habitat types

Dense growth of brown algae e.g *Fucus* sp. and *Sargassum* was noticed. *Halophila ovalis* was growing in the shallow water at: 1-1.5 m depth. Mangrove vegetation is the most abundant in the intertidal zone of the shore-line and cover long areas along the Tihamah coast and was represented by only one species: *Avicennia marina* (Plate 1).



Plate.1. The mangal vegetation in the shore-line habitat types.

Table 1. Spatial variations (mean±standard error) of the physical and chemical characteristics of the soil samples collected from the different habitat types in the Tihamah coastal plains of Jizan Region. Soil Solution: 1:5; Moisture (%); O.C.: Organic Carbon (%); E.C.: Electrical Conductivity; Cations: mg/l

| Habitat types | pH | Moisture % | Texture % | | | CaCO ₃ % | HCO ₃ % | O.C. % | E.C. μ S/cm | Cations | | | |
|--------------------|----------|------------|-----------|------|------|---------------------|--------------------|----------|-----------------|------------|----------|------------------|------------------|
| | | | sand | silt | clay | | | | | Na \pm | K \pm | Ca ⁺⁺ | Mg ⁺⁺ |
| 1.Shore-lines | 7.3±0.03 | 5.02±0.23 | 78.0 | 12.0 | 10.0 | 1.3±.1 | 14.±.54 | 1.23±.04 | 787.3±13.2 | 355.1±16.8 | 29.7±.2 | 91.7±7.7 | 254.6±9.8 |
| 2.Salt marshes | 7.5±0.2 | 3.56±0.27 | 84.0 | 5.0 | 11.0 | 1.5±.06 | 13.2±.9 | 1.4±.04 | 1268.6±64.2 | 540±49.5 | 19.8±3.1 | 196.8±2.2 | 341.2±22.7 |
| 3. Sand Formation: | | | | | | | | | | | | | |
| a.dunes | 7.9±0.05 | 0.86±0.12 | 89.0 | 4.0 | 7.0 | 1.8±.04 | 3.1±.06 | 0.9±.09 | 522.3±106.2 | 465.5±79.8 | 23.3±2.5 | 89.4±11 | 78.5±15.5 |
| b.plains | 8.0±0.04 | 0.27±0.01 | 90.0 | 2.0 | 8.0 | 0.8±0.4 | 2.2±.1 | 0.5±.02 | 201.0±33 | 70.5±10.9 | 3.7±.1 | 42.3±.2.1 | 69.2±13.7 |
| 4.Wadis: | 7.0±0.2 | 0.79±0.03 | 65.0 | 22.7 | 12.3 | 1.1±.06 | 2.4±.1 | 0.86±.03 | 219.1±.23.3 | 44.3±4.4 | 5.5±.1 | 48±.2 | 19.1±.4 |
| 5.Rocky hills | 7.3±0.03 | 0.21±0.43 | 50.0 | 33.0 | 17.0 | 1.8±0.4 | 1.7±.1 | 0.6±.03 | 229.5±15.7 | 45.8±3.4 | 2.9±.2 | 59.3±4.1 | 14.2±1.5. |

Table 2. Floristic list of the species recorded in the different habitat types of Tihamah Region. In this table Ph, Ch, Cr, H, He, G, Th, refer to Phanerophytes, Chamaephytes, Cryptophytes, Hemicyptophytes, Helopytes, Geophytes and Therophytes. Numbers and letters in brackets indicate the dominance of the reference species in the habitat type having these numbers.

| Habitat Type | Dominant Species | Life-form | Remark |
|---|--|-----------|---------|
| 1-Shore line | <i>Haolphila ovalis</i> L. | H | Monocot |
| | <i>Avicennia marina</i> (Forssk.) Vierh. | Ph | Dicot |
| | <i>Halopeplis perfoliata</i> (Forssk.) Bge ex Schw. | Th | Dicot |
| 2- Salt marshes | <i>Leptadenia pyrotechnica</i> (Forssk. Decne (3 b) | Cr | Monocot |
| | <i>Panicum turgidum</i> Forssk. Forssk. (3 b) | Ch | Dicot |
| | <i>Tephrosia apollinea</i> (Del.) Link. (3 b) | H | Monocot |
| | <i>Dipterygium glaucum</i> Decne (3 b) | Ph | Dicot |
| 3- Sand formations a: dunes b: plains | <i>Cyperus conglomeratus</i> Rottb. | Ch | Dicot |
| | <i>Suaeda monoica</i> Forssk. (3 a) | Cr | Monocot |
| | <i>Aeluropus logopoides</i> (L.) Trin. ex Thw. | Ch | Dicot |
| | <i>Tamarix aphylla</i> (L.) Karst. (3 a) | Ch | Dicot |
| | <i>Acacia tortilis</i> (forssk. Hayne (5) | Ph | Dicot |
| | <i>Aeluropus logopoides</i> (L.) Trin. ex Thw. | Ch | Dicot |
| | <i>A. ehrenbergiana</i> Hayne | Ph | Dicot |
| | <i>Calotropis procera</i> (Willd.) R.Br. | Ch | Dicot |
| | <i>Aerva javanica</i> (Burm.f.) Juss. | Ch | Dicot |
| | <i>Blepharis ciliaris</i> (L.) Brtt. | Ch | Dicot |
| <i>Abutilon pannosum</i> (Forst.f.) Schlecht | Ch | Dicot | |
| <i>Salvadora persica</i> L. | Ph | Dicot | |
| 4- Wadis a-dry wadis b-wet wadis | <i>Pandanus odoratissimum</i> L. | Ch | Monocot |
| | <i>Hyphaene thebaica</i> (Del.) Mart. | Ph | Monocot |
| | <i>Phoenix dactylifera</i> L. | Ph | Monocot |
| | <i>Ziziphus spina-christi</i> (L.) Willd. | Ph | Dicot |
| | <i>Typha domingensis</i> Pers. | He | Monocot |
| | <i>Cyperus laevigatus</i> L. | G,He | Monocot |
| 5- Rocky hills | <i>Adenium obesum</i> (Forssk.) R. | Ph | Dicot |
| | <i>Acacia asak</i> (Forssk.) Willd. | Ph | Dicot |
| | <i>Commiphora opobalsamum</i> (L.) Engl. | Ph | Dicot |
| | <i>C. Kotaf</i> (Forssk.) Engl. | Ph | Dicot |
| | <i>Lycium shawii</i> Roem. et Sch. | Ch | Dicot |
| | <i>Capparis cartilaginea</i> Decne | Ch | Dicot |
| | <i>Stipagrostis plumosa</i> (L.) Munro ex T. Anders. | H. | Monocot |

2. The salt marsh habitat types

Salt marshes in the Tihamah are either littoral or inland (Man-made depressions and wet areas in some wadis), (Plate 2). The halophytic vegetation represented by many halophytic species, formed almost pure communities in the littoral salt marshes e.g. *Cyperus conglomeratus*, *Suaeda monoica*. While *Aeluropus lagopoides*, *Sporobolus spicatus* and *Tamarix aphylla* communities constituted the major plant cover of the inland salt marshes. The most common associated species in these habitat are *Cressa critica* and *Sorobolus virginicus*, while *Halopeplis perfoliata* grow in the salt marshes just inland to the mangrove swamps.



Plate.2. *Suaeda monoica* growing on the salt marsh habitat types.

3. The sand formation habitat types

The sand formations are the major land-form in the Tihamah plains and rise up to 40 m above sea level. Formations comprise two main categories: a) dunes and b) plains. Dunes are located both on the coastal and inland. The soil of the coastal dunes is of marine origin and formed from the coral reef, surface sabkhas and beach sand modified by wind action (Plate 3).



Plate.3. Sand formation habitat types.
(Sand dunes)

The inland dunes usually occupy the road sides e.g. the roads of Jizan- Abu Arish and Sabya-Jizan. *Suaeda monoica* formed pure communities on both coastal and inland dunes. *Tamarix aphylla* formed mixed communities on salt affected inland dunes. The nonsaline small dunes were dominated by *Leptadenia pyrotechnica*, *Panicum turgidum*, *Tephrosia apollinea* and *Dipterygium glaucum*. The Tihamah sandy plains are located in the driest part of the region and accordingly, xerophytic vegetation is most prominent. The most common species forming the xerophytic communities in these plains are: *Acacia tortilis*, *A. ehrenbergiana*, *Leptadenia pyrotechnica*, *Calotropis procera*, *Panicum turgidum*, *Aerva javanica*, *Senna italica*, *Dipterygium glaucum*, *Tephrosia apollinea*, *Blepharis ciliaris* and *Abutilon pannosum*: while the associate species in these plains are: *Indigofera spinosa*, *Ziziphus spina-christi*, *Capparis decidua*, *C.orientalis*, *Fagonia indica*, *Citrullus colocynthis*, *Tribulus terrestris* and *T. pentandrus*.

4. The wadi habitat types

Wadis are one of the characteristic geomorphologic features of the Tihamah plains. These wadis are formed of complex network of tributaries starting in the mountain province and large dry rivers extending in sea-ward direction forming wide deltas (Plate 4) wadi's soil is formed of materials derived from the surrounding mountains as wadi terraces. There are at least nine big wadis crossing the study area (Fig. 1).The major wadis are: Itwed, Byash, Dhamad, Jizan and Khulab. These wadis account for a mean annual run-off rate in the Red Sea of 7.4 m³/Sec.



Plate.4. Wadi habitat types.

The dry wadi terraces are occupied by: *Pandanus odoratissimus*, *Hyphaene thebaica* and *Phoenix dactylifera*; whereas beds of the wet wadi are occupied by communities of *Typha domingensis*, *Cyperus laevigatus* with many associates e.g. *Phyla nodiflora*, *Pluchea dioscoridis* and *Scirpus inclinatus*. Beds of the dry wadis, on the other hand, are covered with scattered patches of *Salvadora persica*, *Ziziphus spina-christi* and *Imperata cylindrica* with many associates e.g. *Ruta chalepensis*, *Acacia tortilis*, *Calotropis procera*, *Leptadenia pyrotechnica*, *Capparis decidua*, *C. orientalis*, *Cassia occidentalis*, *Aerva Javanica* and *Corchorus depressus*. Annuals of Gramineae, Leguminosae, and *Zygophyllaceae* grow on abandoned fields of these wadis. These herbaceous communities are often replaced by fast growing perennials and shrubs e.g. *Calotropis procera*, *Aerva javanica* and *Senna alexandrina*. Sorghum and vegetables are the most important crops planted in these habitat types.

5. The Rocky hills habitat types

These habitat types are represented by the rocky hills in between the mountains and the plains provinces. These hills rise up to 200 m (Plate 5) and their gentle slopes are covered by scattered individuals of *Adenium obesum*, *Acacia asak*, *A. tortilis*, *Ruellia patula*, *Commiphora opobalsamum*, *C. kataf* and *Lycium shawii*. The crevices of the rocky slopes are occupied by *Capparis cartilaginea*, while the foothills and basal areas, where the ground surface is covered with stones, pebbles and gravels, are inhabited by *Caralluma quadrangula*, *C. penicillata*, *Aloe vera*, *Stipagrostis plumosa* and *Senna alexandrina*.



Plate.5. The rocky hille with *Acacia tortilis* at its foothills.

Discussion

According to Koppen's climatic system, the Tihamah coastal area is located in the tropical arid zone of the desert province, characterized by high temperature ranges, relative humidity and low rainfall (> 100 mm). The duration amount and distribution of the rainfall in the study area is unpredictable. Summer rainfall is always connected with the influence of Indian monsoon, while the winter rainfall is related to the Mediterranean regime (AL-Sheriff 1984).

Al-Hubaishi and Hohenstein (1984) reported that the southern Arabian phytogeographical region, including the Yemen, contains 2000-2500 species of the flowering plants, with a very high percentage of Afro-Tropical species of the Sudanian region, which is a part of the Paleotropic Kingdom. The results of this study indicated that 153 species prevailed in the Tihamah plains. Of these, 104 species are perennial and 49 annual. Among the families recorded, Gramineae (25.7%) and Leguminosae (10.1%) were the most dominant.

Besides spatial variations in the vegetation composition of the plant communities, the composition of life-form reflects the response of vegetation to variations in certain environmental factor (El-Demerdash 1984). In this respect, chamaephytes and therophytes life-forms attained the maximum figures in the area of study, while both phanerophytes and cryptophytes attained almost the same presentation and the hemicryptophytes the minimum.

The tidal action, waves and geology are responsible for the formation of the littoral shore-line habitat type. According to Zahran (1980), the mangal vegetation on the Tihamah coast constitutes a segment of the mangal vegetation along the Red Sea coast from the Yemen and northward for 2140 Km. The shore-line of Tihamah provides an excellent refuge for many wild plant as well as for birds, fish, shellfish, shrimp and zooplankton (Zahran 1982).

Variations of soil characters that affect the soil water relations particularly soil texture, may lead to the appearance or disappearance of certain communities (Fayed and Zayed 1989). The sand formations with fine-textured soil and high water retaining power, supported the growth of many community types: *Leptadenia pyrotechnica*, *Panicum turgidum*, *Tephrosia apollinea*, and *Dipterygium glaucum*. While, vegetation in the wadis varied according to a) water availability and b) site location in the wadi. Wadis with continuous water supply support the growth of many water loving species e.g. *Typha domingensis*, *Phyla nodiflora*, *Pluchea dioscoridis* and *Cyperus laevigatus*, while the bed of the dry wadis supported growth of many drought resistant species e.g. *Acacia tortilis*, *Hyphaene thebaica*, *Caralluma quadrangula*, *Aloe vera*, *Calotropis procera*, *Salvadora persica*, *Leptadenia pyrotechnica*, *Ziziphus spina-christi*, *Capparis decidua* and *Imperata cylindrica*. The rocky hills which are located in the driest part in the study area, support the growth of many drought resistant species e.g. *Ruellia patula*, *Commiphora opobalsamum*, *C. kataf*, *Lycium shawii*, *Caralluma quadrangula*, *C. penicillata*, *Aloe vera* and *Stipagrostis plumosa*.

In addition to the severe climatic conditions prevailing in the Tihamah plains, many other factors are threatening its wild plants including: a) Agricultural activities, b) Heavy grazing, c) Wood fuel cutting and d) Termites *Microtermes najdensis*, Harris), *M. diversus* (Silvestri) and *Amitermes* spp) appeared to be the most significant.

Heavy grazing in the studied area had resulted in severe destruction of the communities of *Panicum turgidum*. The consequent deterioration of these communities led to the domination of *Dipterygium glaucum*. Other impacts of heavy grazing were a) inhibition of the regeneration of vegetation successions, b) replacement of the palatable species by the less or even toxic ones, *Jatropha villosa*.

The long term lumbering, fire-wood and charcoal activities in the Arabian peninsula is also another factor that puts an even greater pressure on the abundance of the woody and shrubby species and on the floristic composition of their communities. In this respect, the trunk-forming trees of *Acacia mellifera* are replaced to a large extent by the umbrella shaped *Acacia tortilis*. Termites inhabit the soil of Tihamah causing heavy losses in plant communities, eventually leading to a general degradation of the phanerophytes life-form in the Tihamah plains.

In accordance with previous studies of the desert habitat types (e.g. Kassas and Imam 1954, Batanouny 1979, Zahran, 1982 and Fayed and Zayed 1989) the present study indicated that the distribution of the various plant communities and their composition depends on geological history, elevation above sea level, land form, soil conditions, water supply and on anthropozoogenic influences. The study also revealed that the Tihamah plains of the south western region of Saudi Arabia have abundant natural resources and excellent agricultural and fishing potentialities. In spite of this more detailed and urgent quantitative studies in relation to the different environmental factors await to be conducted. Such studies should concentrate on the evaluation of the effects of the environmental factors threatening the wildlife.

Conclusion

Five major habitat types were detected in the Tihamah coastal plains namely: shore-line; sand formations (dunes and plains); salt marshes; wadis and rocky hills. The shore-line habitat types were characterized by dense growth of *Avicennia marina*. The salt marshes habitats were dominated by communities of *Suaeda monoica*, *Aeluropus lagopoides*, *Cyperus conglomeratus*, and *Tamarix aphylla*. Communities of *Leptadenia pyrotechnica*, *Panicum turgidum*, *Tephrosia appollinea*, *Senna alexandrina*, *Aerva javanica*, *Belipharis ciliaris* and *Dipterygium glaucum* dominated the sand formation habitat types. Margins of the dry wadis are dominated by *Pandanus odratissimum*, *Hyphaene thebaica* and *Phoenix dactylifera*; whereas beds of the wet wadis are occupied by communities of *Typha domingensis*, *Cyperus laevigatus*. Beds of the dry wadis on the other hand, were covered with scattered patches of *Salvadora persica*, *Ziziphus spina-christi* and *Imperata cylindrica*. The rocky hills in the study area were dominated by *Adenium obesum*, *Acacia asak*, *A. tortilis*, *Commophora opobalsamum*, *C.Kataf* and *Lycium shawii*.

The present study also indicates that the distribution of the plant communities in Jizan region is mainly controlled by factors affecting the soil water availability. Other factors e.g. heavy grazing, woodfuel cutting and termites play an additional role in this respect.

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يتناول هذا البحث بالدراسة الوصفية المواطن البيئية والكساد الحضري على الأراضي الساحلية بمنطقة جيزان والتي تغطي ٢٤٠٠٠ كيلومتر مربع من سهول تهامة الواقعة على ساحل البحر الأحمر في الركن الجنوبي للمملكة العربية السعودية.

أجريت الدراسة باختيار ٧٠ موقعاً تمثل في مجملها معظم الاختلافات البيئية الظاهرة بالمنطقة. ورصدت الأنواع النباتية كما أخذت عينات تربة تمثل تلك البيئات.

من خلال هذه الدراسة أمكن تحديد خمس بيئات مختلفة بالمنطقة هي على التوالي: بيئة ساحل البحر الأحمر - بيئة المستنقعات الملحية - بيئة التكاوين الرملية (الكثبان والسهول) - بيئة الوديان وبيئة التلال الصخرية.

تم رصد ١٥٣ نوع نباتي بالمنطقة تنتمي إلى ٤٦ فصيلة نباتية تمثل ذوات الفلقتين منها: ٦, ٦٦٪ وذوات الفلقة الواحدة ٧, ٣٢٪ ومعراة البذور ٧, ٠٪.

أوضحت الدراسة أن طراز الحياة الشجري هو السائد بالمنطقة حيث يمثل نسبة ٢, ٣٩٪ بينما تمثل الحوليات ٣٢٪ كما دلت نتائج الدراسة أن النجيليات تشكل ٧, ٢٥٪ وتليها النباتات البقولية بنسبة ١, ١٠٪ من مجموع النباتات التي تم رصدها في مواقع الدراسة.

أوضحت هذه الدراسة أن العوامل المؤثرة على توزيع الكساء النباتي في المنطقة تمثل أساساً في العوامل المتحكممة في الظروف المائية للتربة. كما أن هناك عوامل حيوية أخرى مثل الرعي، وقطع الأخشاب وحشرة النمل الأبيض (الأرضة) تلعب دوراً إضافياً واضحاً في هذا الصدد.