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**Research Article**

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# Phytosociological Analysis of Woody Vegetation through Different Ecosystems in Bura'a Natural Reserve, AL-Hodaidah, Yemen

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**Abstract** This work was performed with the aim to document a quantitative characteristics of the woody plant communities in Bura'a Reserve in Tehama region, Yemen. The study area was divided randomly into three zones: upper, middle and lower depending on the degree of elevation above sea level. The inductive method was used as a basic method and the descriptive approach was used as an assistant method to assess the total number of species. The results showed relative differences between the zones. The middle zone scores the highest plant diversity; whereas the diversity of the plant species in the lower zone is very low with a high increase in the density of the recorded species. Estimated percentage of similarity indicted that the upper and medium zones are relatively more similar.

**Keywords** Phytosociological, Bura'a Reserve

## Introduction

Information on the various vegetation zones of Yemen were available in numerous sources. Early vegetation accounts were given by [20] who has provided lists of herbaceous and woody species growing in various habitats and the different climatic zones. [21] described the vegetation of different habitats in North Yemen and focus on tree species as an indication of the presence of forests. They assessed the changes in the environment that have taken place in the Yemen as indicated by the present vegetation. Also, the vegetation of Yemen has been studied as part of the works of [5], [8], [12], and [18]. [16] identified four vegetation zones in Socotra Island in relation to climatic, geological and topographic factors.

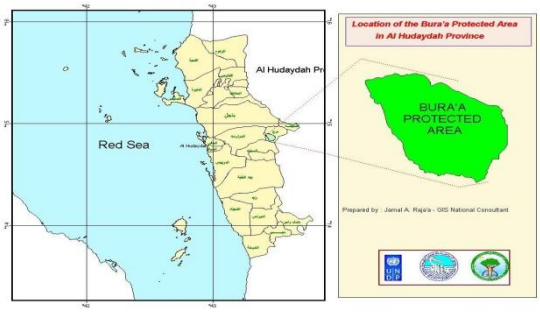
[29] identified eight main vegetation landscapes in Yemen. Yemen had been divided by [31] into three major zones: 1. Tehama or coastal plain, 2. Eastern plateau, and 3. The vegetation of the Tehama foothills; Jabal Bura'a has been classified as part of Tehama Foothills and Low Altitude Western Mountains (< 1000 m). [9] classified Jabal Bura'a as part of the low altitude mountains. The botanical studies on Jabal Bura'a are still limited. The aim of present study is to document the natural vegetation status and floristic composition selected ecosystems at Bura'a Reserve.

## Materials and Methods

### Description of the Study Area

Bura'a Natural Reserve is located in the western foothills of Tehama, northeast of Hodaidah; approximately between latitudes14° 50' ,14°45' N and longitudes 43°24', 43°28' E.,with a total area of about 4287 hectares (equivalent to 43 sq. km) (Natural Reserves in the Republic of Yemen, 2005) [26]. Administratively the Reserve follow Hodaidah Governorate, Bura'a Directorate (Map1) [22].

Bura'a mountain is considered as one of the granite rocks of the volcano of Yemen [3]; characterized by their rough texture; resistant to erosion and corrosion [19]. Soil is sedimentary composed of mud, rock and other materials that crumble from the highlands [4]. Temperatures are moderate to semi-hot, vary due to geographical location. and prevailing winds [6] with an average of 30° C. The annual rainfall rate is 442.7mm. Humidity records differ during the year with an average of 63.9%. The surface run-off from the rainfall is the only source of water [25].




*Map 1: Bura'a Natural Reserve. Adopted. source [30]*

**Vegetation Sampling**

The reserve was divided into 3 different vegetation zones (upper. medium and lower) in each zone 2 vegetation sites were selected (map 2). The selection of the sites was based on observed variations in vegetation types and topographical feature. The sites were marked using GPS as evident by the coordinates in Table (1). Woody species (trees and shrubs) were collected and identified. To estimate the total number of species two circular areas of 0.1 ha (around 1,000 square meters) and a radius of 17.84 meters were randomly used for every site following the procedure of [2].

*Map 2: Studied vegetation sites*

**Table 1:** Characteristic feature of selected sites

| Zone | Site | Latitude (N) | Longitude (E) | Elevation (M) |
|---|---|---|---|---|
| Upper | 1 | 14o 52` 147 | 43o 26` 951 | 756 |
| | 2 | 14o 52` 233 | 43o 26` 740 | 795 |
| Medium | 3 | 14o 52` 593 | 43o 26` 726 | 466 |
| | 4 | 14o 52` 521 | 43o 26` 766 | 520 |
| Lower | 5 | 14o 52` 416 | 43o 26` 962 | 358 |
| | 6 | 14o 52` 434 | 43o 26` 700 | 341 |

In each site woody species were counted. From the counted data the vegetation parameters (density, relative density (RD%), abundance, relative abundance (RA%), frequency and relative frequency (RF%) were calculated to obtain the importance value index (IVI) for each species in each zone using [15] and [14] formulas. The species data was classified into groups using the IVI.

To assess the similarity and dissimilarity in diversity and density of the woody vegetation in the studied zones Biodiversity Professional statistical analysis software [24] was used**.**

## Results and Discussion

### Phytosociological Analysis

The vegetation in Bura'a Natural Reserve is characterized by its diversity of plant communities in different environments. These environmental differences led to differences in the number and abundance of the woody species. The results reveal the presence of 28 species (Table 2).

**Table 2:** List of species in the studied zones

| S. No. | Scientific Name | Zones | | |
|---|---|---|---|---|
| | | Upper | Medium | Lower |
| 1 | *Acacia asak* (Forssk.) Willd. | - | + | + |
| 2 | *A. ehrenbergiana* Hayne. | - | - | + |
| 3 | *Adenium obesum* (Forssk.) Roem. & Schult | - | + | + |
| 4 | *Albizia lebbeck* (L.) Benth. | + | + | - |
| 5 | *Annona squamosa* L. | + | - | - |
| 6 | *Balanites aegyptiaca* (L.) Delile | - | - | + |
| 7 | *Barbeya oleoides* Schweinf. | + | + | - |
| 8 | *Berchemia discolor* (Klotzsch) Hemsl. | - | + | - |
| 9 | *Breonadia salicina* (Vahl) Hepper &J.R.I.Wood | + | + | - |
| 10 | *Calotropis procera* (Aiton) Dryand. | + | - | - |
| 11 | *Commiphora quadricincta* Schweinf. | - | + | - |
| 12 | *Dichrostachys cinerea* (L.) Wight & Arn. | + | - | - |
| 13 | *Dobera glabra* (Forssk.) Juss. ex Poir. | - | + | + |
| 14 | *Ficus ingens* (Miq.) Miq. | + | + | + |
| 15 | *F. populifolia* Vahl | + | + | - |
| 16 | *F. sycomorus* L. | - | + | - |
| 17 | *F. vasta* Forssk. | - | + | - |
| 18 | *Grewia tembensis* Fresen. | - | + | - |
| 19 | *Jatropha curcas* L. | + | - | - |
| 20 | *Mangifera indica* L. | - | + | - |
| 21 | *Olea europaea* L. | + | - | - |
| 22 | *Phoenix dactylifera* L. | + | + | - |
| 23 | *Prosopis juliflora* (Sw.) DC. | + | + | + |
| 24 | *Tamarindus indica* L. | + | + | - |
| 25 | *Terminalia brownie* Fresen | + | + | - |
| 26 | *Trichilia emetica* Vahl | + | + | - |
| 27 | *Vepris nobilis* (Delile) Mziray | - | + | - |
| 28 | *Ziziphus spina-christi* (L.) Desf. Fl. | + | - | + |
| | Total | 16 | 20 | 8 |

**Upper Zone:**

The total number of woody plants in the upper zone is 16 species (Fig. 1). The dominant species is *Calotropis procera* (IVI < 35). *Barbeya oleoides*, *Trichilia emetica* and *dichrostachys cinerea* are abundant (IVI 25-35). *Prosopis juliflora*, *Jatropha curcas*, *Terminalia brownii* and *Phoenix dactylifera* can be considered as frequent species (IVI 15-25). The rest families are occasional (IVI 5-15). The spread of *Calotropis procera* is due to its adaptability to difficult environmental conditions such as dryness and low moisture content; also the plant produces many hairy seeds that help in dispersal. It is evidence by many authors that the spread of *Calotropis procera* indicate soil poverty. *Annona squamosa* scored the lowest IVI. According to [23] and [13], the genus *Annona* is tropical, growing between 800 – 1600 cm.; based on these facts J. Bura'a environmental conditions is less than the plant requirements.

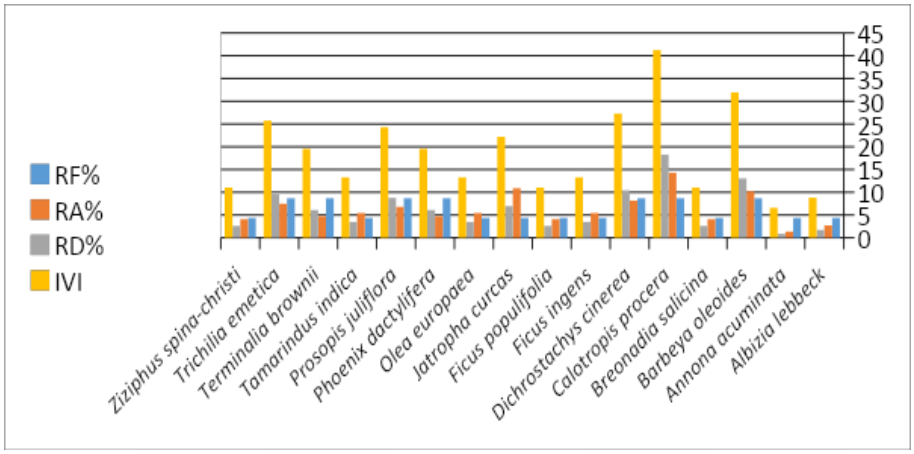



*Figure 1: Vegetation parameters for Trees and shrubs in the upper zone*

**Medium Zone**

The medium zone records 20 species (Fig. 2). The dominant plant is *Adenium obesum* (IVI = 38.682). *Prosopis juliflora* is abundant (IVI= 31.893). While the frequent species are *Vepris nobilis*, *Berchemia discolor*, *Grewia tembensis* and *Breonadia salicina* (IVI 15-25). The rest species are occasional (IVI 5-15).

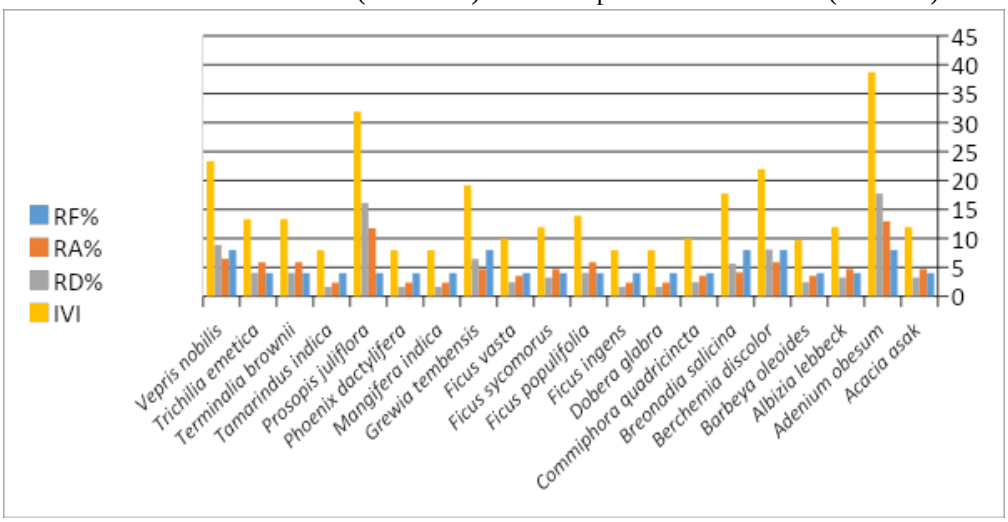



*Figure 2: Vegetation parameters for Trees and shrubs in medium zone*

The dominant species in this zone is the poisonous *Adenium obesum* which is adapted to grow in rocky environmental conditions. The spread of the plant may be due to the fact that it produces winged seeds which are wind dispersers. It is evident that the less occurrence of other woody species such as *Dobera glabra*, *Ficus ingens*, *Mangifera indica*, *Tamarindus indica* and *Phoenix dactylifera* may be due to illegal felling by locals for domestic use in the form of charcoal production. Stems and branches of some trees are also used in local folk industries, bee hives and roofing of rural houses.

**Lower Zone**

The total number of plants reported in the lower zone is 8 species (Fig. 3). The predominant is *Prosopis juliflora*; with an IVI of 87.6903. *Balanites aegyptiaca* and *Acacia ehrenbergiana* (IVI 40-50) are of abundant prevalence. *Acacia asak*, *Adenium obesum* and *Ficus ingens* are frequent (IVI 20-30). *Dobera glabra* and *Ziziphus spina-christi* are of occasional occurrence (IVI 10-20).

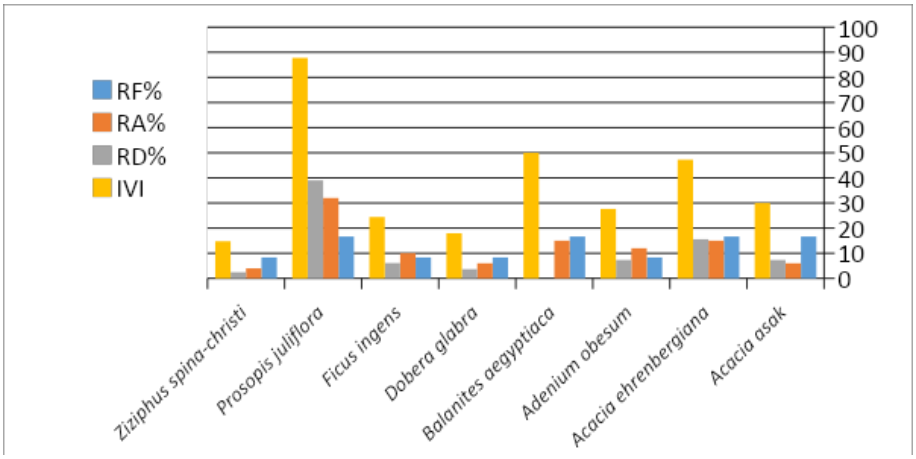



*Fig 3: Vegetation parameters for Trees and shrubs in lower zone*

*Prosopis juliflora* spread is mainly due to its poor requirements and adaptability to hard conditions like dryness and salinity; it is known to replaces other plants and inhibit their growth. The plant produces a large number of pods each containing many seeds. These seeds are distributed within the feces of the animals which are feed with the desirable pods; this phenomenon accelerate the germination of the seeds.

The floristic gradient in the hills vegetation zones is governed by local topographic features (altitude). The total amount of annual precipitation and the fairly high relative humidity are the main abiotic factors affecting the natural vegetation cover and its performance in the upper and medium zones which score relatively high diversity. This result agreed with [7] who reported that increase in the proportion of vegetation cover and quality is co-related with rise from the sea level. Vegetation in the upper zone contains an abundance of plants relatively lower than the medium zone; due to the severity of the mountain slopes and the spread of insect pests, this finding agree with [27]. The medium zone is more diverse than the other vegetation zones; this may be attributed to the fact that it is characterized by its narrow wadi beds and deep valleys filled with deposits that result in mineral-rich soil and represent favorable micro-sites for plant growth. Also, seeds may be locally present in the medium zone or transported from adjacent landscape by altitudinal gravity (or undulations), topography or by seasonal streams of water.

The results reveal that the lower zone contains low diversity, this may be due to climate change, increase of drought as a result of low rainfall quantity and distribution, great change in temperature and high evaporation rates, and overgrazing; in addition to different human activities represented in expansion of urbanization and population increase. This confirms the findings of [11] and is also in line with what [28], and [10]. Decrease in woody species is mainly due to felling by man and heavy browsing by domestic animals. Hardly, wooded tree species suitable for fuel-wood with other important commercial qualities such as *Ficus* spp. *Dobera glabra, Tamarindus indica and Ziziphus spina-christi* have declined in abundance. It was agreed that open grazing and persistent pastoral pressure led to a few non-palatable plants and an increase in non-palatable species for animals; the degradation of browsed species is indicated by a rise in abundance of non-palatable species such as *Calotropis procera* and *Leptadenia arborea*. The spread of *Acacia* trees and availability of *Ziziphus spina-christi* and *Balanites aegyptiaca* in the study area agreed with what [1] concluded in Tehama plain. The existence of *Acacia ehrenbergiana* confirmed what [17] concluded in his study about planted species in wooden belts of Tehama. Seed survival in the lower zone may be at risk due to climatic adversity or predation by livestock.

It is clear from figure (4) that the upper and medium zones score the highest similarity percent (55,5556%). Similarity between the medium and lower zones is 37,037o% while the percentage similarity between the upper and lower zones is 17.3913.

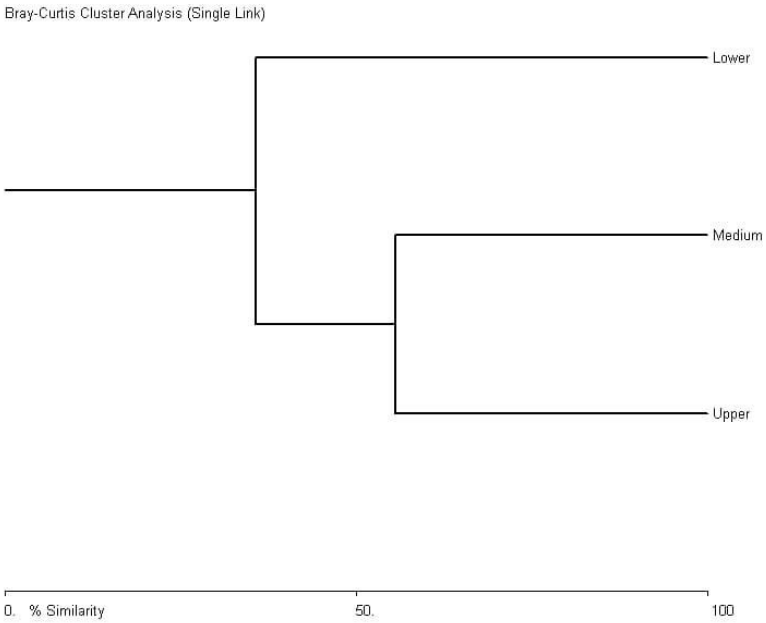



*Figure 4: Similarity % between studied zones*

**Conclusions**

The study revealed that diversity and density of the natural vegetation layers are affected by the degree of elevation. Estimation of the IVI showed that in the 3 studied zones the mature trees and shrub increase with increment of elevation. The medium zone is more diverse than the other vegetation zones and the lower zone contains low diversity.

**Recommendations**

Special attention should be directed to linkages amongst factors of water, soils nutrients and destruction of the natural vegetation in Bura'a natural reserve; as it represents one of important and unique reproductive ecological zones in Yemen. It is recommended that this study should be followed by detailed ecological and floral studies. The expected result would serve towards developmental management of the area and understanding of plants as renewable resource for the benefit of man and his domestic animals.

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