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# Size Distributionof Some Endangered Plant Species, Al-Jabal Al-Akhdar, Libya.

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AL-JABAL Al-AkhdarMountainis the richest vegetation and highest species diversity in Libya. The aim of the present study was to evaluate the population structure of twelve endangered species in Al-Jabal Al-Akhdar. These species are: *Arbutus pavarii* Pamp., *Cupressus sempervirens*L., *Ceratonia siliqua*L., *Juniperus phoenicea*L., *Laurus nobilis*L., *Olea europaea*L., *Pinus halepensis* Miller., *Pistacia lentiscus* L., *Querecus coccifera*L., *Seriphidium herba-alba* (Asso) Soják.,*Thymus capitatus* (L.) Hoffmanns. & Link and *Ziziphous lotus*(L.) Lam. These species collected from downstream, midstream and upstream of Al-Marj-Al-Baida motorway, El-Beida, Jardas Jerrari, Shahat, Sidi Ahmad Al-Hemery, Susah and Wadi El-Kouf in Al-Jabal Al-Akhdar. The size index of each individual was calculated and then used to classify population into seven size classes. The height, mean diameter, height to diameter ratio, size index and volume per individual in each size class were determined. Generally, the height to diameter ratio was more than unity for *Arbutus pavarii*, *Cupressus sempervirens*, *Ceratonia siliqua*, *Juniperus phoenicea*, *Laurus nobilis*, *Olea europaea*, *Pinus halepensis* and *Querecus coccifera*, this means that the diameter of these species tend to expand vertically rather than horizontally, while the height to diameter ratio was less than unity for *Pistacia lentiscus*, *Seriphidium herba-alba*,*Thymus capitatus* and *Ziziphus lotus*.Five forms of size distributions along the different elevations were recognized: more or less inverse J-shaped distribution, positive skewed distribution, bell shaped distribution, more or less J-shaped distribution and more or less stationary size distribution biased to large size.

**Keywords**: Size structure, Endangered, Elevation gradient,Al-Jabal Al-Akhdar, Libya.

The human activities have dramatically affected the biodiversity of Al-Jabal Al-Akhdar, Libya. In recent decades, this effect has been intensified due to the increase in the population and the import of modern mechanization which has caused an increase of the destructive effects of human activities. Although this region is one of the important areas for wildlife in Libya, it suffers from extreme biodiversity destruction and degradation. The breakdown of authority and spread of weapons associated with the conflict may prove a more significant and is an immediate threat which was underlined by a recent (May 2011) quote from a Libyan scientist. So, the situation has become very dangerous regarding the forest as many people have taken the advantage of the chaos and removed hundreds of hectares to change the land use to agricultural lands in the area under study.Furthermore, the climatic changes with decreasing the amounts of precipitations during last four decades, led to complete damage of some plants in the study area, and changing the vegetation composition.

It is very important now to begin extensive environmental studies and conservation programs, including not only soil and biodiversity conservation but also beauty conservation and attention to local inhabitants because they play an important role in the ecosystem throughout the whole area (EL-Barasiand Manam, 2013).

At Al-Jabal Al-Akhdar, the decline of species such as *A. pavarii*, a vulnerable endemic shrub (Kabiel *et al*., 2016a) and common keystone species *J.phoenicea*, an evergreen tree that is, in many areas, showing low juvenile recruitment and dieback of vegetative branches (Kabiel *et al*., 2016b).*Arbutus pavarii,*an endemic species, classified as one of the red list of IUCN inthe study area due to excessive human disturbance (IUCN, 2013).

The size structure of plant populations has been frequently used to assess regeneration status and to predict future population changes by assuming that populations with many small stems in relation to larger ones are self-replacing or increasing, whereas populations with relatively few small stems are believed to be declining in abundance (Buyavejchewin *et al*., 2003 and Baker *et al*., 2005).

The distribution of plant species along elevation gradients is governed by a series of interacting biological, environmental and historical factors (Colwell and Lees, 2000). Elevation represents a complex gradient along which many environmental variables change simultaneously (Austin *et al*., 1996). Thus, the effect of each variable could be difficult to separate and these interacting factors would be difficult to disentangle. Furthermore, the observable associations between species distribution and elevation bands may help to understand the possible effects of environmental changes, *i.e*., by providing baseline information from which to measure or gauge the effect of climate change and anthropogenic changes on vegetation.

The target species in this study were twelve endangered species declared according to Al-Idrissi *et al*. (1996); Eldoumi *et al*., (2002) and EL-Barasi andManam. (2013). These species are: *Arbutus pavarii* Pamp., *Cupressus sempervirens* L., *Ceratonia siliqua* L., *Juniperus phoenicea* L., *Laurus nobilis* L., *Olea europaea* L., *Pinus halepensis* Miller., *Pistacia lentiscus* L., *Querecus* *coccifera* L., *Seriphidium herba-alba* (Asso) Soják., *Thymus capitatus* (L.) Hoffmanns. & Link and *Ziziphous lotus* (L.) Lam.They were distributed along the different elevation levels (downstream = level I, midstream = level II and upstream = level III) at selectedseven studies wadis in Al-Jabal Al-Akhdar.

The present study aims to investigate the population structure of the twelve endangered plant species, in terms of size distribution, height, diameter and density in their favorable habitats, and to assess the effect of different habitats, which reflect the elevation gradient, on the size distribution and density of occurrences of the study species.

## Materials and Methods

*Study area*: The Al-Jabal Al-Akhdar mountainous region is in NE Libya, reaching 878m above sea level (a.s.l.) and characterized by a Mediterranean climate with cool rainy winter and hot dry summer (El-Tantawi, 2005). The location of the seven study wadis are shown in Fig. 1 and described in Table 1.

| Study wadis | Altitude m (a.s.l) | Latitude | Longitude | Habitat |
|---|---|---|---|---|
| 1-Al-Marj-Al-Baida motorway | 425.5 | 32°29'1.00"N | 20°57'10.60"E | North-west slope |
| 2- El-Beida (Belghra) | 624 | 32° 45′ 59″ N | 21° 44′ 30″ E | North-east slope |
| 3-Jardas Jerrari | 691 | 32° '31 33 " N | 21° '47 15" E | Southern dry slope |
| 4-Shahat | 351.4 | 32°50'43.60"N | 21°35'14.50"E | Northern slope |
| 5-Sidi Ahmad Al-Hemery | 855.5 | 32°37'55.10"N | 21°47'22.70"E | Mountain top |
| 6-Susah | 11.2 | 32°53'45.31"N | 21°35'50.17"E | Coastal plain |
| 7-Wadi El-Kouf | 369.7 | 32°40'57.00"N | 21°33'55.00"E | Wadi |

**TABLE 1. (a.s.l) The study wadis in Al-Jabal Al-Akhdar landscape. Altitude = meter above sea level**

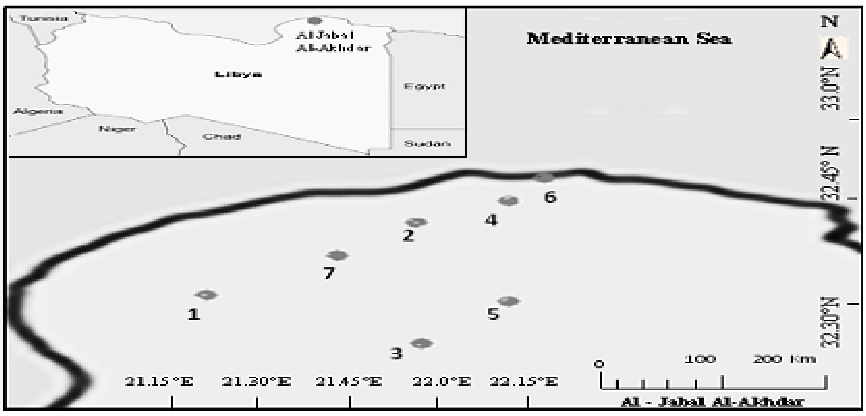


**Fig. 1. Location map indicating the study area.**

**TABLE 2. Annual averages of maximum, minimum, mean temperature, total rainfall, relative humidity and wind velocity of Shahat, Al-Marj and Libyan Meteorological Department,Tripoli within Al-Jabal Al-Akhdar areaduring (2015-2016).**

| Site | Temperature °C | | | Total rainfall mm $yr^{-1}$ | Relative humidity % | Wind velocity km/hr |
|---|---|---|---|---|---|---|
| | Max. | Min. | Mean. | | | |
| 1-Al-Marj-Al-Baida motorway | 10.7 | 34.1 | 22.4 | 379 | 65 | 68 |
| 2-El-Beida (Belghra) | 12 | 28.8 | 20.4 | 567 | 68 | 72 |
| 3-Jardas Jerrari | 7 | 19 | 13 | 285.3 | 52 | 70 |
| Shahat | 8.1 | 28.1 | 18.1 | 527 | 53 | 55 |
| Sidi Ahmad Al-Hemery | 8 | 20 | 14 | 578 | 50 | 73 |
| Susah | 10.7 | 23.5 | 17.1 | 341.4 | 73 | 42 |
| Wadi El-Kouf | 10.2 | 25.1 | 17.65 | 413.8 | 55 | 70 |

*Climate*:

The climatic data were obtained from some stations, chosen to match with the seven studies wadis (Table 2). The distinctive features of the climate of the study area are a concentration of rainfall during cool winter season and a very marked summer drought.The lowest mean minimum air temperature was in Jardas Jerrari and Sidi Ahmad Al-Hemery sites(13°C and 14°C, respectively), while the highest was in Al-Marj-Al-Baida motorway site (22.4°C). The relative humidity values ranged between 50% in Sidi Ahmad Al-Hemery sites and 73% in Susah study site. The total rainfall varied values between 285.3 mm $yr^{-1}$and 578 mm $yr^{-1}$ in Jardas Jerrari and Sidi Ahmad Al-Hemery,respectively.

*Data collection:*

Sixty three (10m×10m) were selected at the seven wadis in Al-Jabal Al-Akhdar at the three different levels (21 in downstream, midstream and upstream). In each quadrates, the species list, the number of individuals and visual cover (%) of each species were recorded.Voucher specimens of the recorded species were deposited in the herbaria of Faculty of Science, Ain Shams University, (Egypt)and Faculty of Science, Omar Al-Mokhtar University, (Libya). Identification andnomenclature were according to Ali and Jafri (1976); Jafri and El-Gadi (1977 –1993) and Boulos (1977, 1995, 1999, 2005 and 2009). Life forms of the recorded species were identified following the system of Raunkier (1934). In each site, the number of the target twelve individual was counted, and the height (H) and mean crown diameter (Dbased on 2-4 diameter measurements / ind.). The size index of each individual was calculated as the mean of its height and diameter [(H+D)/2]. The size estimateswere then used to classify population into seven size classes. The size classes (m ind$^{-1}$.) are (**1**=0<1, **2**=1.1-2, **3**=2.1–3, **4**=3.1–4, **5**=4.1–5, **6**=5.1–6 and**7=** 6.1–7m ind$^{-1}$.), except for *S.herba-alba* and *T.capitatus* were by centimeter (cm ind$^{-1}$).

*Soil analysis:*

Soil samples were collected from the surface of each location, or up to the rocks or hard pans in case of shallow. In each location, one composite sample was collected from soil profiles (0 – 25cm), air dried thenphysical and chemical parameters of such soil samples were analyzed. Soil texture was determined according toGupta (2000). Soil reaction (pH) was determined in the soil paste using a Beckman bench type pH-meter (Watson and Brown,1998).Electrical conductivity (E.C) of the saturated soil extracts was determined as described by Allen *et al*, (1976) and expressed as dSm$^{-1}$. The anions ($Cl^-$, $SO_4^{2-}$, $CO_3^-$, $HCO_3^-$) and cations ($Na^+$, $K^+$, $Ca^{2+}$ and $Mg^{2+}$) of the soil extracts were analyzed following the method described by Blancher *et al*, (1965) and their values expressed as (m.eq. L$^{-1}$.).

## Results

Twelve endangeredperennial species belonging to eleven families were distributed along different elevation levels in seven studies wadis at north and south ofAl-Jabal Al-Akhdar. Cupressaceaewas represented by two species: *C.sempervirens* and *J.phoenicea*and the other families were represented only by one species (Table3). Ten species were phanerophytesand twospecies werechamaephytes (*S.herba-alba*and *T. capitatus*). The phytogeographical elements of the studied species indicated that ten of the studiesof species are Mediterranean elements represented by *C.siliqua*, *J.phoenicea*, *L.nobilis*, *O.europaea*, *P.halepensis*, *P.lentiscus*, *Q.coccifera*, *S.herba-alba*,*T.capitatus* and *Z.lotus*, while *A.pavarii* and *C.sempervirens*are endemic toAl-Jabal Al-Akhdar.

The mean height to diameter ratio, simple linear correlation coefficient (r) and size index of the twelve studies plant species in Al-Jabal Al-Akhdar region are shown in Table (4). Generally, the height to diameter ratio was more than unity for *A.pavarii*, *C.sempervirens*, *C.siliqua*, *J.phoenicea*, *L.nobilis*, *O.europaea*, *P.halepensis* and *Q.coccifera*, this means that the diameter of these species tend to expand vertically rather than horizontally, while the height to diameter ratio was less than unity for *P.lentiscus*, *S.herba-alba*,*T.capitatus* and *Z.lotus*, this means that the diameter of these species tend to expand horizontally rather than vertically.

The relationships between the individuals heights to diameters of the twelve target species were simple linear with (r) value (Pearson correlation coefficient), and ranged between 0.291 for *P.lentiscus* (lowest r value) and 0.837 for *L.nobilis* (highest r value), which recorded at north wadis (Shahat) as shown in Fig. 2.

**TABLE 3. List of the twelve endangered perennialspecies with their families, local name and uses.Abbreviation: A= Active constituent, E=Edible, F= Fuel, G= Grazing and M=medicinal.**

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| Family Name | Scientific Name | Local Name | | Uses | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | M | G | E | F | A |
| Anacardiaceae | *Pistacia lentiscus* L. | Battoum | بطوم | + | + | + | + | + |
| Asteraceae | *Seriphidium herba-alba* (Asso) Soják | Shih | شيح | + | + | + | + | + |
| Cupressaceae | *Cupressus sempervirens* L. var. horizontalis (Mill.) Gord. | Srow | سرو | + | + | - | + | + |
| | *Juniperus phoenicea* L. | Arar | عرعار | + | + | + | + | + |
| Ericaceae | *Arbutus pavarii* Pamp. | Shmary | شماري | + | + | + | + | + |
| Fabaceae | *Ceratonia siliqua* L. | Kharroub | خروب | + | + | + | + | + |
| Fagaceae | *Quercus coccifera* L. | Ballout | بلوط | + | + | + | + | + |
| Lamiaceae | *Thymus capitatus* (L.) Hoffmanns. & Link | Zaatar | زعتر | + | + | + | + | + |
| Lauraceae | *Laurus nobilis* L. | Rand | رند | + | + | + | + | + |
| Oleaceae | *Olea europaea* L. | Zaitoun | زيتون | + | + | + | + | + |
| Pinaceae | *Pinus halepensis* Miller. | Senouber | صنوبر | + | + | - | + | + |
| Rhamnaceae | *Ziziphus lotus* (L.) Lam. | Sidr | سدر | + | + | + | + | + |

**TABLE 4. Mean (±) standard deviation of some demographic variables: (H: Height, D: Diameter, $R^2$: simple linear correlation coefficient between height and diameter and size index.Note: (*) measures of *S.herba-alba* and *T.capitatus*were by centimeter (cm).**

| Species | H (m) | D (m) | H/D | $R^2$ | Size index (m) |
|---|---|---|---|---|---|
| *Arbutus pavarii* Pamp. | 2.23 ± 0.843 | 1.4 ± 0.527 | 1.65 ± 0.456 | 0.523 | 1.83 ±0.634 |
| *Ceratonia siliqua* L. | 4.1 ± 0.629 | 3.1 ± 0.651 | 1.3 ± 0.286 | 0.398 | 3.6 ± 0.584 |
| *Cupressus sempervirens* L. var. horizontalis (Mill.) Gord. | 4.4 ± 1.130 | 3.1 ± 0.662 | 1.4 ± 0.245 | 0.665 | 3.75 ± 0.866 |
| *Juniperus phoenicea*L. | 2.26 ± 1.21 | 1.9 ± 0.749 | 1.2 ± 0.354 | 0.521 | 2.13 ± 0.917 |
| *Laurus nobilis* L. | 3.6 ± 0.504 | 2.7 ± 0.491 | 1.3 ± 0.110 | 0.837 | 3.14 ± 0.488 |
| *Olea europaea* L. | 2.75 ± 0.712 | 2.26 ± 0.736 | 1.2 ± 0.341 | 0.470 | 2.6 ± 0.694 |
| *Pinus halepensis* Miller. | 4.6± 1.027 | 3.18 ± 0.609 | 1.4 ± 0.474 | 0.635 | 3.9 ± 0.781 |
| *Pistacia lentiscus* L. | 1.6 ± 0.711 | 2.1 ± 0.844 | 0.8 ± 0.481 | 0.291 | 1.9 ± 0.693 |
| *Querecus coccifera* L. | 4.4 ± 0.619 | 3.24 ± 0.482 | 1.4 ± 0.153 | 0.511 | 3.8 ± 0.574 |
| **Seriphidium herba-alba* (Asso) Soják | 28± 7.846 | 36 ± 5.465 | 0.7 ± 0.186 | 0.354 | 32 ± 9.49 |
| **Thymus capitatus* (L.) Hoffmanns. & Link | 29.7 ± 8.22 | 35.3 ± 5.79 | 0.84 ± 0.201 | 0.364 | 32.5 ± 6.52 |
| *Ziziphus lotus* (L.) Lam. | 2.3 ± 0.626 | 2.5 ± 0.897 | 1 ± 0. 292 | 0.445 | 2.4 ± 0.703 |

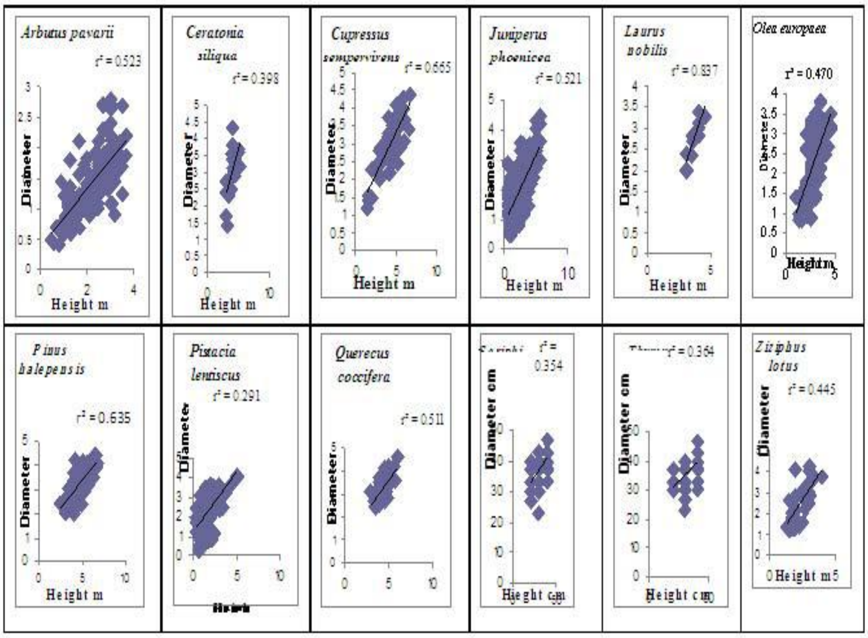



Fig. 2.Height diameter relationships for the studies endangered species in Al-Jabal Al-Akhdar region, $R^2$ = pearson correlation coefficient

The diagrams illustrating the size distribution (Fig.3) of the studied species approximate one of the following size distributions: more or less inverse J-shaped distribution, positively skewed distribution towards the small size, more or less J-shaped distribution, stationary size distribution and more or less symmetrical distribution (i.e bell shaped).

In the present study, it was found that *A. pavarii* exhibited more or less J-shaped distribution along elevation levels I (down-stream) but symmetrical distribution (bell shaped) along elevation levels II and III of wadis Al-Marj-Al-Baida motorway, El-Beida, Shahat, Sidi Ahmad Al-Hemery and Wadi El-Kouf.*Ceratoniasiliqua* exhibited more or less symmetrical distribution (bell shaped) along elevation levels I and II of wadis Al-Marj-Al-Baida motorway, El-Beida, Shahat, Susah and Wadi El-Kouf. *Juniperus phoenicea* exhibited more or less positively skewed distribution towards the young individuals in the three studied levels at wadis Al-Marj-Al-Baida motorway, El-Beida, Jardas Jerrari, Shahat, Sidi Ahmad Al-Hemery, Susah and Wadi El-Kouf.

On the other hand,both *P.lentiscus*and *C.sempervirens* exhibited more or less positively skewed distribution towards the young individuals in the three levels at wadis Al-Marj-Al-Baida motorway, El-Beida, Shahat, Sidi Ahmad Al-Hemery, Susah and Wadi El-Kouf.*Oleaeuropaea* exhibited more or less J-shaped distribution along elevation levels I (down-stream) but symmetrical distribution (bell shaped) along elevation levels II and III of wadis Al-Marj-Al-Baida motorway, El-Beida, Shahat, Susah and Wadi El-Kouf.

*Pinushalepensis* exhibited more or less symmetrical distribution (bell shaped) along elevation levels I, II and III of wadis Al-Marj-Al-Baida motorway, Shahat, Sidi Ahmad Al-Hemery, Susah and Wadi El-Kouf.*Querecuscoccifera* showed more or less inverse J-shape distribution at down-stream and mid-stream but symmetrical (bell shaped) along elevation level III of wadis Al-Marj-Al-Baida motorway, El-Beida, Shahat, Susah and Wadi El-Kouf.*Ziziphous lotus* exhibited more or less J-shaped distribution along elevation levels I (mid-stream) but symmetrical distribution (bell shaped) along elevation level III of wadis Jardas Jerrari and Susah.

*Laurus nobilis*exhibited more or less stationary size distribution (biased to large size) in the two levels of Shahat'wadis, while *S.herba-alba* and *T. capitatus* exhibited more or less positively skewed distribution towards the young individuals in the three studies levels at wadis Jardas Jerrari.

The negative skewed distribution of *C.siliqua*, *L. nobilis*,*Q.coccifera* and *P.halepensis* indicated the dominance of mature individuals over the juvenile ones. This distribution characterizes a declining population; because the population has a large proportion of larger individuals than smaller ones (*i.e.*

limited regeneration capacity). This may indicate that the recruitment of these species is restricted which may be related to hyper-aridity and low fertility

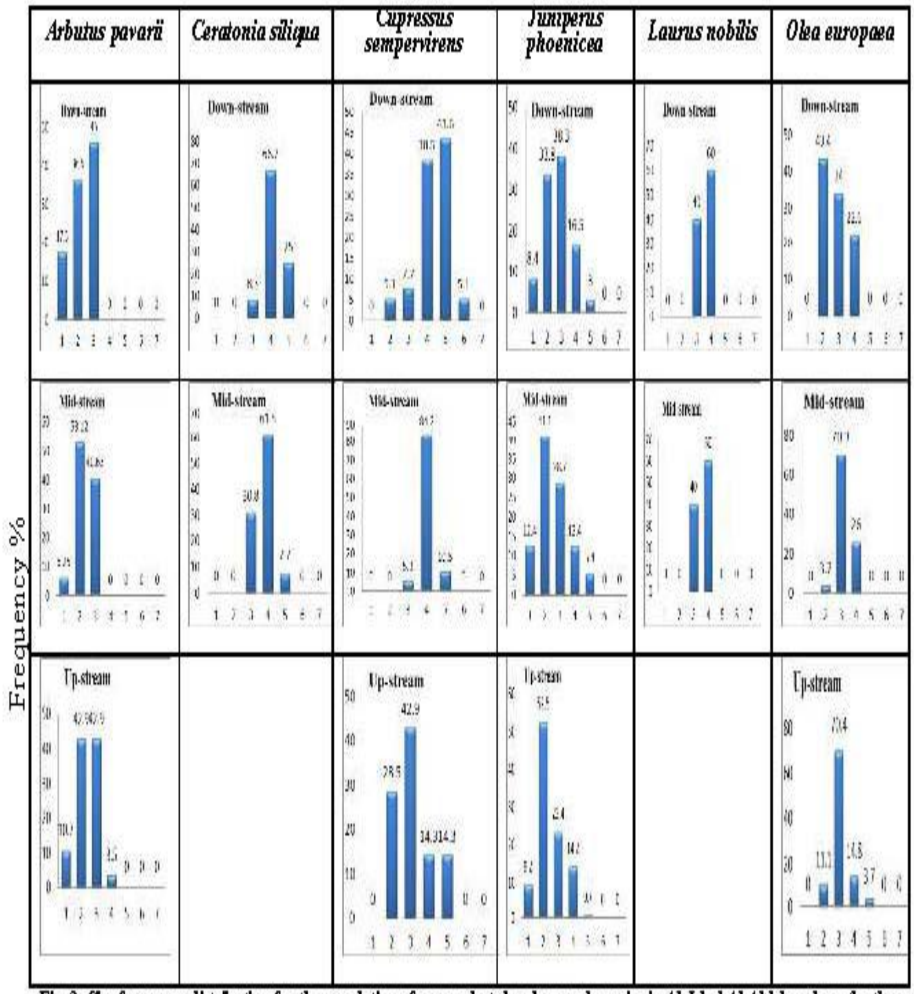
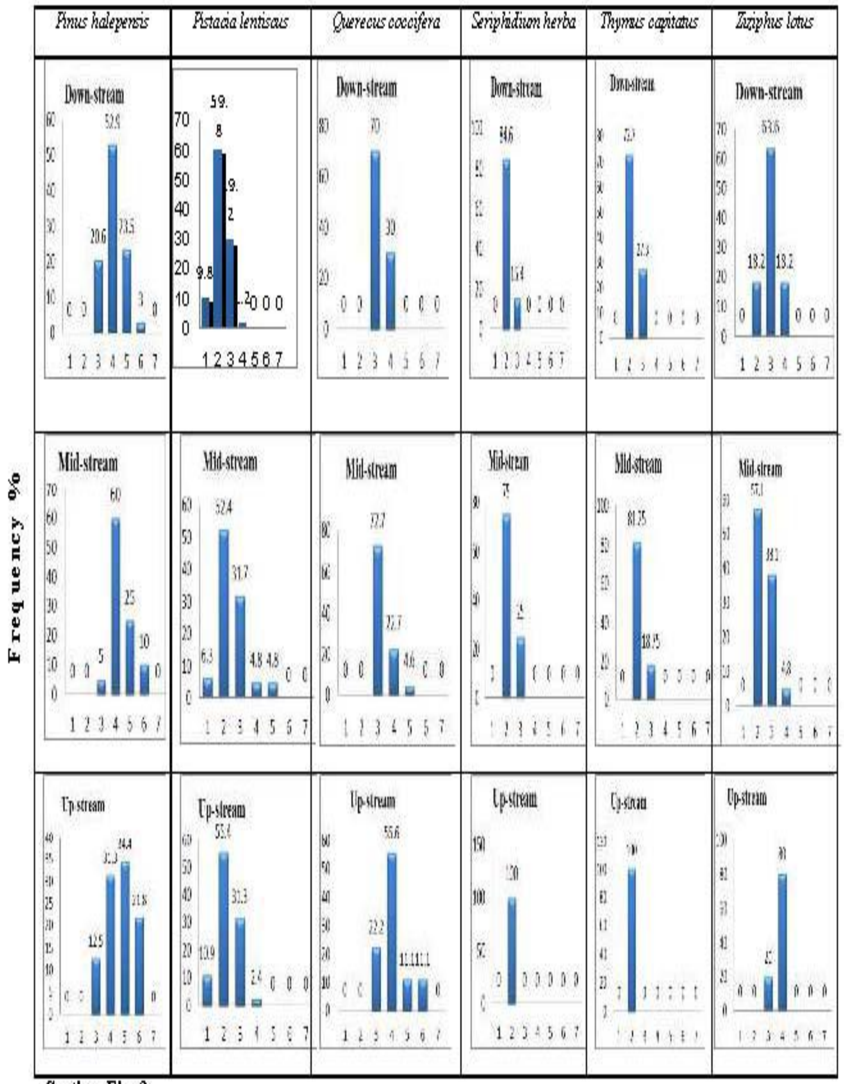



Fig. 3. Size-frequency distribution for the population of some selected endangered species in Al-Jabal Al-Akhdar along the three elevation levels. The ranges of size classes are follows: 1>1 , 2=1.1-2, 3=2.1-3 ,4=3.1-4 ,5=4.1-5, 6=5.1-6, 7=6.1-7 m.




**Continue Fig. 3.**

**Size class**

بطبع ٩٠%

Soil chemical and physical analyses in different elevation levels indicated that, at Al-Jabal Al-Akhdarwadis soils at elevation downstream were characterized by the highest values of E.C(0.304ds/m) as well as sulphates, bicarbonates, magnesium, potassium and sodium (3.23, 0.73,1, 3.6 and 0.73 m.eq.L$^{-1}$,respectively) (table 5). Soils at midstream were characterized by the lowest values of E.C (0.214 dsm$^{-1}$) as well as sulphates and sodium (1.72 and 2.58m.eq.L$^{-1}$, respectively), but the highest value was calcium (5.9 m.eqL$^{-1}$.). The highest chloride was recorded in soils of upstream level.Silt and E.C content in soil showed significant variations between three levels.

**TABLE 5. Means ± SD of the soil characteristics along downstream,midstream andupstream of the studied wadis in Al-Jabal Al-Akhdar.**

| Soil variables | Elevation levels | | | F – value |
|---|---|---|---|---|
| | Downstream | Midstream | Upstream | |
| pH | 7.8±0.37 | 7.7±0.41 | 7.7±0.32 | 0.216 |
| E.C dsm$^{-1}$ | 0.304±0.146 | 0.214±0.86 | 0.272±0.135 | 2.75* |
| Sand (%) | 22.8±5.58 | 23.75±7.02 | 22.24±8.01 | 0.252 |
| Silt (%) | 41.1±9.18 | 34.81±7.8 | 34.1±10.1 | 3.84* |
| Clay (%) | 36.1±11.82 | 41.49±12.25 | 43.7±15.11 | 1.87 |
| $CO_3^-$(m.eq. L$^{-1}$.) | 0.0±0.0 | 0.0±0.0 | 0.0±0.0 | 0.0 |
| $HCO_3^-$((m.eq. L$^{-1}$.) | 0.73±0.52 | 0.67±0.54 | 0.61±0.74 | 0.146 |
| $SO_4^-$(m.eq. L.$^{-1}$) | 3.23±5.9 | 1.72±1.77 | 3.01±4.0 | 0.552 |
| $CI^-$(m.eq. L.$^{-1}$) | 1.6±4.22 | 0.81±1.6 | 2.94±5.1 | 1.337 |
| $Ca^{+2}$ (m.eq. L.$^{-1}$) | 4.71±11.15 | 5.9±14.04 | 5.6±13.6 | 0.053 |
| $Mg^{+2}$ (m.eq. L.$^{-1}$) | 1±2.5 | 0.85±1.88 | 0.33±0.69 | 0.762 |
| $Na^+$ (m.eq. L.$^{-1}$) | 3.6±6.89 | 2.58±4.56 | 3.42±6.52 | 0.161 |
| $K^+$ (m.eq. L.$^{-1}$) | 0.73±1.19 | 0.54±0.68 | 0.69±0.89 | 0.237 |

significant at P= 0.05

## Discussion

Many shrubs and trees of the arid regions are of structural and economic importance (Crisp and Lange, 1976). They play an important role in soil protection and stabilization against ersion by wind or water, provide a source of forage for animals and fuel for local inhabitants (Thalen, 1979).All the phanerophytes found in the Al-Jabal Al-Akhdarsite were shrubs or facultative shrubs, more precisely, nanophanerophytes which are ¼m to 6 m tall. These species have the capability to survive the extremely dry soils with a wide range of salinity gradients (Zahran and Willis, 1992; Shaltout *et al*, 2003; El-Bana and Al-Mathnani, 2009). Al-Jabal Al-Akhdar wadis were markedly Mediterranean in floristiccomposition and characterized by phanerophytes forming fragmented patches of *C. sempervirens*,*J. phoenicea*, *O. europaea*, *Q. coccifera*, *C. siliqua* and *P. halepensis*. This includes *J. phoenice* which is considered as one of the threatened trees in the Mediterranean Basin (El-Bana *et al*., 2010).

The geographical elements of Libyan flora are dominated by the chorotypes of Mediterranean Sea and the Sahara Desert. The floristic elements and distribution characteristics also indicated that the climate and environmental conditions, ecological amplitude and adaptive capacity of the plants are influenced by the floristic origin and spatial patterns of plant diversity. Plant community patterns can be a functional tool for ecological restoration. Therefore, native species should be used for cultivation and regional vegetation should be used during the process of ecological recovery and rehabilitation.

The height and stem diameter of the studied individual species of different taxa are particularly important because they revealed the maximum size attained by functionally different species groups, which are crucial to a variety of ecological and evolutionary hypotheses (Niklas *et al*., 2006).

The relationship between tree height and trunk diameter has been of interest ever since McMahon's (1973) off-cited study of the proportions of trees in relation to the limits imposed by mechanical support requirements. The extent to which trees approach these limits affects the cost in biomass of reaching a given position in the forest canopy and hence is of broad significance (Givnish, 1995; Aiba and Nakashizuka, 2007).

The height-to-diameter ratio gives an idea about the growth habit of the plant, variation in this ratio is lengthy a result of spacing (Wonn and O'Hara, 2001), under hyper-arid condition. This ratio is less than unity for many species (*i.e*., the plant tends to expand horizontally rather than vertically. In thisstudy,*P. lentiscus*, *S. herba-alba*, *T. capitatus* and *Z. lotus*exhibited the above behavior in this growth. This behavior may be a strategy of the desert trees and shrubs in order to provide safe sites for their self-regeneration, as the horizontal expansion usually provides shade which leads to decrease the severe heating effect and increase the soil moisture (Shaltout and Mady, 1993).

On the other hand, the height to diameter ratio in some species was exceed unity such as *A. pavarii*, *C. sempervirens*, *C. siliqua*, *J. phoenicea*, *L. nobilis*, *O. europaea*, *P. halepensis* and *Q. coccifera*, which means that their individuals tends to expand vertically rather than horizontally and this may be attributed to the high density or consequently high intra-specific competition of these plants (Galal, 2011 and Mosallam *et al*., 2013).

The distribution of plant species along elevation gradients is governed by a series of interacting biological, environmental and historical factors (Colwell and Lees, 2000). In this context,*C. siliqua* and *L. nobilis* were exclusively recorded along the downstream and midstream of the studied wadis, which characterized by high values of E.C,calcium, sulphates, bicarbonates, magnesium, potassium and sodium. Also,*A. pavarii*, *P. halepensis, Q. coccifera, J. phoenicea, O. europaea, P. lentiscus, Z. lotus, T. capitatus, C. sempervirens* and *S. herba-alba* were exclusively represented along the three levels. (Stated that species with limited elevation range always replace each other with some overlap along the mountainside). Moreover, the higher number of species in the lower elevation may be attributed to that low elevation may receiver larger amount of runoff water than higher ones. Other climatic and abiotic factors vary along mountain gradients but have a more complex relationship to elevation. The best example, and probably most important of such a factor is precipitation (Gritti *et al*., 2006; Hegazy *et al*., 2008 and 2016).

The obtained results showed that density histograms of size distributions are good indicators of future trends in population number for the studied species especially for *J. phoenicea* and *A. pavarii*. Most of the studied species showed a "reverse-J" size structure, which is usually taken as an indicator of self-replacing populations. The size structures are ultimately formed by realized growth and mortality rates (Wright *et al*., 2003; Kabiel *et al*., 2016 a,b), and species with similar initial size structure can follow very distinct trajectories over time due to differences in vital rates. The negative skewed distribution of *C. siliqua*, *L. nobilis,Q. coccifera* and *P. halepensis* indicated the dominance of mature individuals over the juvenile ones. This distribution characterizes a declining population; because the population has a large proportion of larger individuals than smaller ones (i.e. limited regeneration capacity). This may indicate that the recruitment of these species is rare which may be related to hyper-aridity and low fertility (Shaltout *et al*., 2014 and 2015).The size and age of some plant life forms (notably trees) may be correlated in a general way, but unless there is evidence on this point, the interpretation of size as age may lead to simplistic or even inaccurate conclusions (White and Harper, 1970; Caswell, 1986).

Smaller trees were significantly more likely to die than larger trees within the young stands. Tree-diameter distributions within young stands were left skewed but those of older populations were normally distributed. These observations are consistent with asymmetric competition winnowing out small, suppressed trees from young stands, but having less effect in older stands, coincided with the results of Mosallam *et al* (2013).

## Conclusion

The present study makes an assessment for twelve endangered with two endemic species in seven wadis at Al-Jabal Al-Akhdar northeast Libya, the results showed that histograms of size distributions are not good indicators of future trends in population number for some studied species such as *A. pavarii, C. sempervirens, C. siliqua, L. nobilis, Q. coccifera* and *P. halepensis*soit is hope that this study helping us in planning for conservation of these plants, increase protection for the limited capacity regeneration species.

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## التوزيع الحجمى و ديناميكية بعضالأنواع النباتية المهددة بالإنقراض، الجبل الأخضر- ليبيا.

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تمتلك منطقة الجبل الأخضر العديد من المناظر الطبيعية وأعلي تنوع نباتي في البلاد.تهدف الدراسة الحالية الى متابعة التوزيع الحجمي و العددي لبعضالأنواع النباتية المهددة بالإنقراض على ثلاثة ارتفاعات مختلفة بسبعة وديان فى الجبل الأخضر. تم تجميع نبات الشماري (*Arbutus pavarii*)، السرو( *Cupressus sempervirens*)، الخروب (*Ceratonia siliqua*)، العرعار( *Juniperus phoenicea*)، الرند (*Laurus nobilis*)،الزيتون(*Olea europaea*)، الصنوبر (*Pinus halepensis* )، بطوم (*Pistacia lentiscus*)، البلوط(*Querecus coccifera*)، الشيح (*Seriphidium herba-alba*) ، زعتر(*Thymus capitatus*) والسدر (*Ziziphous lotus*). تمتقييم التركيبة السكانية للانواع المهددة بالإنقراضفيتو زيعحجمي علىطولمستوياتارتفاعاتمختلفة (أسفلمجرى، منتصف الطريق و أعلي الجبل) فيسبعة أودية فيمنطقة الجبلا لأخضر. وتم قياس الأرتفاع (H) والقطر (D)لعدد من الافراد لكل الانواع.وكانالأرتفاعإلىنسبةالقطرأكثرفي (الشماري *Arbutus pavarii*، سرو*Cupressus sempervirens* ، خروب*Ceratonia siliqua* ، عرع رفينيقي *Juniperus phoenicea*،الرند *Laurus nobilis* ، الزيتون *Olea europaea* ،صنوبرحلبي*Pinus halepensis* و البلوط *Querecus coccifera*) وهذايعنيأنقطر هذهالأنواعتميلإلىالتوسععموديابدلامنأفقيا،فيحينكانالأرتفاعإلىنسبةقطر هاأقل في البطوم*Pistacia lentiscus*، الشيح *Seriphidium herba-alba*، الزعتر *Thymus capitatus* و السدر*Ziziphus lotus* ، وهذا يعني أنقطرهذ هالأنواعتميلإ لىالتوسيعأ فقيابد لامنعموديا.

وقد استنتجت الدراسة الحالية أن هناك خمسة انماط نمو للتوزيع الحجمى لهذه النباتات التي تنمو باودية الجبل الأخضر. واعطت النتائج مؤشرات سلبية عن التوزيع الحجمى و العددى لبعض هذه النباتات مثل الخروب ( *Ceratonia siliqua*)، الرند (*Laurus nobilis*)، البلوط (*Querecus coccifera*) و الصنوبر (*Pinus halepensis*) حيث تزيد اعداد افرادها الناضجة ذات الحجم الكبير عن افرادها ذات الحجم الصغير.