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Floristic and ecological investigation of Wadi Al–Agar in Al–Jabal Al– Akhdar–Libya

Mohamed A. Alaib *, Immhemed El- Sherif, Ramadana I. Al-Hamedi

Botany Department, Faculty of Science, Benghazi University, Benghazi – Libya

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* Corresponding author:
E-mail address: adrawi2002@yahoo.co.uk
M.A. Alaib

ABSTRACT

Floristic and ecological investigation of Wadi Al—Agar was carried out. The study area lies between 20 45'00" and 20 01' 42" E longitude and 30 35' 00" and 32 01' 15" N latitude of the northeast region of Libya (known as Al—Jabal Al—Akhdar). An open scrub represents the vegetation of the Wadi, which is a very characteristic and natural type of Mediterranean plant communities. A large number of maquis species are found at several elevation parts of the Wadi. About 317 taxa of the vascular plants are investigated in the area. The results revealed that, these taxa are belonging to 66 families two families of Gymnosperms and the remaining 64 families are belonging to Angiosperms. Dicotyledons are represented by 262 species, 171 genera and 55 families and Monocotylendons are represented by 51 species, 37 genera and 9 families. In addition to that, the ten largest families according to the number of species are Asteraceae (46 species), Poaceae (26 species), Lamiaceae (19 species), Apiaceae (13 species), Brassicaceae (13 species), Boraginaceae (11 species), Geraniaceae (11 species), Liliaceae (11 species), and Ranunculaceae (9 species). In this study, there are 18 endemic taxa have been collected. In addition to 23 species reported by some authors, there are no specimens for these species have been collected in Libya. The species *Clematis vatalba* and *Clematis montana* have been collected for the first time and they form a new record for Libya.

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1. Introduction

The last two centuries have seen many attempts by scientist to explore the geology (Rohlich, 1978; Megreisi, 1980), Geomorphology (Gimingham & Walton, 1954); Geography (Jonson, 1973), climate and flora (Jafir & El-Gadi, 1977-1986; El-Gadi, 1988-1989) of Cyrenaica in Al—Jabal Al—Akhdar.

The history of exploration of the flora and vegetation of Cyrenaica dates back to 1703 when Lemaire made some observation about Sylphium plant. Dela-Cella (1819) made the first systematic collection of Libyan plants; he collected some 260 species along the coastal strip, from Tripoli to the Egyptian borders, from which 132 species from Cyrenaica. Pacho (1827) collected some 39 species of flowering plant from Cyrenaica. Beechy and Beechy (1828) surveyed the plants of the coastal plain between Tripoli and Derna. They collected about 13 species from Cyrenaica.

The important work of Rohlfs (1881) provided the most comprehensive information on the vegetation of Tripolitania, Fezzan, Ghadames, Kufra, Aoujila and Cyrenaica as well as a list of vernacular names of plants. Taubert (1887) also made rich collection from the Cyrenaica. He collected about 485 species of flowering plants (Pampanini, 1931).

Durand and Baratte (1910) published "Flora Libycae Prodromus". It was the first attempt to bring out a consolidated flora of Libya. Some 1026 species have been dealt with but, unfortunately, neither description of species nor keys were provided in his work. Vaccari (1914) made rich collections (559 species) along the coastal plane from Benghazi to Tubruk. In his work, he gave important information on the vegetation of Cyrenaica.

Floristically, Cyrenaica is relatively well known, and all records up to 1930 are contained in the comprehensive "Prodrmo Della Flora Cyrenaica" (Pampanini, 1931). In his work Pampanini dealt with all plant groups of Libya. He described species and provided keys for their identification. Maugini (1931) made observations on the pastures of Cyrenaica. The vegetation of these pastures is represented by 35 families of flowering plants. The members of the family Poaceae most dominant followed by these of Asteraceae, Fabaceae and Apiaceae. Maire and Weiller (1939) studied Cyrenaica region making many remarks on the flora and vegetation. Sandwith and Simpson (1941) summarized the history of investigation on the Libyan Flora and listed a number of new taxa to Cyrenaica.

Gimingham and Walton (1954) studied the structure of scrub communities on the lime stone plateau of northern Cyrenaica. The study included distribution of some species and their relative dominance and variations. They found that south facing wadi slopes, which suffer from more desiccating conditions than their northward oriented representations of the less well adapted species, dominate in these demanding conditions.

Boulos (1972) compiled a bibliography which includes existing literature up to 1971 on the flora and vegetation of Libya. He made extensive collections from different parts of Libya and participated in the formation of the nucleus of the Herbarium of Tripoli University. Keith (1973) published "A preliminary Check List of the Flora of Libya", though this work without description of species and keys for their identification. It was a very useful compilation as it contains many remarks about the uses of plants and their vernacular names.

Tripoli University, with the financial support of Arab Development Institute, has taken up "The Flora of Libya Project" to bring out a proper flora of the country. Descriptions of individual families were published separately during 1976 to 1989; volumes 1-24 by Ali and Jafri (1976-1977), volumes 25-144

by Jafri and El-Gadi (1977-1986) and the volumes 145-147 by El-Gadi (1988-1989).

Faruqi (1979) has studied Libyan grasses described a new generic record from Libya. Brullo and Furnari (1979) provide critical taxonomic and nomenclatural notes on the flora of the Cyrenaica and described several new taxa.

Brullo (1978, 1979, 1982, 1983, 1984) has published many papers on Libyan plants described several new taxa and made many nomenclatural changes. Brullo and Pavone (1983) and Bartolo et. al., (1984) have studied cytotaxonomy of some Liliaceae from Cyrenaica. Qaiser and El-Gadi (1984) have published a critical analysis of the flora of Libya. They have listed the endemic plants and also reorganized their four centers of endemism in Libya. El-Gadi et. al., (1987) have reported some species which have not been previously recorded in Libya.

El-Sherif et al., (1991) published a list of plants from wadi Murqus in Al-Jabal Al-Akhdar. Also in their study, they recognized *Cuscuta monogyna* as a new record in Libya. Mugasaby and Alaib (1992) worked on vegetation of a sector of Mediterranean coastal region in Libya and studied life forms in this region. El-Sherif and Sing (1996) worked on the vegetation and flora of Benghazi, and found that the total of 573 species of flowering plants belonging to 373 genera and representing 97 families among them 377 are indigenous species. Asker (1989) worked on the vegetation and flora of wadi Al-Ashra and found that the total of 237 species of flowering plants belonging to 148 genera and 57 families.

Al—Jabal Al—Akhdar is represents important phyto-geographical units in Libya and therefore the study of the vegetation and distribution of its different habitat types is of special interests. A part from collecting plant and studying the flora of Libya there seem to be limited ecological studies made on Libya as a whole and on Al—Jabal Al—Akhdar in particular. The need was felt therefore to make a more detailed ecological study of the area.

The present study is an attempt to establish the basis for a more intensive approach to study the different ecosystems of Al—Jabal Al—Akhdar, which was started with the studies of Wadi Murqus (El-Sherif et. al., 1991); and Wadi Al-Asrha (Asker, 1998). This study is a continuation of above mentioned studies and will focus on vegetation of Wadi Al—Agar in the western part of Al-Jabal Al—Akhdar.

2. Study area

Location: The study area is located on the eastern coast of Libya in Al–Jabal Al-Alkhdar region. It lies between 20 45'00" and 20 01'42" E longitude and 32 35'00" and 32 01'15" N latitude .It extends approximately for 17 Km from north (the end point of the Wadi in the sea) to south direction between Farzugha in the west and Al—Marj in the east. The area rises to about 380 m above the sea level.

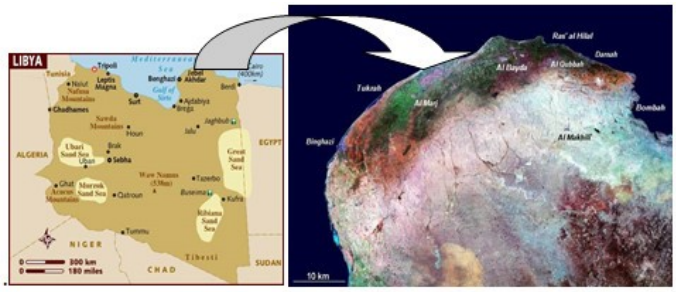

Fig. 1: Map of study area

Physiography: According to physiographic features, the study area can be divided morphologically into three parts:

I. The Upper terrace (about 380 m above sea level) comprise the southern part of the Wadi, from Al—Marj east Farzugha village, to the start point in the catchments basin and formed stream which was shallow and increasing in the depth wherever there be directed to north.

II. The middle terrace (150–300 m above sea level) wider in comparison to lower and upper terraces, it forms a belt, which is covered by dense vegetation while the Wadi bed covered by gravel and alluvial deposits. In general it comprised two slopes. The first is opposite to the east and is covered by dense vegetation. The second opposite to the west, and have low vegetation.

III. The lower terrace (0–100 m) cuts the coast plain region at the Ardano village about 6 Km east Tukrah. In this part, the Wadi is less deep and ended by open region to the sea. In general, the Wadi is represented by the gravel land, alluvium clay. The sand dunes are present at the north of the Wadi near the sea, which covered by halophytic plants.

Soils: The influence of the soil genesis factors, such as climate, vegetation and parent material is more or less reflected in the profile characteristics of the soils. In general the area are composed of Eocene rocks (Tertiary) which consist of nummulitic limestone in part chalky, marly and cherty, while quaternary deposits occur mainly on the coastal plain, mostly, along the slopes of the hills namely Colluvium and in the Wadi bottoms namely Alluvium. The major soil types found in the area are, terrarossa is dominant in the upper terrace and alluvium loam-clayey in the bottom, while eolian sand area soil dominate at the narrow area along coastal plain.

I. Alluvium

It represents essentially an alluvium soil, which is developed in the alluvium of Wadi bottom, and it has been designated as yellowish brown alluvial soil because its dominant colour. Textures are loam or clayey and gravel; sometimes these soils are more or less stony. The dominance of a component in the loam – clayey complex depends largely on the conditions of deposition and this differs in different parts of the Wadi. In the Wadi bed pebbles, boulders and rock debris are common.

II. Terra Rossa

This type of soil is wide spread on the area, this soil was developed from limestone under the condition of the Mediterranean climate, which enriched in sesquioxides and silica, and contains large quantities of self of the alkalis and alkaline earth. The high iron content together with low humus content are responsible for the red colour and which often is brilliant (Buru 1968). They are mostly with alkaline reaction and ferruginous concretion.

III. Eolian sands

This type covers very narrow area along the coast plane near Tukrah, litho sols of extreme stoniness predominate saline solonchak soil are common immediately behind the coastal dunes wherever these formation have not been eroded by an encroaching sea. They exist at least in small quantities at the mouth of the Wadi, where they principally overlie the carbonate sandstone.

Climate: The climatic conditions prevailing in the study area, which is a part of Al—Jabal Al—Alkhdar, has Mediterranean climate Cyclonic rains occur in winter, and the hot, dry summer is a result of high- pressure zone. The main characteristics of the climate in this area are instability caused by the contrary effects of the Sahara and the sea.

The rainfall in the study area is markedly seasonal and irregular in amount .The annual rainfall at the area varies considerably around the mean from one month to another, year to year. Most of the rainfall occurs in late autumn and early spring (during the period between Octobers a March). The peak rainy months are

December, January and February. In general, the rainfall starts in the month of October sometime in September and extends up to March sometime up to April. It was low as 295.1 mm and as high as 648 mm. The annual mean about 418.6 mm (Kawasma, 1979).

Temperature varied considerably from summer to winter. In general, the winter extends from December to March but December, January and February are the coolest months and the summer extends from May to August; June and July being the hottest months of the year. The monthly mean temperature varies; it is 7.2 C° in February and 29.8 C° in June.

The relative humidity in general was high in the study area. The monthly. Mean, however, varies from 53.3% (June) to 76.6% (January). January, February, December and November are the most humid months of the year, where the relative humidity is above 70.9% as the maximum and the minimum below 54.3% in May and June.

In Al—Jabal Al—Akhdar variations in wind velocity are less distinct than those of other climatic features. The northern and north-western wind is dominant in the study area. It is humid wind and makes the air cooler in the winter and brings the rain. While the southern and southwestern winds in summer make the air warmer. The average wind speed of the study area varies from 8.3 Km/h (October) to 11.1 Km/h (April).

3. Collection of the Specimens

Fieldwork continued for approximately 12 months intensive collection in various parts of the study area. During this period at least one field trip per month was done for sample collection and vegetation observation. The field trips were more frequently done during the rainy seasons and springtime, where the most of the plants are in flowering conditions. The plant specimens were collected in flowering or and in fruiting condition. Herbaceous plant wherever possible were collected with underground parts. In case of woody plants, a branch or twig of about 25 cm was collected. At least four specimens of each species were collected.

Specimens collected more than once from the same place at same times were given a field number. The information such as the date of collection, the locality, the habitat the flower colour, abundance, vernacular name and the uses if any, were recorded at the time of collection.

The specimens were pressed in field as they were collected or they brought to the herbarium and then pressed there. They were carefully displayed on the blotter or newspaper sheet. The overlapping leaves or branches were removed if that necessary. The larger specimens were accommodated on the sheet in a V-shaped or N-shaped manner, placed in the sheet one over another and then tightly bounded in a plant presser.

For drying the presser, containing specimens was placed in the sun or in an oven with hot air circulation. After that, the specimens were examined individually, rearranged, transferred to fresh sheet and again tightly bounded in the presser. The specimens were changed to dry sheet every two or three days, until specimens were completely dry. In damp environment, artificial heat was used.

After drying specimens were flooded with poisoning solution (Mercuric Chloride 35 gm, Ammonium Chloride 70 gm in 1000 ml Alcohol) to protect them from fungi and pests . When specimens were completely dry they were mounted on herbarium sheet with stander sizes (28.75 ×41.25 cm) with the aid of adhesives. To hold heavy or woody specimens strips of adhesive tape were used. The large twig sizes were stitched with the help of thread. On the lower right hand corner of the herbarium sheet, a label was glued and all information from the field notebook was transferred to it.

The identification of the specimens was done by utilization of available taxonomic literature (see references). Wherever possible, identification was confirmed by comparing with the specimens in the herbarium. The specimens collected in this work have been deposited in Cyrenaica Herbarium, Botany Department, Benghazi University, Benghazi, Libya.

4. Results

The climate, depth of soils, and relief are the major factors, which affect distribution of the vegetation in the study area. The Wadi lies within maquis vegetation, which is a very characteristic and natural type in Al—Jabal Al—Akhdar of Mediterranean plant community.

The vegetation in the study area is represented by an open scrub on the stony slopes, and by tall shrubs and tree in the Wadi bed where a large number of the maquis species are found at elevation parts of the Wadi in response to particular edaphic factors. According to topographic map of the area, the study area extends over a horizontal distance of 17 km and rises from sea level to an altitude of almost 380 m. The transect taken from the north to the south brings out the following zones:

Zone I:

The first zone lies at the end of the Wadi and extends to about 2 km to the south direction. Along the Mediterranean coast, the zone occupies a narrow sandy beach 50 m in width .The soils in this zone especially near the sea are made of loose mobile sand grains, to the south they become consolidated in to porous rocks. The plants growing with high density and sociability on the dunes are mainly geophytes. The most common maritime species are: *Ammophila australis,* this is species accumulate sand most actively due to upward growth of its rhizome system, tall sea shore grass with contracted, spike-like panicle; *Pancratium maritimum* and *Narcissus tazett*. On the consolidated part of the dunes, have stands of *Nitraia retusa* an evergreen spine, much branched shrub of the Zygophllaceae. The maritime influence is reflected particularly by such species as *Limonium pruinosum, Cichorium spinosum, Polygonum maritimum* and *Sarcopoterum spinosum.*

In addition, some dwarf bushes of distorted and browsed *Pistacia lentiscus, Rhus tripartita* and *Periploca angustifolia* which are influenced by maritime. Moreover, several annuals make their appearance after rain particularly species of Poaceae, Fabaceae and Asteraceae are common.

Zone II:

The second zone lies about 4 km south of first zone .The Wadi at this zone forms a narrow rocky channel covered by stones and gravel in the Wadi bed. The vegetation in this area is represented by an open scrub, dominated by several species such as *Pistacia lentiscus, Ceratonia siliqua, Rhus tripartita, Calicotome spinosa* and *Spartium junceum.* In the open area appeared the species *Genista acanthoclada,* besides another species such as; *Sarcopoterium spinoum, Cistus parviflorus, Cistus salvifolius, Teucrium bervifolium, Teucrium barbeyanum, Lycium europaeum, etc*

Zone III:

The third zone, occupying the next 5 km, rising rapidly to the south, forming plane area on altitude of about 290 m above sea level. The vegetation over the whole of the third zone, which constitutes the major part of the study area in this Wadi, it is very dense in comparison with other parts of the Wadi.

The vegetation cover in this zone consists of many species such as: *Juniperus phoenicea*, *Olea europea, phillyrea latifolia, Quercus coccifera, viburnum tinus, Arbutus pavarii,* (species endemic to Al—Jabal Al—Akhdar), *Ephedra altissima, Rosmarinus officinalis* found on slopes in the zone throughout the Wadi .

Besides that there are many species in the area such as: *Capparis spinosa, Teucrium berevifolium, Teucrium barbeyanum, Spartitium junceum, Centaurea Cyrenaica, Globularia alypum, Calicotome spinosa, Ceratonia silique* . etc.

Zone IV:

The fourth zone lies about 6 k m south of the third zone at the catchment basin of the Wadi, rising gently to the south to altitude

of about 380 m above sea level. The Wadi at this region formed rocky channel with medium depth.

The vegetation as described for the third zone continues to the fourth zone, but includes individuals of few additional dwarf shrubs, such as "*Thymus capitatus, Teucrium divaricatum".* In addition to that there are several species such as: *Phlomis floccose, Genista acathoclada, Sarcopoterium spinosum, Pistacia lentiscus, Rhamnus alaternus and Calicotome spinosa* and several herbaceous perennials, found growing in open patches, including tuberous or bulbous stems such as: *Urginea maritima, Asphodelus microcarpus, Narcissus tazett,* etc. The following climbers and twiners are also common throughout the Wadi in particular those which are climbing on trees and shrubs in the Wadi bed. They include *Lonicera etrusca, Smilax aspera, Galium mollugo, Clematis flammula, Clematis cirrhosa and convolvulus maireanus.* A large numbers of annuals are also found in open places under the protection of trees and shrubs. The most numerous species belongs to *Erodium, Geranium, Convolvulus, Trifolium, Medicago, Allium, Silene, Linum, Euphorbia, Avena, Bromus, Reseda, Ranunculus, Crepis, Echium, Lostus, Outs, Ononis, Ammi, Hordeum* and *Vicia.*

Finally in this study, 18 endemic species found in the Wadi (Table 1), and 23 species reported by some authors. Moreover, there are no specimens for these species have been collected in Libya (Table 2).

Table 1: List of endemic species in the study area.

Species	Family
Anthemis taubertii Durand & Barratte.	Asteraceae
Allium longaunm Pamp..	Alliaceae
Allium ruhmerianum Aschers.	Alliaceae
Arbutus pavarii Pamp.	Ericaceae
Arum cyrenaicum Hruby.	Araceae
Bellis sylvestris var. Cyrenaica Beg.	Asteraceae
Centaurea cyrenaica Beg. & Vac.	Asteraceae
Convolvulus maireamus Pamp.	Convolvulaceae
Cyclamen rohlfsianum Aschers.	Primulaceae
Cynoglossum clandestianum Desf.	Boraginaceae
Echinops cyrenaicus Durand & Barratte.	Asteraceae
Ferula marmarica Asch. & Tabub.	Apiaceae
Onopordum cyrenaicum Maire &Weiller.	Asteraceae
Onosma cyrenaicum Durand & Barratte.	Boraginaceae
Poygala aschersoniana Chodat.	Polygalaceae
Romulea cyrenaica Beg.	Iridaceae
Teucrium barbeyanum Asch.& Tabub.	Lamiaceae
Valerianella petrovichii Ashers.	Valerianceae

5. Discussion

The vegetation of Wadi Al-Agar is represented by an open scrubs which is a very characteristic and natural type of Mediterranean plant community (Polunin and Huxley, 1972). A large number of the maquis species are found at several elevation parts of the Wadi. Usually, maquis classified into high maquis and lower maquis. A high maquis are characterized by presence of a number of trees and large shrubs growing as high as 4-5 m such as *Quercus coccifera, Juniperus phoenicea, Olea europea, Arbutus pavarii*, etc. A lower maquis , where the small shrubs and bushes 1.5–2 m high, such as *Rosmarinus officinalis, Spartium junceum, Lycium europaeum, Cistus parviflorus*, etc (Polunin and Huxley, 1972).

In the study area, communities of the two type of Mediterranean vegetation (high and low maquis) occur. In addition to these two types, a large numbers of herbaceous plants are found under the protection of trees and shrubs. The major components of the maquis vegetation in the four zones of the study area can be summarized in the follows:

In the first zone, the direct maritime influence is observed in the vegetation, which is reflected particularly by such species as *Ammophila australis, Sporoblus virginicus, Limonium pruinosum, Nitraria retusa*, while a structural element less familiar in sand dunes is represented by woody chamaephytes and dwarf- shrubs, including the succulent leaved such as *Nitraria retusa* and *Cichorium spinosum* which grow in dome-shaped mass of prickly branches are present in isolated units. *Cichorium spinosum-Limonium pruinosum* association with its variants includes some phytosociologically important perennials such as *Cynodon dactylon, Polypnum maritimum, Pancratium maritimum, and Sporoblus virginicus*, and a series of annuals.

Table 2: List of collected species which reported by some authors in flora of Libya and there is no specimens found for these species in Libya

Species	Family
Clematis flammula L.	Ranunculaceae
Pisum elatius M. Bieb.	Fabaceae
Trifolium arvense L.	Fabaceae
Phillyrea angustifolia L.	Oleaceae
Centaurium tenuiflorum (Hoffm& Link)Fritsch.	Gentianaceae
Gallium mollugo L.	Rubiaceae
Valantia lanata Delile & Coss	Rubiaceae
Convolvulus maireanum Pamp.	Convolvulaceae
Convolvulus oleifolius Des.	Convolvulaceae
Convolvulus tricolor L.	Convolvulaceae
Anchusa aggregata Lehm.	Boraginaceae
Cynoglossum clandestianum Desf.	Boraginaceae
Salvia viridis L.	Lamiaceae
Teucrium campanulatum L.	Lamiaceae
Lonicera etrusca Santi.	Caprifolaceae
Crepis libyca (Pamp) Shab.	Asteraceae
Launaea tenuiloba (Boiss.) Kuntze	Asteraceae
Pulicaria inulodies (Poir.) DC.inuloides	Asteraceae
Xanthium strumarium L.ssp .italicum (Moretti) D.Love	Asteraceae
Allium ruhmerianum Asch.	Alliaceae
Asparagus albus L .	Asparagaceae
Ornithogalum tenuifolium F. Delaroche ssp. Tenuifolium	Asparagaceae
Sorghum halepense (L) Pers.	Poaceae

In the second zone in the Wadi, *Ceratonia siliqua–Pistacia lentiscus* form loose association. This association is very peculiar because of the more or less continuous coverage of shrubs and the scattered trees of *Ceratonia Siliqua*. Among the shrubs associating with *Pistacia lentiscus* the following are common: *Calicotome vilosa, Cistus salvifolius, Cistus parviflorus, Phlomis floccosa* and other species of the maquis associations. A similar association of these two species was also described by Gimingham and Walton (1954) in northern Cyrenaica. It is also association described by Zohary (1944) in Palestine.

In the coastal plateau and in the open areas in the Wadi *Sarcopoterium spinosum* is clearly dominate member of this association and with it are grouped a number of species such as *Phlomis floccosa, Urginea maritima* and a large number of annual plants. In this places the extreme pressure, by human and animal, that has removed other elements of the natural flora and created an altered set of micro-climatic conditions such as increased sunlight, reduced ground cover, and augmented solar insulation, that are more conducive to xerophytic species. These species are also an indicator of degraded soil, especially, where both these condition occur.

However, the major maquis community remains a mixed one. In the second zone which characterized by jumbling of several species such as *Ceratonia siliqua*, *Olea europea*, *Phillyrea latifolia, Rhus tripartita* and *Pistacia lentiscus* and lower layer of *Cistus parviflorusC. Salvifolius, Teucrium bervifolium* and *Genista acanthoclada* and a large number of annual plants.

The vegetation in the third zone, several new species is started to appear in the major maquis community such as *Arbutus pavarii* though occurs throughout the Wadi, this species to be exposed to damage by a grazing. Damage to the leading shoot in the seedling stage is frequently fatal (Gimingham and Walton, 1954) However, *Arbutus pavarii*, is resistant to heavy grazing, tends to from a thicket of slender trunks with branching confined mainly to the upper regions. This species to be exposed to continue cutting where, it has failed to eliminate this species has favored the development of lateral sprouting and lower, more bushy profile (Johnson 1973).

Quercus coccifera is the only wild species of oaks occurring in Libya now confined to a small area in Al-Jabal Al-Akhdar. This species observed in the Wadi at certain altitude almost up to 100 m above sea level. This species is increasingly restricted to the most inaccessible parts of Al—Jabal by the pressures of both human and animal factors. According to Gimingham and Walton (1954) the vegetation in the Wadi are characterized by two large shrub communities; the first type in the flat open area is dominated by *Pistacia lentiscus*, is very extensive with occasional presence of *Ceratonia siliqua,* and the second type, mixed maquis, the most regular and abundant of these is *Arbutus pavarii* with *Ceratonia siliqua,* and *Smilax aspera* is abundant as climber over the dominant shrubs. *Pistacia lentiscus* present in a subordinate stratum, *Sarcopoterium spinosum*, *Cistus parviflorus* to be formed field layer.

Another interesting observation is the presence of maquis communities in present study on the Wadi. A mixed maquis community was observed throughout the Wadi particularly in the bed and in the branches with a jumble of shrubs or small tress, abundance of *Juniperus phoenicea, Olea europea, Arbutus pavarii, Phillyrea latifolia.*

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