

floristic composition, Chorological and Flowering phenology of geophytes in Al-Jabal Al-Akhda Regoins, North Libya

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التركيب الفلوري، والتوزيع الجغرافي وفينولوجيا الإزهار للنباتات الأرضية المختزنة في مناطق الجبل الأخضر، شمال ليبيا.

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Abstract:

Geophytes represent an important component of Mediterranean vegetation due to their ecological adaptations and underground storage organs that allow them to survive unfavorable environmental conditions. This study investigates the floristic composition, life-forms, chorotype, flowering phenology and flower colour of geophytes in Al-Jabal Al-Akhdar (Green Mountain) northeastern Libya. Field surveys were carried out across different elevation zones to evaluate species diversity and ecological distribution patterns. A total of 69 species belonging to 12 families were recorded. The geophytes were representing by different underground organs including blubs, rhizomes, tubers and corms. The results showed that species richness varied along the elevation gradient with the mid-elevation zone (301-600 m) exhibiting higher diversity compared with lower (0-300 m) and higher elevations (601-800 m). Chorological analysis indicated the predominance of Mediterranean elements in the flora. Flowering phenology revealed that most species flower during winter and spring which corresponds with favorable climatic conditions in the white, yellow, pink and purple being the most common. Among the recorded species *Urginea maritima* was one of the most common and widely distributed geophytes in several habitats of the study area. The results highlight the ecological importance and diversity of geophytes in Al-Jabal Al-Akhdar and provide baseline information for future botanical and ecological studies in the region.

Keywords: floristic composition, Geophytes, Chorotype, Flowering phenology, Al-Jabal Al-Akhdar.

الملخص:

تمثل النباتات الأرضية أحد المكونات المهمة للغطاء النباتي في إقليم البحر المتوسط وذلك بسبب تكيفها البيئي وامتلاكها أعضاء تخزين أرضية تساعدها على البقاء خلال الظروف البيئية غير الملائمة. وتهدف هذه الدراسة الى تحليل التركيب الفلوري وانماط اشكال الحياة واصول الجغرافية النباتية اضافة الى مواعيد التزهير وألوان الأزهار لنباتات الأرضية في منطقة الجبل الأخضر شمال شرق ليبيا. اجريت الدراسة الميدانية في عدة مواقع تمقل مستويات مختلفة لدراسة تنوع الانواع وتوزيعها البيئي. حصرت النتائج عن تسجيل 69 نوعا نباتيا ضمن 12 عائلة وتمثلت النباتات الأرضية في عدة اشكال من

الأعضاء الأرضية مثل الأبال، الريزومات، الدرناات والكرومات. كما أظهرت النتائج أن مستوى الارتفاع المتوسط (301-600م) يتميز بأعلى تنوع في الأنواع مقارنة بالمستويين المنخفض (0-300م) والمرتفع (601-800م). أوضحت دراسة أصول الجغرافية النباتية سيادة العناصر المتوسطة في الفلورا. كما بينت نتائج مواعيد التزهير أن معظم الأنواع تزهر خلال فصلي شتاء والربيع وبينما تنوعت ألوان الأزهار بين الأبيض والأصفر والوردي والبنفسجي ومن بين الأنواع المسجلة برز النوع العنصل الفرعوني كأحد أكثر النباتات الأرضية انتشاراً في عدة مواطن ضمن الدراسة. تؤكد هذه النتائج الأهمية البيئية وتنوع النباتات الأرضية في الجبل الأخضر، كما توفر معلومات أساسية للدراسات النباتية والبيئية المستقبلية في المنطقة.

الكلمات المفتاحية: التركيب الفلوري، النباتات الأرضية، التوزيع الجغرافي، التغييرات التزهير، الجبل الأخضر.

Introduction:

The word geophyte is used to describe all underground storage organs, structures that allow plants to survive unfavorable weather conditions (heat or cold) or to allow plants to flower at times where resources, like water, warmth, or sun, are not highly abundant, if at all. However, the word geophyte was created as part of a plant classification system based on the location of dormant buds in relation to growth habit and location relative to the ground (i.e., above or below the soil level or water), [1] and [2].

Al-Jabal Al-Akhdar region in northeastern Libya represents one of the most important Mediterranean biodiversity host spots in North Africa. owing to its relatively high rainfall, altitudinal variation and heterogeneous substrates, the region harbors a remarkable floristic diversity compared to the surrounding arid landscape [3] and [4]. Its semi-Mediterranean climate and complex topography create suitable ecological niches for various life-forms particularly geophytes. [5], [6], [7], [8], [9] and [10].

Geophytes are perennial plants that survive unfavorable seasons through underground storage organs such as bulbs, rhizomes, tubers or corms. This adaptive strategy enables them to withstand prolonged summer drought and grazing pressure, making them a significant ecological component of Mediterranean– type ecosystem [11], [12], [13] and [14]. In semi-arid environments, geophytes often contribute substantially to seasonal plant cover, especially during spring [15]. From a phytogeographical perspective, geophytes play an essential role in understanding chorological pattern and floristic affinities. Inflorescences may be produced before, during or at the end of the vegetative growing season, a phenology that is constant for most species. Biogeographically, geophytes are widespread around the world in many habitats, but nowhere are they more diverse and abundant than in the five Mediterranean-climate ecosystems of the world [16] and [17].

Mediterranean climates are well known for their remarkable plant diversity [18], and the high numbers of geophytes they harbour have long been noted [19]. The Mediterranean basin is considered a global center of geophytic diversity, where many taxa exhibit distinct chorotypes reflecting historical biogeographical processes. Investigating chorological composition helps clarify the relative contribution of Mediterranean, Saharo-Arabian, Irano-Turanian and endemic elements within regional floras [20] [21], [22], and [23]. The geophyte floras of some of these regions have been the subject of taxonomic and ecological reviews (e.g. south-western Australia: [24], [25]; California: [26; Chile: [27].

Despite the ecological importance of Al-Jabal Al-Akhdar detailed quantitative studies focusing specifically on geophytes remain limited. Previous floristic surveys have addressed general vegetation composition, however targeted assessments of geophytes diversity, life-form spectrum and chorological structure are still lacking. such studies are essential for understanding vegetation dynamics biodiversity conservation priorities and ecological responses to climatic variability [28], [29] and [30]. They resprout new foliage in the following growing season. Inflorescences may be produced before, during or at the end of the vegetative growing season, a phenology that is constant for most species. Biogeographically, geophytes are widespread around the world in many habitats, but nowhere are they more diverse and abundant than in the five Mediterranean-climate ecosystems of the world [16] and [26].

Therefore, the present study aims to (1) analyze the floristic composition of geophytes in Al-Jabal Al-Akhdar, (2) evaluate their life-form spectrum according to Raunkiaers classification, and (3) determine their chorological affinities. (4) Assessment of geophytes diversity indicators in different sites. (5) to record the flowering periods and flower colors for each geophytes species. The findings are expected to contribute to regional biodiversity knowledge and provide a scientific basis for conservation planning in northeastern Libya.

Materials and Methods:

Study sites: The Green Mountain is located in northeastern Libya, and the field was studied in 2024-2025, and 10 different sites were selected according to their difference from sea level. As shown by the table (1) and the site map Figure (1), we divided the ten sites into three groups based on elevation: Site

1 represents (0-300 m), Site 2 (301-600 m), and Site 3(601-800 m). In each of the ten sites, five squares were established, each with an area of 5x5 m², and the geophytes were collected and identified.

The Floristic Analysis: It is known that the life forms of geophytes plants appear in the form of bulbs, corms, tubers, and rhizomes buried beneath the soil surface, and they are identified according to the Libyan flora [31] and [32], The floristic categories of the investigated species were made to assign the registered species to world geographical groups according to [33] and [34]. Furthermore, All the plants species were classified on the basis of life forms as defined by [8]. Data was collected on flowering times and flower color from Libyan flora [35].

Climate: The Green Mountain has a Mediterranean climate, with dry and hot conditions from May to September and cold and rainy conditions in winter from December to March. The average annual rainfall reaches approximately 550 mm, with the highest amounts in December and January and the lowest in March. The average annual temperature reaches about 16°C, with the lowest average in February and the highest in June. The prevailing winds are northwesterly and north in winter and southerly and southwesterly in summer [36] and [37].

Table (1): Location and elevation of study sites.

Level	Sites	Location	Elevation m.s.a.l	Aspect	
Low 0-300 m	S1	El-Ghareeb	N 32° 35' 23.7" E 21° 06' 7.7"	233	Northern
	S4	Shahat	N 32° 53' 1.5" E 21° 55' 9.3"	204	Northern
	S5	Susa	N 32° 54' 17.0" E 22° 01' 9.1"	15	Northern
Mid 301-600 m	S2	Qasr Libya	N 32° 36' 10.2" E 21° 21' 7.5"	425	Northern
	S3	Wadi El-Kouf	N 32° 40' 55.2" E 21° 32' 2.2"	339	Northern
	S8	Taknis	N 32° 26' 59.5" E 21° 06' 19.5"	448	Southern
	S9	Wadi El-Akar	N 32° 29' 55.0" E 20° 43' 41.7"	317	Northern
High 601-800 m	S6	Slonta	N 32° 34' 18.9" E 21° 39' 2.4"	761	Southern
	S7	Gandula	N 32° 29' 55.0" E 20° 43' 1.7"	686	Southern
	S10	Labrag	N 32° 47' 29.3" E 22° 05' 9.3"	673	Northern

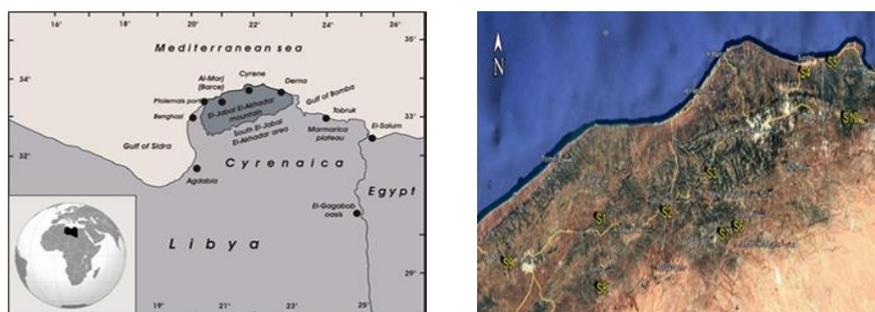


Figure (1): Map of the study sites.

Results and Discussion:

In this study the total of 69 species of geophytes were recorded in 50 stands, 10.15% of these being endemic (Appendix 1). The species belonged to 12 families and 33 genera. The great majority (95.65% of the species) were monocots, and most of these (8.69%) were concentrated in the largest monocot family, Liliaceae (16 sp). The largest six families were the Orchidaceae (12 sp), Cyperaceae (10 sp), Alliaceae (11 sp), Iridaceae (8 sp), and Amaryllidaceae (3 sp), all other families included less than 3 geophytic species. The largest genus was Allium (11 sp), followed by Carex (5 sp), Orchis (5 sp), Ophrys (5 sp), and for each of Romulea and Asphodelus (3 sp). Table (2), (3) and (4). Figure (2), (3) and (4) and this agrees with previous studies that focused on surveying the vegetation in the Al-Jabal Al-Akhdar areas [38], [39], [40], [41], [42], [43], [44], [45], [46] and [47].

Monocotyledonous geophytes formed the dominant component of the flora, reflecting their ecological adaptation to the Mediterranean climate to the region. Monocot families, which include species with bulbs. Corms and rhizomes are well adapted to survive the dry summer period by remaining dormant underground. this ability enables them to complete their cycle during the favorable wet season and maintain their populations over time. Dicotyledonous geophytes, although represented by fewer families, still contributed significantly to the overall diversity of the area. Many dicot geophytes possess tubers or rhizomes, allowing them to persist under similar environmental conditions [48]. And adds to the ecological complexity of the mid elevation flora. The higher number of monocot families compared to dicot families aligns with patterns observed in Mediterranean ecosystems where geophytes flora is generally dominated by monocotyledons. Overall the study highlights the ecological

and floristic importance of geophytes in Al-Jabal Al-Akhdar, whit monocots playing a major role in maintaining the species richness and adaptive resilience of the plant community [49] and [50].

Table (2): of plant groups in all the study sites

Taxa	Families	Genera	Species
Monocotyledonous	8	25	60
Dicotyledoneae	4	8	9
Total	12	33	69

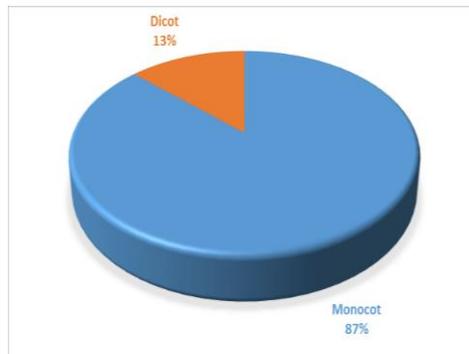


Figure (2): percentage Monocot and Dicot of geophytes according to Species.

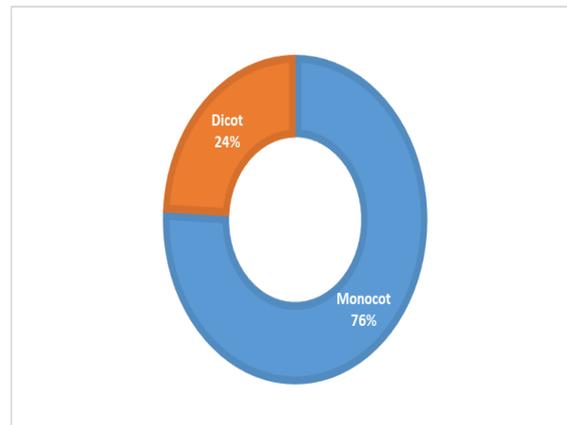


Figure (3): percentage Monocot and Dicot of geophytes according to Genera.

Table (3): The comparison of Genera and the number of species at the study area

Families	Number of Genera	%	Number of species	%
Liliaceae	9	27,28	16	23,2
Orchidaceae	4	12,21	12	17,4
Cyperaceae	4	12,21	10	14,5
Alliaceae	1	3,03	11	16,0
Poaceae	1	3,03	1	1,45
Iridaceae	4	12,21	8	11,6
Amaryllidaceae	2	6,06	3	4,35
Asteraceae	3	9,10	3	4,35
Araceae	2	6,06	2	2,90
Oxalidaceae	1	3,03	1	1,45
Onagraceae	1	3,03	1	1,45
Primulaceae	1	3,03	1	1,45
Total	33	100	69	100

Table (4): The distribution of genera at the study area

Genera	Species per genera		Genera	Species per genera	
	Numbers	%		Numbers	%
Allium	11	33,33	Panocratium	1	3,03
Carex	5	15,16	Arisarum	1	3,03
Orchis	5	15,16	Arum	1	3,03
Ophrys	5	15,16	Scorzonera	1	3,03
Romulea	3	9,1	Otanthus	1	3,03
Asphodelus	3	9,1	Cicerbita	1	3,03
Bellevalia	2	6,07	Scilla	1	3,03
Gagea	2	6,07	Eleocharis	1	3,03
Scirpus	2	6,07	Crocus	1	3,03
Narcissus	2	6,07	Epilobium	1	3,03
Cyperus	2	6,07	Cyclamen	1	3,03
Gladiolus	2	6,07	Oxalis	1	3,03
Iris	2	6,07	Smilax	1	3,03
Urginea	2	6,07	Asparagus	1	3,03
Androcymbium	1	3,03	Neotinea	1	3,03
Poa	1	3,03	Barlia	1	3,03
Ornithogalum	1	3,03	Colchicum	1	3,03

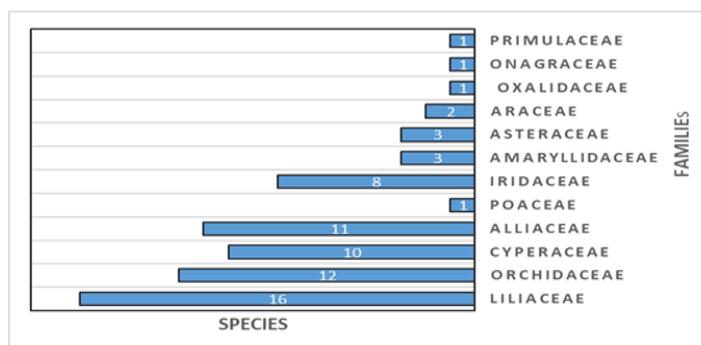


Figure (4): The distribution of species of geophytes according to families

The results showed that when analyzing life forms according to Raunkiaer for geophytes plants in the study areas, that it is seen that mostly bulbous taxa has been found with the rate of 45 % (31 sp), Rhizome of 23% (16 sp), Tuber of 20 % (14 sp) and the least corm of 21% (8 sp). Figure (5), (6) and (7) Similar patterns were found by [27] and [51] for the geophyte flora of Chile. The present study revealed clear variation in the types of underground storage organs among geophytes recorded in al Jabal Al-Akhdar. Bulbous species represented the dominant group, followed by rhizomatous plants, while tuberous and corms species were comparatively less frequent. The predominance of bulbous geophytes may be related to their high ecological adaptability to Mediterranean climatic conditions, particularly the seasonal rainfall and the prolonged dry summer period. Bulbs enable plants to store nutrients and water underground. Allowing them to survive unfavorable environmental conditions and resume growth rapidly during the wet season. Rhizomatous species also formed an important component of the geophytic flora in the study area. Rhizomes allow plants to spread vegetative and occupy larger areas, which may increase their ecological success in habitats with relatively favorable soil moisture conditions. In contrast, tuberous and corms species showed lower representation, possibly due to their more specific ecological requirements and narrower distribution within the study region [52]. These difference in underground storages organs reflect the various adaptive strategies developed by geophytes to cope with the environmental conditions of Al-Jabal Al-Akhdar. Similar patterns have been reported in other Mediterranean ecosystems where geophytes represent an important component of the flora due to their ability to withstand seasonal climatic stress [53] and [54].

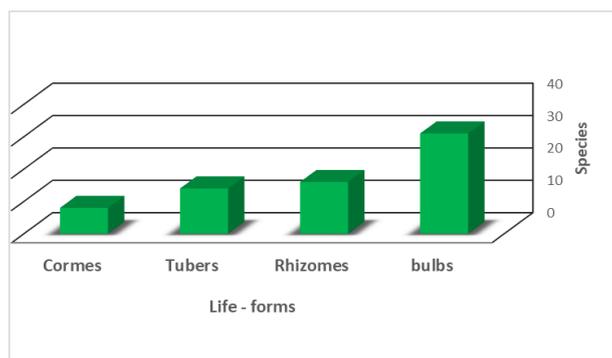


Figure (5): The distribution of geophytes according to underground types.

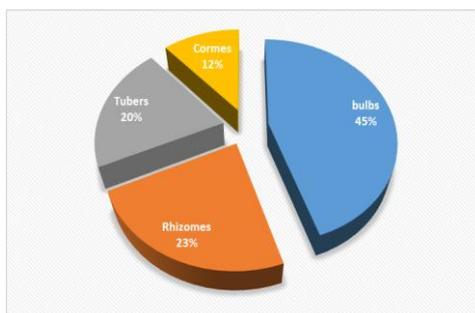


Figure (6): shows the percentage of life forms in the study area.

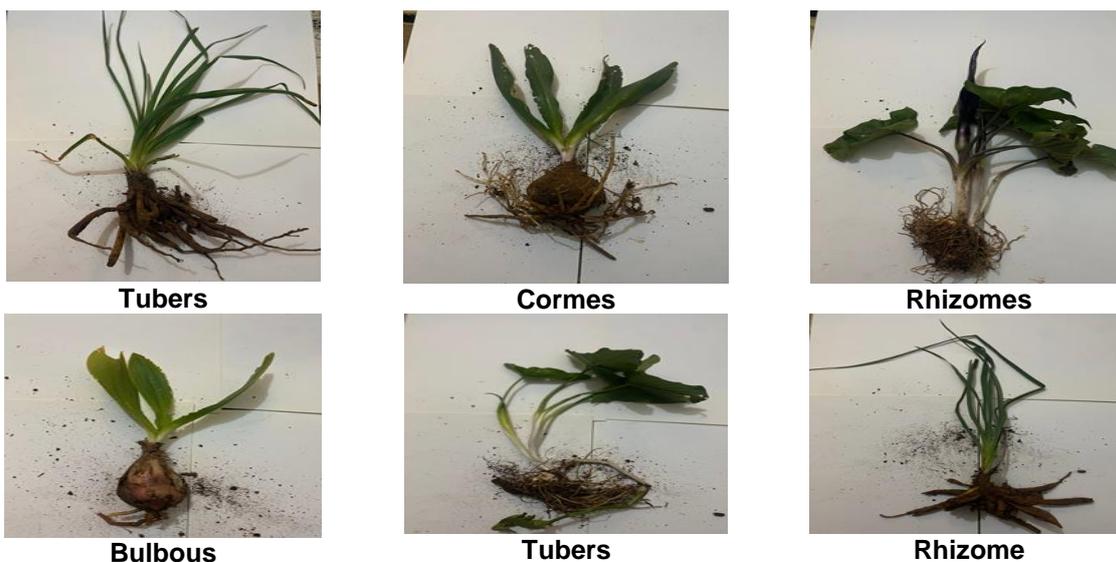


Figure (7): Types of life-forms of geophytes in the study area.

The species of geophytes distribution survey by altitude indicated that the number of plant species increased as the altitude increased, except for the region between 300 and 600 m a.s.l that showed a lower number of plants than in the other survey areas at higher altitudes. The present study has demonstrated [53] that a large number of the species are concentrated in mid altitude (301--600 m a.s.l) areas. But at higher altitudes above 601-800 m a.s.l, the number of the species tends to decline Table (5), Figure (8) and (9). An accurate trend of distribution in terms of species richness by altitude has yet to be demonstrated due to a variety of environmental elements in each region. Previous studies on the richness of species by altitude have reported that the higher the altitude, the lower the number of species [55] [56], [57] and [58]. at mid-altitudes may be the most important factors for peak species richness of plants in this region. In regard to climatic factors, mainly temperature and rainfall, temperature decreases with increasing altitude while rainfall increases non linearly with altitude in the semi-arid and hence produce a double complex gradient and affect the abundance and diversity of species along the mid altitudinal gradient [28], [59], [60] and [61].

Table (5): Showing the Number Species of geophytes at each elevation levels.

Family	Low	Mid	High
Liliaceae	8	12	7
Orchidaceae	7	10	5
Cyperaceae	7	9	6
Alliaceae	5	9	6
Poaceae	1	1	1
Iridaceae	5	7	5
Amaryllidaceae	3	3	2
Asteraceae	2	3	3
Araceae	2	2	2
Oxalidaceae	1	1	1
Onagraceae	1	1	0
Primulaceae	1	1	0
Total	43	59	38

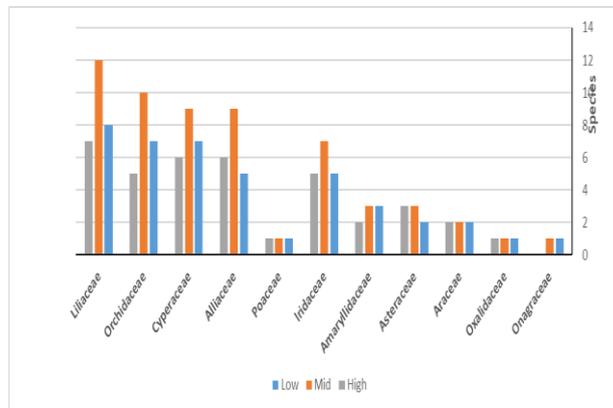


Figure (8): The distribution of species of families of geophytes according to Difference Altitude.

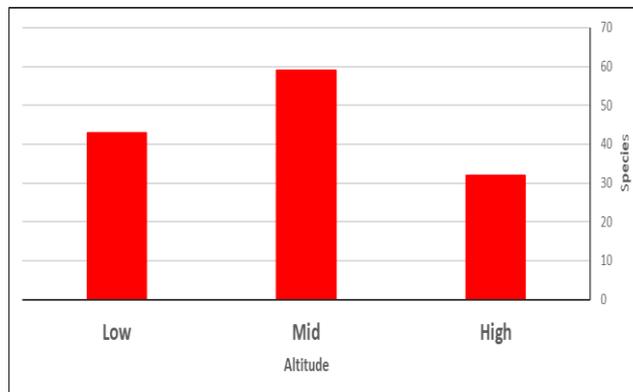


Figure (9): shown Number of species of geophytes according to Difference Altitude.

Results of the total chorological analysis of the surveyed geophytes presented in (Figure 9), which revealed that 69 species of the total recorded species were mono-regional in being native to Mediterranean chorotype (43 species) and Euro-Siberian chorotype (3 species). the recorded species were Bi-regional (10 species) in being native to Mediterranean + Euro-Siberian (4 species), Mediterranean + Irano-Turanian (5 species), the recorded species were Pluri-regional Mediterranean + Irano-Turanian + Euro-Siberian regions (2 species.), and cosmopolitan elements, (3 species). Table (6) Figure (10). From a phytogeographical point of view, the recorded species may be classified as mono-regional, bi-regional or Plural-regional species. Of the total 69 species, 46 species (67%) were mono-regional species, 10 species (15%) were bi-regional species and 11 species (3%) were Plural-regional species. Results showed the highest of the species of the study area belonged to Mediterranean region. seem to be dominant in all the studied sites and showed an increasing trend with altitude. Fig (11) These results are in the agreement of the other [34], [62], [63], [64], [65], [66] and [67].

The chorological analysis of the recorded geophytes species in Al-AJabal Al-Akhdar revealed the dominance of the Mediterranean chorotype. This dominance can be attributed to the Mediterranean climatic conditions prevailing in the region, which are characterized by mild and wet winters and hot dry summer. such climatic conditions favor the growth of geophytes, which survive unfavorable seasons though underground storage organs such as bulb, rhizomes, tubers and corms. In addition to the Mediterranean elements several species belong to other chorotypes such as Mediterranean-European and Mediterranean-Irano-Turanian elements. The presence of these chorotypes reflects the transitional geographical position of Libya between different floristic regions, allowing the coexistence of species with different phytogeographical affinities. A smaller proportion of the recorded species showed wider distribution patterns such as pluri-regional or cosmopolitan elements. These species generally possess a high ecological tolerance that enable them to adapt to a wide range of environmental conditions.

The predominance of Mediterranean chorotype among the geophytes is consistent with previous floristic studies conducted in North Africa and other Mediterranean regions. This pattern highlights the strong relationship between geophyte diversity and Mediterranean environmental conditions, Furthermore the chorological composition observed in the study emphasizes the phytogeographical importance of Al-Jabal Al-Akhdar as one of the most botanically diverse regions in Libya These results are consistent with the studies of [68], [69], [70], [71], [72] and [73].

Table (6): The number of the recorded taxa belonging to the main floristic categories and their relevant percentages (%) in Jabal Al-Akhdar. Cosmopolitan (COSM), Euro-Siberian (ES), Irano-Turanian (IT), Mediterranean (Med), Paleotropical (PAL), Saharo-Arabian (SA), Tropic (Trop) and Endemic (End).

Chorotype	Number of species	percentage (%)
Mono-regional		
Med	43	53.33%
Euro	03	4.45%
Subtotal	46	66.67%
Bi-regional		
Med / Ir-Tu	05	7.78%
Med / Eu-Si	04	6.67%
Eu-Si / Trop	01	2.23%
Subtota	10	14.50%
Pluri-regional		
Med /Ir-Tu/Eu-Si	02	6.67%
Subtotal	02	2.89%
COSM	03	27.27%
PAL	01	9.10%
End	07	63.70%
Subtotal	11	15.95%
Total	69	100%

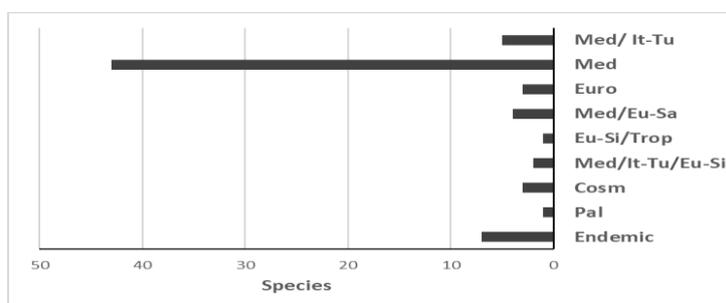


Figure (10): Shows of Chorotype of Geophytes.

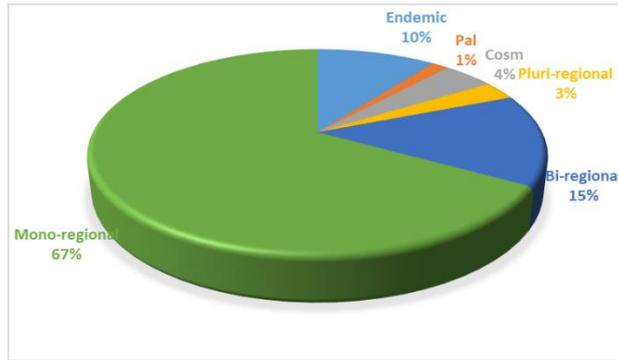


Figure (11): The frequency of the recorded plant species of families' relation to their floristic category

Seven species are endemic to geophytes in this study Table (7) Fig (12). They compose about 10.14% of the total number of species. The taxa endemic to area is *Allium negrianum* and *Allium ruhmerianum* Asch (Alliaceae 43%), *Arum cyrenaicum* (Araceae 14%), *Romulea cyrenaica* Beguinot (Iridaceae 14%), *Bellevalia Cyrenaica* Maire & Weiller (Liliaceae 14%), *Orchis cyrenaica* Dur & Barr (Orchidaceae 15%) and *Cyclamen rohlfsianum* Aschers (Primulaceae 14%). And these form part of the endemic species in the Green Mountain, And Comparing it with the number of endemic species in Al-Jabal Al-Akhdar is simple, as it represents 11.86%, About 84 species are recorded in the Libyan flora, approximately endemic 70 % of them are found in the Al- jabal Al- Akhdar region (about 59 endemic species) And this agrees with the studies of both [31] and [47].

Table (7): The distribution of Endemic of geophytes at the study area.

Taxon	Family	Life form	Taxa	Local Name
<i>Allium negrianum</i> Maire & Weiller.	Alliaceae	bulbs	Monocot	Bossalia
<i>Allium ruhmerianum</i> Asch	Alliaceae	bulbs	Monocot	Bossalia
<i>Arum cyrenaicum</i> Hruby	Araceae	corms	Dicot	Renish
<i>Romulea cyrenaica</i> Beguinot.	Iridaceae	corms	Monocot	-
<i>Bellevalia cyrenaica</i> Maire & Weiller	Liliaceae	bulbs	Monocot	-
<i>Orchis cyrenaica</i> Dur. & Barr.	Orchidaceae	tubers	Monocot	Orchid
<i>Cyclamen rohlfsianum</i> Aschers.	Primulaceae	tubers	Dicot	Rukkof

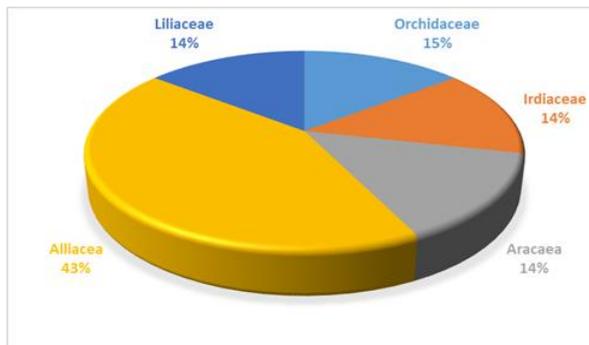


Figure (12): The Percentage of the Endemic species of families 'in study area.

Within the results of the assessments made by the flower colors of geophytes located in Al-Jabal Al-Akhdar, the highest rate has been Yellow flowered geophyte taxa with 38 % ratio. 26% of them has been found to be white flowering species and %15 has been violet flowering species and has been purple (7%) flowering specie. The lowest rate with 1% has been yellowish brown and pink flowering species Figure (13), (14) On the other hand [74] has said that when we use the geophytes in landscape designs, preferring the short and short flowering species can be preferred in the drifts will be more effective and will achieve a natural appearance.

Flowering start time and flowering periods of the geophytes is a very important issue in planting design as well as their flower colors. Within the results of the assessments made by the flowering times of geophytes located in study area, it has seen that 42 % of the district geophytes are flowering in March-Julye and 30 % of them are flowering in March- April. 22% of them are flowering in February - April. Autumn and winter flowering geophytes are the least and also it has seen that in October and December geophyte taxa is flowering in AL-Jubal Al-Akhdar, Figure (15) and (16).

The flowering phenology and flower color of geophytes in Al-Jabal Al-Akhdar region provide important insights into their ecological strategies and reproductive adaptations. The data show that most geophytes species flower during mid-spring period, which coincides with moderate temperatures and optimal moisture conditions in this mountainous area. Some species exhibit early or late flowering patterns reflecting species-specific responses to microclimatic variations and ensuring temporal separation that reduces competition for pollinators [75] and [76]. a Flower color among the studied geophytes is variable with light yellow and white hues being the most common, while pink and yellowish-brown flowers occur less frequently. this variation likely represents different pollination strategies, where bright colors attract diurnal insects, and more subdued colors may be associated with specialized pollinators or abiotic dispersal mechanisms. The correspondence between flowering time and flower color suggests that most species have evolved synchronized phenological and visual cues to optimize reproductive success. Furthermore, altitudinal differences appear to influence both flowering time and color distribution. species at higher elevations tend to flower slightly later due to cooler temperatures while mid-elevation species dominate the mid-spring flowering peak [77]. Overall the variation in flowering phenology and flower color among geophytes contributes to functional diversity within the plant community promoting ecosystem resilience reducing interspecific competition.

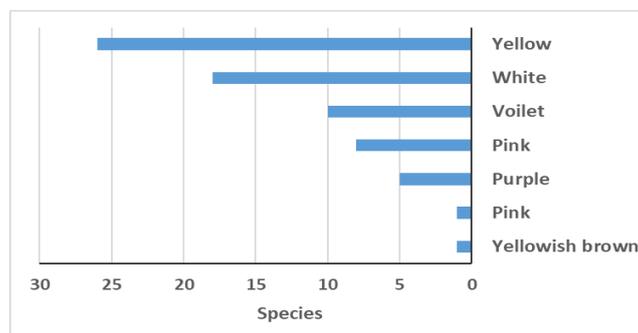


Figure (13): The distribution of geophyte taxa according to flower colors.

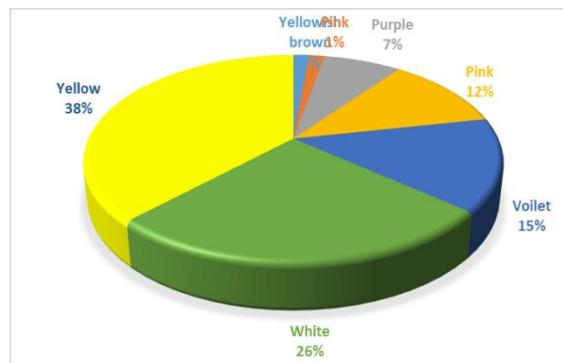


Figure (14): The percentage of geophyte taxa according to flower colors.

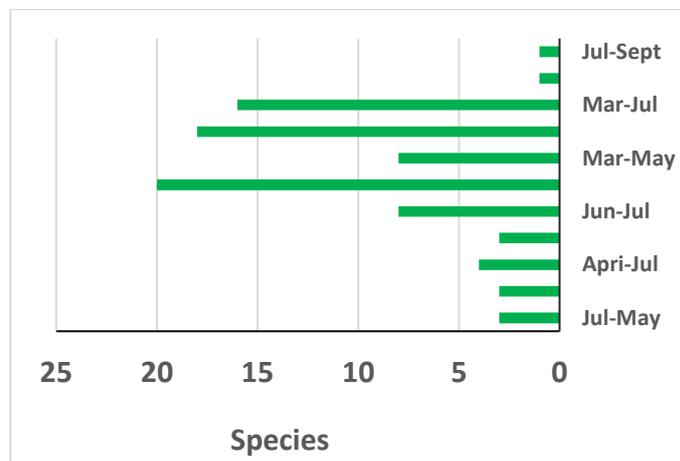


Figure (15): The distribution of geophyte taxa according to flowering start times.

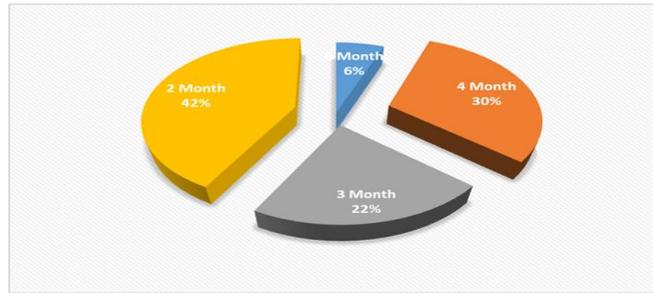


Figure (16): The distribution of geophyte taxa according to flowering periods

The geophytes species *Urginea maritima* showed relatively high abundance and wide distribution across several habitats of Al-Jabal Al-Akhdar Figure (17). this species is well adapted to Mediterranean ecosystems and commonly occurs in open rocky areas, grasslands and disturbed habitats with calcareous or sandy soils, its large underground bulb enables the plant to survive the long dry summer period and regenerate rapidly during favorable seasons.

The high density of this species in many sites may be related to its strong ecological tolerance and its ability to grow under harsh environmental conditions such as drought, shallow soils and exposure to fire. In addition, the bulb structure stores water and nutrients, allowing the plant to persist for many years and maintain stable populations within Mediterranean landscapes. Furthermore, the species typically occurs from sea level up to about 600 m elevation in Mediterranean regions, which corresponds to many habitats of the Green Mountain. This altitudinal range and ecological plasticity may explain its frequent occurrence and relatively high population density compared with some other geophytes record in the study area.

The widespread distribution of *Urginea maritima* in the study area therefore reflects its ecological adaptability and its successful survival strategy as a bulbous geophyte in Mediterranean climates [2], [78] and [79].



Figure (17): *Urginea maritima* (L.) Baker.

Conclusion:

This study highlight the floristic composition, life-forms, chorotype and flowering phenology of geophytes species in the Al-Jabal Al-Akhdar region of Libya. A total of 69 species belonging 33 genera and 14 families were recorded, indicating a considerable diversity of geophytes in this Mediterranean ecosystem. The result showed that geophytes are represented by different underground storage organs such as bulb, rhizomes, corms and tubers which help these plants survive seasonal climatic conditions. The analysis of life forms revealed that most of the recorded species are adapted to the Mediterranean climate, where geophytes complete their growth and flowering during the favorable seasons. Chorotype analysis indicated that many species belong mainly to the Mediterranean phytogeographical region, reflecting the strong Mediterranean floristic influence in Al-Jabal Al-Akhdar.

Flowering phenology showed that most species flower during late winter and spring which corresponds with the period of higher rainfall and moderate temperatures in the region. Among the recorded species, *Urginea maritima* is one of the most common geophytes and shows wide ecological distribution in the study area. This species is well adapted to different habitats and is characterized by its ability to survive dry summer conditions through its large bulb. Overall, the diversity and ecological characteristics of geophytes in Al-Jabal Al-Akhdar highlight the importance of this region as a significant center of Mediterranean plant diversity in Libya.

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Appendix (1):

Geophytes Floristic list in Jabal Al-Akhdar regions: Life –forms and Abbreviation of the chorology: (IT) Irano-Turanian, (Med) Mediterranean, (ES) Euro- Siberian, (COSM) Cosmopolitan, (Trop) Tropica and (End) Endemic.

Species	Family	life-form	chorotype	flowering periods	ower colours
Allium roseum L.	Alliaceae	bulbs	Med	Mar-Apr	Pink
Allium ampeloprasum L	Alliaceae	bulbs	Med	May-Jul	Pink
Allium orientale Boiss	Alliaceae	bulbs	Med	Mar-Apr	White
Allium erdelii Zuec	Alliaceae	bulbs	Med	Mar-Apr	White
Allium nigrum L.	Alliaceae	bulbs	Med	Mar-Apr	White
Allium schubertii Zuec	Alliaceae	bulbs	Med / Ir-Tu	Apr-May	Pink
Allium negrianum Maire & Weiller.	Alliaceae	bulbs	Endemic	May-Jul	White-Violet
Allium barthianum Asch & Schw.	Alliaceae	bulbs	Med	Apr-May	Violet
Allium paniculatum L.	Alliaceae	bulbs	Med/ Eu-Si	Mar-Jul	White
Allium ruhmerianum Asch	Alliaceae	bulbs	Endemic	May-Dec	White
Allium subhirsutum L.	Alliaceae	bulbs	Med	Feb-May	White
Narcissus elegans(Haw.) Spach.	Amaryllidaceae	bulbs	Med	Oct-Nav	Yellow
Narcissus tazetta L.	Amaryllidaceae	bulbs	Med	Nav-Jan	White
Pancratium maritimum L.	Amaryllidaceae	bulbs	Med	Jun-Jul	White
Arisarum vulgare Targ.Tozz.	Araceae	corms	Med	Feb-Mar	Yellow
Arum cyrenaicum Hruby	Araceae	corms	Endemic	Feb-Mar	Yellow
Scorzonera lacinita L.	Asteraceae	tubers	Med /Ir-Tu/ Er-Si	Mar-Apr	Yellow
Otanthus maritimus (L.) Hoffmanns& Link.	Asteraceae	Rhizomes	Med	Feb-Apr	Yellow
Cicerbita haimanniana (Ascher.) Beau	Asteraceae	Rhizomes	Med	Mar-May	Violet
Carex illegitima Cesate.	Cyperaceae	Rhizomes	Med	Mar-Apr	Yellow
Carex divisa Huds.	Cyperaceae	Rhizomes	Eu-Si	Feb-Jul	Yellow
Carex flacca Schreb.	Cyperaceae	Rhizomes	Med	Mar-Jun	Yellow
Carex distans L.	Cyperaceae	Rhizomes	Med	Mar-Jun	Yellowish brown
Carex extensa Good.	Cyperaceae	Rhizomes	Cosm	Apr-May	Yellow
Cyperus laevigatus L.	Cyperaceae	Rhizomes	Cosm	Apr-Sept	Yellow
Cyperus longus L.	Cyperaceae	Rhizomes	Med	Apr-Sept	Yellow
Eleocharis palustris (L.) R.Br.	Cyperaceae	Rhizomes	Eu-Si	Mar-Oct	Yellow
Scirpus maritimus L.	Cyperaceae	Rhizomes	Cosm	Jul-Sept	Yellow
Scirpus lacustris L.	Cyperaceae	Rhizomes	Trop/Eu-Si	Mar-Jul	Yellow
Gladiolus byzantinus Miller .	Iridaceae	corms	Med	Mar-Apr	Violet
Gladiolus segatum Ker. Gowl.	Iridaceae	corms	Med / Ir-Tu	Mar-Apr	Purple
Iris germanica L.	Iridaceae	Rhizomes	Med	Jun-May	Violet
Iris sisyrinchium L.	Iridaceae	Rhizomes	Med / Ir-Tu	Feb-Apr	Violet
Romulea cyrenaica Beguinot.	Iridaceae	corms	Endemic	Feb-Mar	Yellow
Romulea bulbocodium (L.) Seb&Mauri	Iridaceae	corms	Med / Eu-Si	Jan-Apr	Yellow
Romulea colmnena Seb&Mauri	Iridaceae	corms	Med	Feb-jun	Yellow
Crocus boulosii Greuter.	Iridaceae	corms	Med	Feb-Jun	Yellow
Urginea maritima (L.) Baker.	Liliaceae	bulbs	Med	Jul-Oct	White

<i>Asparagus aphyllus</i> L.	Liliaceae	bulbs	Med	Aug-Sept	White
<i>Colchicum ritchii</i> R.Br.	Liliaceae	bulbs	Med	Oct-Dec	White
<i>Androcymbium gramineum</i> (Cav.) Mc.	Liliaceae	bulbs	Med	Oct-Dec	Violet
<i>Asphodelus microcarpus</i> Salzm&Viv	Liliaceae	bulbs	Med	Dec-Apr	Violet
<i>Asphodelus aestivus</i> Brot.	Liliaceae	bulbs	Med	Jan-Feb	Pink
<i>Asphodelus tenuifolius</i> Cav.	Liliaceae	bulbs	Med	Jun-Mar	Yellow
<i>Gagea trinervia</i> (Viv) Greuter	Liliaceae	bulbs	Med	Mar-May	White
<i>Scilla villosa</i> Desf.	Liliaceae	bulbs	Med	Jan-Mar	Violet
<i>Urginea autumnalis</i> (L.) EL-Gadi	Liliaceae	bulbs	Med	Sept-Nov	Violet
<i>Ornithogalum tenuifolium</i> Guss	Liliaceae	bulbs	Med	Jan-Mar	White
<i>Bellevalia sessiliflora</i> (Viv) Kunth.	Liliaceae	bulbs	Med	Jan-Mar	White
<i>Bellevalia cyrenica</i> Maire & Weiller	Liliaceae	bulbs	Endemic	Jan-Feb	White
<i>Smilax aspera</i> L.	Liliaceae	bulbs	Med/ Ir-Tu	Nov-Jun	White
<i>Bellvalia mauritanica</i> Pomel.	Liliaceae	bulbs	Med	Feb-May	White
<i>Gagea reticulata</i> (Pall.) Schult.	Liliaceae	bulbs	Med	Mar-Apr	Yellow
<i>Oxalis articulata</i> Savig.	Oxalidaceae	Rhizomes	Plu	Mar-Apr	Pink
<i>Epilobium hirsutum</i> L.	Onagraceae	Rhizomes	Euro	May-Jul	Pink
<i>Orchis collina</i> Soland.	Orchidaceae	tubers	Med	Jan-Apr	Purple
<i>Orchis papilionacea</i> Linn	Orchidaceae	tubers	Med	Mar-May	Purple
<i>Orchis simia</i> Lamk.	Orchidaceae	tubers	Med	Mar-May	Pink
<i>Ophrys bolosericea</i> (Burm.F.) G.Sampaio.	Orchidaceae	tubers	Med	Mar-May	Purple
<i>Ophrys rosea</i> (Desf.) G.Sampaio.	Orchidaceae	tubers	Med	Feb-May	Yellow
<i>Ophrys bombyliflora</i> Link.	Orchidaceae	tubers	Med	Feb-Apr	Yellow
<i>Neotinea maculata</i> (Desf.) Stearn.	Orchidaceae	tubers	Med	Mar-Apr	White
<i>Barlia robertiana</i> (Lois.) W.Greuter	Orchidaceae	tubers	Med	Jan-Apr	Purple
<i>Ophrys fusca</i> Link	Orchidaceae	tubers	Med / Eu-Si	Feb-May	Yellow
<i>Ophrys speculum</i> Link	Orchidaceae	tubers	Eu-Si	Feb-Apr	Yellow
<i>Orchis cyrenaica</i> Dur. & Barr.	Orchidaceae	tubers	Endemic	Feb-Apr	Yellow
<i>Orchis italica</i> Poir.	Orchidaceae	tubers	Med	Mar-Apr	Violet
<i>Poa bulbosa</i> L.	Poaceae	bulbs	Ir-Tu /Med/Eu-Si	Mar-May	Yellow
<i>Cyclamen rohlfsianum</i> Aschers.	Primulaceae	tubers	Endemic	Oct-Dec	Pink