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Investigation of the Autecology of Hawthorn in Northwestern Syria

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***Abstract* - This research was carried out in Idlib Governorate, located in northwestern Syria, during the years 2021, 2022, and 2023. The self-environment of the Crataegus genus was also studied in the study areas, by conducting botanical surveys there, according to the Braun-Blanquet method. The results showed that Crataegus has environmental flexibility as it spreads in multiple bioclimatic environments. Specie Crataegus monogyna belonging to the order *Quercetaliapubescentis*, which follows the *Querceteapubescentis* order, whose components are part of the plant alliance *Quercioninfectoriae*. Which includes deciduous oak forests within the Supra-Mediterranean structure. As for the species C. azarolus, it belongs to the order *Quercetaliailicis*, which belongs to the class *Querceteailicis*, and whose components are considered within the botanical alliance *QuercionCalliprini* within the Eu-Mediterranean structure. In general, the hawthorn did not constitute a characteristic type of species, but was always accompanying species, and did not rise to the level of characteristic types of species included in the designation of plant communities specialized in it.**

Keywords: Hawthorn, Autecology, Plant Communities, Phytosociology, Botanical Surveys.

I. INTRODUCTION

The hawthorn plant is an important medicinal plant. It is a medium-sized shrub with deciduous leaves, not more than 8 meters high. Its branches end with thorns. The flowers of the hawthorn are white, red, or pink and have a strong smell. They bloom between April and June in large bouquets, and then the buds grow. The fruits are spherical in shape, small, and red or yellow when ripe, containing 2-3 seeds. The leaves are shiny and silvery green, and come in various shapes and sizes, with tough skin. Hawthorn belongs to the genus *Crataegus*, which is part of the subfamily Pomoideae and the rose family Rosaceae. The genus *Crataegus*, commonly known as the hawthorn, includes about 200 species distributed in temperate and subtropical regions of the Northern Hemisphere (Dönmez, 2004; Makhoul and Mahfoud, 2007). Hawthorns are usually thorny shrubs or low trees about 5-15 meters high. The lifespan of hawthorn can exceed 200 years, and today more than 20 species of hawthorn are used in medicine, some of which are found in pharmacies in many countries (Chang *et al.*, 2002).

The study of the autecology of the *Hawthorn* genus is important for understanding the distribution of its species. This involves determining whether the species are widely or narrowly distributed and whether they are dominant or companion species within plant communities. Studying the environments in which these species spread provides insights into their flexibility. For example, some widely distributed species like sumac can thrive in different soil types and are considered invasive due to their high flexibility. On the other hand, narrowly distributed species like chestnut are environmentally inflexible, as they thrive in lime-free soils (Nahal, 2002).The northern region of Syria, particularly the degraded mountainous areas of Aleppo and Idlib, has traditional systems with many multi-use woody species. For these systems to effectively contribute to sustainable land management and mitigate conflicts between agricultural lands and natural forests, it is important to have a better understanding of them. This can be achieved through inventorying and studying their different components, as well as the different woody species that characterize them. *C. azarolus* was suggested as a species within the agroforestry systems (Khatib, 1999).

Several national research studies have been conducted in Syria to study the plant species and their autecology. These studies have found that hawthorn often grows as a companion plant. For example, Barbero et al. (1976) studied forests of brutian pine, Aleppo pine, cypress, fir, and cedar in the coastal mountain range. Chalabi (1980) conducted an environmental, social, and botanical study of fir and cedar forests in Jabal al-Nabi Matta, oak forests in the Qadmus area, and semi-Azri oak forests in al-Bayr, al-Basit, Salnfa, and the mountains of western Homs. This study also included an in-depth taxonomic study of the *Quercus* genus in Syria, along with dendrometric and dendroclimatological analyses. Ghazal (1994) researched the endangered species *Quercus aegilops*in Syria, and the botanical social composition of its forest remains. Karzon (1996) studied the distribution and living

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conditions of the chestnut tree in Syria and identified hawthorn as a companion plant in the Wadi al-Nadara area in Homs. Finally, Ghazal Aswad (1998) conducted an ecological and phytosociological analysis of the biodiversity of vascular plants in the Fornlaq Forest and its surroundings in the Bayer and Basit areas in the coastal region north of Latakia.

The research conducted by Martini (1999) focused on ecological and phytosociological analyses of the forests on the eastern slopes of the Syrian coastal mountain range. Zidan (2004) studied plant biodiversity and its role in sustainable development in Jabal al-Zawiya. Ghazal (2008) conducted ecological, phytosociological, and geographical studies in the forests of the Eu-Mediterranean structure in western Syria. Al-Ayyoubi (2009) conducted an environmental, social, and botanical study of the Jabal al-Wastani region. Al-Hassan (2014) conducted a study on the Qusayr Plateau, which included an analysis of biodiversity, ecology, phytosociology, and demographics in northwestern Syria. The study covered over 40 thousand hectares in the Jisr area, identifying the prevalent plant species and their respective plant communities.

Based on the information above, it is important to study the hawthorn's environment to understand its distribution, adaptability, and plant classification. This knowledge will be useful for future reforestation efforts and managing its spread.

II. MATERIALS AND METHODS

2.1 Climatic and bioclimatic analyses of the study area:

To understand the climatic characteristics and their impact on the study region, we calculated and analyzed the climatic data using the following methodology and equations:

The Emberger index: developed by the French climatologist Emberger (1942), is a meteorological tool used to assess the amount and distribution of rainfall in a given area during a given period. It helps determine whether the area is more or less dry by comparing the actual rainfall with the normal rate for the same period. The index classifies areas based on annual rainfall, ranging from per-arid to per-humid.It is valuable for evaluating agricultural potential and its impact on water resources in a givenarea. The index is calculated using a specific formula (Bounif, et al., 2023) based on Emberger's work (Emberger, 1942).

$$Q_2 = \frac{P}{[(M+m)/2] * (M-m)} * 1000$$

The scientist Embergerinitially proposed this equation to link Mediterranean climate models with the natural plants in Morocco, which Sauvage (1963) modified according to the following formula:

$$Q_2 = 2000P/M^2\text{-}m^2$$

Where:

Q_2: Emberger index (Thermal rainfall coefficient).
P: Average annual rainfall (mm).
M: Average maximum temperature of the hottest month (°C, replaced in the equation in Kelvin °K).
m: Average minimum temperature of the coldest month (°C, replaced in the equation in Kelvin °K).

Al-Hassan (2014) explained from Chalabi (1980) that the scientist Amberger arranged the Q_2 values on the vertical axis and the m values on the horizontal axis, to define the bioclimatic floors, which are named in order:

per-arides bioclimatic structure $20 \geq Q_2$
arides bioclimatic structure $30 \geq Q_2 > 20$
semi- arides bioclimatic structure $50 \geq Q_2 > 30$
sub-humid bioclimatic structure $90 \geq Q_2 > 50$
humid bioclimatic structure $90 < Q_2$
per-humid (high mountain structure)

Sauvage (1963) implemented the same climate plan but using the Q_2 values, and as a result, he reached the same classification thresholds (structures). Returning to Emberger's bioclimatic plan, it became clear that based on the m values, each of the previous bioclimatic structures was divided into the following variables:

Warm winter: +7°C < m, characterized by the absence of frost.
Temperate winter: +3°C< m≤ +7°C, frost occurs only occasionally.
Cool winter: 0°C < m ≤ +3°C, frost occurs normally.
Cold winter:-3°C<m≤ 0°C, frost occurs for a long period.
Frigid winter: m ≤ -3°C.

To improve accuracy, each bioclimatic structure can be segmented into three parts: lower, middle, and upper. This can be achieved by dividing the vertical distance between the floor plane lines into three equal sections. For instance, the lower third of the sub-humid structure represents a lower sub-humid structure, and so forth.

2.2 Determining the methodology for the socio-botanical study:

In our study to analyze the vegetation cover, we utilized the Braun-Blanquet method (1935), which was systematically organized at the International Station of Mediterranean and Alpine Geobotany, Montpellier (SIGMA). The work was carried out according to Lacoste and Salanon (1969) and

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Chalabi (1980) and explained in Al-Hassan (2014). The study consisted of two main stages:

1. The first stage focused on conducting a plant inventory to determine the widespread species. This involved creating plant inventory lists, taking readings, and recording notes.
2. The second stage involved organizing these lists within a socio-botanical table. The final form of the table allowed for the identification of potential social plant units.

2.3 Identifying the study area:

The work involved visiting the sites to study the autecology of the *Crataegus* genus. To determine the optimal site, it is important to choose sites with homogeneous environmental conditions, where the species appears regularly within the scope of the social unit being studied. The phenotypic characteristics of the site indicate whether it is a good choice.

2.4 Conducting a plant survey:

The sites with hawthorn trees and similar topographic and plant characteristics were chosen. The phenotypiccondition of the plant is the best indicator of a good site choice, and the following factors were used to determine the plant survey's homogeneity:

- Similar environmental conditions at the site.
- Dominance of one or more plant species.
- Regular appearance of plant species in the survey area with similar environmental conditions.
- The survey area (in m^2)is determined to accurately represent the environmental characteristics, geographical nature, and plant diversity of the site. The area is considered sufficient for conducting an inventory when no new species are encountered, known as the minimum area. A minimum area of 100 m^2 is typically used to ensure the stability of the species increase curve (Chalabi, 1980; Chalabi, 1982; Blondel, 1987).

According to Chalabi (1980), and Chalabi and Jaloud (2003), as explained in Al-Hassan (2010; 2014), the plant inventory survey is not only focused on the plant cover but also extends to the characteristics of the environment that this cover occupies. Therefore, the survey also determines the characteristics of the surrounding environment, which are represented by the following points:

- Elevation above sea level: estimated in meters.
- Topographic slope of the site: estimated as a percentage of the slope angle.
- Exposure according to the four main directions and their derivatives.
- Proportion of plant coverage (%).
- Average height of trees (m).
- Average diameter of trees (cm).
- Nature of the parent rock and the properties of the soil arising from it, if possible.
- Date of the survey.

After that, we recorded all plant species on the site, including trees, shrubs, perennial herbs, and annuals. We created a list for each species, with two numbers mentioned next to each one. The first number indicated the abundance and dominance index, while the second number indicated the species' ability to live socially.

Abundance and dominance index:

It is estimated by choosing a number from one to five, representing a level determined by the following:

5: Many individuals cover more than ¾ of the bare surface.
4: Abundant individuals covering ½ to ¾ of the bare surface.
3: Unspecified number of individuals covering from ¼ to ½ of the bare surface.
2: Limited number of individuals covering less than ¼ of the bare surface.
1: Somewhat abundant individuals with weak coverage, covering less than 1/20of the bare surface.
+: A very small number of individuals with limited presence and coverage.

Sociability Index:

The sociability index indicates the likelihood of individuals of the same species living in scattered, isolated manner or in plant colonies. Dispersion and aggregation are related to the pattern of dispersal and reproduction of the species, and they indicate the conditions of the microclimate. Sociability is estimated using a numerical series of five numbers ranging from one to five, where the number indicates:

5 Almost pure plant communities.
4 Plant colonies of significant expansion.
3 Plant patches of individuals of the species in question.
2 Individuals gathered in bunches.
1 Individuals scattered individually.

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2.5 Comparing botanical surveys and identifying plant communities:

Plant findings were compared using a primary table with two entries:

- Columns representing plant surveys.
- Rows recording species.

The intersection of the column and row is where we record the indexes of abundance and dominance, as well as the tendency to social life. By comparing the surveys in the tables with each other, we can identify surveys that have a greater number of similar and common species. We then change their positions vertically to see the botanical kinship between the different surveys. In the last column of the botanical social table, we assign a Roman numeral from I to V for each species to indicate the presence index. This helps us to show the percentage of lists in which a species is found. For example, plants found in 1-20% of the lists are given the number (I) for the presence index, while those found in 81-100% of the lists are given the number (V). Alternatively, we can directly write the number of times the species appears in its lists, which is the approach we adopted in our study (Chalabi, 1982).

All plant species were examined, and their presence in different discoveries was studied. The species found in nearly all discoveries are called accompanying species, while those found in some discoveries and not in others are typically called characteristic species. According to Ellenberg (1956), species are considered characteristic if they are present in at least 50% of the discoveries belonging to the group that distinguishes them and are rare or completely absent in other groups.

According to Guinochet (1973), a species is considered characteristic of a community if it is exclusive to that community and strongly associated with its environment, even if it is found in only one plant discovery. This determination should be based on a thorough understanding of the plant groups and social taxonomic units studied in other areas, as well as a comprehensive knowledge of the species' autecology. Chalabi and Al-Jaloud (2003) emphasize that the selection and discovery of characteristic species should rely on accurate knowledge of the species under study.

III. RESULTS AND DISCUSSION

The autecology of wild hawthorn species, which are naturally distributed in Idlib Governorate, was studied, where a climatic study was initially conducted, and then inventories were conducted and collected.

3.1 Climatic Study:

A climatic study was conducted in selected areas to analyze the variation of distinctive climatic characteristics affecting plant species and their communities. The data from ICARDA in 2010 and from previously prevailing climatic stations were relied upon for this study (Table 1).

Table (1): Climatic data and Amberger index for climate stations at the study sites

Station	Height (m)	P (mm)	M	m	Longitude	Latitude	Index Q_2	Bioclimatic Structure
Bdama	490	1014	28	4.5	36.23	35.81	159.91	Humid
Jisr al-Shughour	195	756	32	3.5	36.32	35.81	88.40	Semi-humid
Darkush	225	630	33	3.7	36.41	35.99	72.58	Semi-arid
Ariha	350	495	32	2.6	36.60	35.81	58.00	Semi-arid
Armanaz	250	580	35	1.5	36.50	36.08	59.53	Sub-humid
Harem	125	500	37	2.5	36.51	36.20	49.56	Semi-arid

- Jisr al-Shughour station, situated at an elevation of 195 meters.
- Darkoush station represents the lowest point and the northern border of the study area, located at an altitude of 225 meters.
- Badama station is the most representative site area, with an average altitude of 490 meters (Zainiya, Janoudiya, Azar, Shaturiyya, Baksariya...).
- Ariha station, located at an altitude of 350 meters, is the most representative of the Jabal al-Arbaeen and Muhambal sites.
- Armanaz station, situated at an altitude of 250 meters, along the highest mountain.
- Harem station, located at an altitude of 125 meters.

3.2 Emberger's thermal rainfall coefficient:

The thermal rainfall coefficient Q_2 was calculated for the selected climatic stations, including the default station. This was done according to the equation in the study methodology and using the data and results shown in Table (1).

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The calculation also involved applying the thermal rainfall coefficient of Emberger modified by Chalabi (1980) so that the upper limit of the sub-humid bioclimatic structure area aligns with the current state of forest vegetation in the Syrian coastal mountain range, as illustrated in Figure (1).

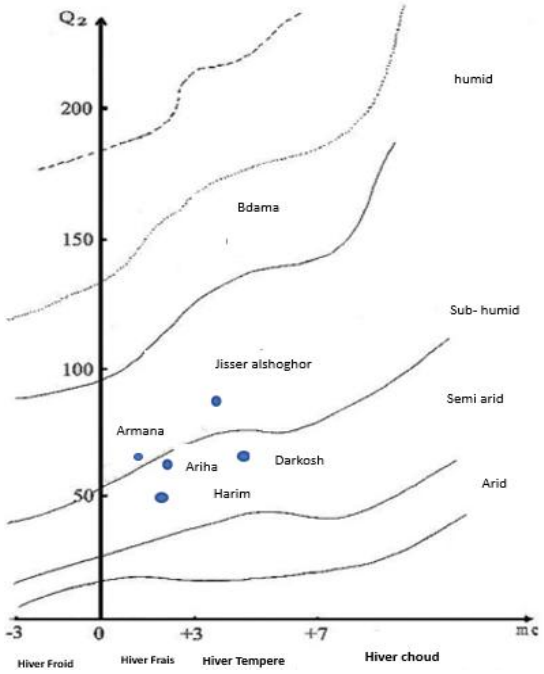

Figure (1): Emberger plot (thermal rainfall coefficient) for the study sites (Emberger, 1942)

3.3 Study location /sites:

To study the hawthorn's autecology, its distribution sites were divided into the areas shown in Table (2). The surveys were split into three groups: surveys in the Pine Forest, surveys in the common Quercus, and surveys in scattered sites (forests and roadsides).

Table (2): Surveys data in the areas of spread of the *Crataegus* genus

Survey No.	Aggregate table No.	Date of survey	Area	Site name	Altitude above sea level (m)	Mother rock	Forest/vegetation type
1	4	6/2022	Jisr al-Shughur	Hamama	350	Chalky	Artificial afforestation
2	4	10/2022		Zainiya	334	Marinite Limestone	Protea pine forest
3	4	10/2022		Al-Janoudiya	553	Marinite Limestone	Protea pine forest
4	5	12/2023	Darkush	Darkush entrance (left of the road)	130	Hard Limestone	Maqui Quercus
5	5	12/2023		Darkush entrance (right of the road)	140	Hard Limestone	Maqui Quercus
6	5	10/2022		Sheikh Muhammad Shrine (Saadiya)	380	Hard Limestone	Quercuss
7	5	7/2022		Sheikh Issa Shrine (Nazareth)	410	Hard Limestone	Quercuss
8	6	6/2024	Jabal al-Zawiya	Al-Rami	724	Hard Limestone	Maqui Quercus remains
9	6	6/2024		Marayan	810	Hard Limestone	Maqui Quercus remains
10	6	6/2024		Bzabur	705	Hard Limestone	Maqui Quercus remains
11	6	5/2024		Jericho	465	Hard Limestone	Maqui Quercus remains
12	6	5/2024		Mahmal	352	Hard Limestone	Maqui Quercus remains
13	6	11/2022	Harem	Armanaz (Biatis)	285	Hard Limestone	Artificial afforestation
14	6	11/2022		Aqaba	390	Hard Limestone	Maqui Quercus remains

3.3.1 Jisr al-Shughour area:

Jisr al-Shughour area forests (Jabal al-Qusayr) are located northwest of the governorate, between the passage of the town of Bdama and the Orontes Valley, the Bayer block, and the northern Kabir River Valley. The rocks of this plateau are limestone, and

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it is divided by a large fault. This plateau forms low hills and mountains, and its average height is 500 m. Many valleys descend from it ending in the Orontes River, the most important of which is the White River. As for the plant aspect, it is dominated by dense forests of *Quercus calliprinos*, *Q. infectoria*, Laurus nobilis, and h *Crataegus* spp. (With a rich presence of *Ostryacarpinifolia* and Platanus orientalis, especially near waterways, where the altitude above sea level is 850 m in the site of Ma'arbaya and Al-Draybat) with a rich plant margin in the southern region of this plateau on the hard limestone rocks, which sometimes mix with some spots and areas where the *Pinus brutia* dominates, and this dominance increases as we head north, where the forests of *Pinus brutia* and its communities prevail, and the Quercus. sp disappear (relatively) as a change occurs like the mother rock, while it is hard limestone, interspersed with terra-rosa soils and aggregate soils with gravel, it becomes in the pine area of the soft Marne limestone type, with a decrease in altitude above sea level from about 950 m to 500 m on average, and so on until we reach Al-Maland, Al-Janoudiya, Al-Tayyiba and Al-Maysar north and east towards Al-Yaqoubiyya, Al-Hamamah, Al-Qaniya and even Darkoush, where you can see the forests of the *Quercus calliprinos*, Laurus nobilis, and the remains of the Quercus aegliops are rarely seen with its companions on the banks of the Orontes River, especially in Jabal al-Wastani. This plateau is crossed by several waterways that have their vegetation (Al-Hassan, 2014).

- **Hamama sites:**

The site is an artificial afforestation site, 285-350 m above sea level, more than 40 years old, and located on the western bank of the Orontes Valley, on calcareous marsh soil (chalk rocks). This site was previously afforestation with *Pinus pinea*, *Pinus brutia*, and *Cupressus sempervirens*. This site was exposed to many fires that destroyed most of the site area. In 2012, fires destroyed most of its area. The site was also exposed to cutting down trees and converting them to agricultural land. The site suffers from difficulty in the natural regeneration process, and we noticed the scarcity of accompanying plant species. The survey (R1) was conducted from the southern end of the site, and it was organized in Table (3).

- **Al-Zainiya site:**

It is considered one of the most important forest sites in the study area, covering the largest continuous area of *Pinusbrutia* forests in the region, which was approximately 5000 hectares (Al-Hassan, 2014). This site starts from the Forest Protection Center in Al-Zainiya, where the elevation above sea level is 334 m. This site belongs to the sub-humid middle bioclimatic structure, and the moderate thermal variable, as the borders of this site reach Badama, whose climate station records 1014 mm/year, and it belongs botanically to the Eu- Mediterranean.

Al-Zainiya forests are characterized by the presence of pinusbrutia, with its typical accompanying plant margin, growing on marsh soils. We noticed that the region has been exposed to repeated fires, which directly affected the plant coverage and existing forest species and their composition, whether in terms of the type of existing species or their quantity. In a study by Al-Hassan (2014), it was mentioned that the forest coverage ranged between 70-85% and reached 100% in some areas. Now, the area has become exposed, and has lost its basic vegetation cover, and the vegetation cover has become about 40-60%, and some species indicating deterioration and recurrent fires have prevailed, such as Cistus salviifolius, and Arbutus andrachna. The R2 survey was conducted, and the associated species include *Quercus calliprinus*, *Quercus infectoria*, *Pistacia palaestina*, *Crataegus monogyna*, *Rhamnuspalaestina*, *Juniperusoxycedrus*, *Phillyrea media*, *Smilax aspera*, *Crataegus azarolus*, *Cytisopsisdorycniifolia*, *Orchis* sp, *Lygia aucheri*, *Hypericumrussegger*, *Micromeriamyrtifolia*, *Anarrhinum orientale*, *Gonocytisuspterocladus*, *Styraxofficinalis*. This site has recently been exposed to repeated fires, in addition to illegal logging, and here it should be noted that it is necessary to intervene to help the desired species control the site. The basic rule adopted in afforestation is afforestation with the original plant, which in this case is the Brutia pine, so it is necessary to secure the appropriate environment around its seedlings, from space for lighting, and reducing competition for water and food in the soil, and it is necessary to accelerate the growth of slow-burning broad-leaved species, such as *Quercus calliprinos*, *Phillyrea media*, *Ceratonia siliqua*, *Acacia cyanophylla*, and *Eucalyptus camaldulensis*, to serve as what is called natural fire lines, which work to obstruct the fire and prevent the rapid spread of fire between trees within the site, Table (3).

- **Al-Janoudiya site:**

This site is located at an altitude of about 553 meters above sea level, overlooking the Latakia Mountains, the Turkmen and Kurdish Mountains, the Aqraa Mountain overlooking the Mediterranean Sea, the border city of Kasab to the west, and the central mountain to the east. An exploration was conducted on the Al-Janoudiya-Azar Road. The existing soil is limestone marsh, and the area is a pine forest area, but the area was exposed to cutting and repeated fires, which destroyed large forest areas, and the soil

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became exposed and vulnerable to deterioration, as the area was previously rich in plant species, which formed plant communities, and extended over large areas, but now the area has become almost barren, and species indicative of repeated fires have spread in it. The R3 detection was carried out, and the plants found were *Myrtus communis*, *Spartiumjunceum*, *Crataegus monogyna*, *Rubus sanctus*, *Asparagusacutifolius*, *Rosaarvenses*, *Laurus nobilis*, *Styrax officinalis*, *Ruscus aculeatus*, *Smilax aspera*, *Rosa canina*. The inventory area was close to the borders of some orchards, so we noticed the presence of the *Crataegusazarolus* var. *chlorocarpa*, which is widely cultivated in those areas, and therefore it was recorded in the inventory, knowing that it does not exist naturally, but rather it was previously planted and adapted to the conditions of the area, Table (3).

Table (3): Botanical surveys that contributed to the identification of hawthorn within the pine forest community

	Hamamah	Zainiya	Janoudiya	
PR.	1	2	3	Survey No.
	350	334	553	Height above sea level (m)
	15	40	20	Slope (%)
	S	E	WN	Exposure
	55	60	90	Percentage of vegetation cover (%)
	-	3	5	Average tree height (m)
	-	8	12	Average tree diameter (cm)
	Cm	C.d.	Mar.	Type of parent rock
	100	100	100	Survey area (m²)
	6/2023	10/2023	10/2023	Survey date
3	4.4	3.3	2.2	*Pinus brutia*
2	3.3	.	1.1	*Pinus pinea*
2	.	+	2.2	*Gonocytisuspterocladus*
1	+	.	.	*Cupressus sempervirens*
1	.	1.1	.	*Cytisopsisdorycniifolia*
1	.	+	.	*Hammatolobiumlotoides*
1	+	.	.	*Eucalyptus camaldulensis*
1	.	+	.	*Teucrium stachyophllum*
2	.	+	2.2	*Dorycniumhaussknechtii*
2	+	1.1	.	*Pistacia palaestina*
3	+	+	+	*Smilax aspera*
1	.	.	1.1	*Myrtus communis*
1	+	.	.	*Quercus calliprinos*
1	.	1.1	.	*Phillyrea media*
2	+	+	.	*Cyclamen persicum*
1	.	1.1	.	*Eryngium falcatum*
1	.	.	+	*Fontanesiaphillyreoïdes*
1	.	+	.	*Laurus nobilis*
3	+	+	+	*Crataegus azarolus*
2	.	+	+	*Crataegus azarolus* var *chlorocarpa*
2	.	+	+	*Crataegus azarolus*var *chlorocarpa*
2	+	.	+	*Asparagus acutifolius*
1	.	+	.	*Rubus sanctus*
1	.	+	.	*Osyris alba*
1	1.1	.	.	*Rhus cotinus*
2	+	.	+	*Styrax officinalis*
2	.	+	1.2	*Cercis siliquastrum*
1	.	.	+	*Cephalanthera longifolia*
3	+	+	1.1	*Crataegus monogyna*
1	.	.	+	*Tamus communis*
2	.	+	2.2	*Hedera helix*
1	.	+	.	*Pteridium aquilinum*
1	.	.	+	*Prunus ursina*
3	+	+	+	*Cistus salviifolius*
1	+	.	.	*Dorycniumhirsutum*
2	.	+	+	*Spartiumjunceum*
1	+	.	.	*Poterium spinosum*
1	+	.	.	*Thymus syriaca*

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1	.	+	.	*Salvia viscosa*
1	+	.	.	*Micromeriamyrtifolia*
1	.	1.1	.	*Silene aegyptiaca*
1	.	.	+	*Iris histrio*
1	.	1.1	.	*Cerastiumdichotomum*
1	.	+	.	*Torilishetrophylla*
1	.	.	+	*Bromus lancelatus*
1	+	.	.	*Galium aparine*
1	+	.	.	*Marrubium vulgare*
1	+	.	.	*Cynosurus echinatus*
2	.	+	+	*Rubussanctus*
1	.	.	+	*Rosa arvenses*
2	.	+	+	*Rosa canina*
2	+	+	.	*Arbutus andrachna*

Abbreviations: Presence: PR., Parent rock: Marl: Mar., Marne limestone: C.m., – Hard limestone: C.d., No readings Nèant: N

3.3.2 Darkoush area:

- **Darkoush entrance site:**

The vegetation on the edges of the road leading to Darkoush city, at the entrance to the city, was studied. The site includes Maqui *Quercus* (deteriorating condition of *Quercus*), at an altitude of about 120-140 m, the rocks are hard, and the soil is red terra-rosa, and includes many plant species, the most important of which is *Quercus calliprinos* with some of its companions. The site has been severely degraded, especially from repeated cuts, which caused the site to be partially exposed. The spots in which the discoveries were made are the spots that still preserve the remains of the natural vegetation that was prevalent in them. survey (R4) and survey (R5) were made, right and left of the road, Table (4).

- **Shrines:**

Some discoveries were studied in the Darkoush area, and it is necessary to recall the religious sites and shrines in the area, and the types that surround them that are of great importance, which are listed in Table (4). In addition to *Quercuscalliprinos*, there are giant individuals of *Quercus infectoria*, other rare species of *Quercus aegilops*, and even rarer species of *Quercus castaneaefolius*, and *Quercus brantii*, which are rarely found in the region. The shrines are remaining evidence of the vegetation communities that were prevalent in the region before reaching the stage of plant deterioration that we have reached because of human encroachments.

- **Sheikh Mohammed Shrine Site:**

It is necessary to point out the great and special importance of the Sheikh Mohammed Shrine site in the village of Saadia. It is located at an altitude of 380 m. The plant is located on red terra-rosa soil, resulting from hard limestone rocks. According to Ghazal (1994), this site is the only one of its kind in the real Mediterranean structure that contains four species of *Quercus*:*Quercus calliprinos*, *Quercusinfectoria*, *Quercus castaneaefolia*, *Quercus aegilops*, and this was confirmed by Al-Hassan (2014) in his previous study. R6 was conducted in the village of Al-Saadia. Unfortunately, these trees, despite their size, rarity, and environmental importance, were subjected to cutting operations that had never happened before in this way, and these quantities, and perhaps some species have completely disappeared, which we no longer see, or perhaps in the future, we will not see them in their natural form or condition (Table 4).

- **Sheikh Issa Shrine Site:**

The site overlooks the Orontes River from the eastern side, its height reaches 410 m, the site contains deciduous oak species, in addition to *Quercus calliprinos*, giant individuals of *Quercusinfectoria* are spread, other rare individuals of *Quercus aegilops*, and even rarer individuals of *Quercusbrantii*, as the presence of the Orontes River has created a microclimate that has allowed *Quercusinfectoria* (which is usually located at the lower feet of the upper structure) to creep down towards the real structure, and some accompanying species were present with it such as the common hawthorn *Crataegus azarolus*, and *Pistaciaatlantica*, and the survey (R7) was made. The discoveries made on the Eu-Mediterranean structure have been collected within *Quercetumcalliprini* in Table (4).

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Table (4): Botanical surveys that contributed to the identification of hawthorn within the *Quercetumcalliprini*

	Darkoush entrance (right of the road)	Darkoush entrance (left of the road)	Sheikh Mohammed Shrine	Sheikh Issa Shrine	
PR	4	5	6	7	Survey No.
	130	140	380	410	Height above sea level (m)
	20	60	65	60	Slope (%)
	E	W	E	E	Exposure
	80	60	60	65	Percentage of vegetation cover (%)
	2	25	25	2	Average tree height (m)
	10	100	85	10	Average tree diameter (cm)
	C.d.	C.d.	C.d.	Cret.	Type of parent rock
	100	100	100	100	Survey area (m²)
	2022/5	2022/5	2022/5	2022/7	Survey date
2	.	.	1.1	2.2	*Quercusaegilops*
4	4.4	3.2	1.1	2.2	*Quercus calliprinos*
4	+	+	2.2	2.2	*Quercus infectoria*
1	.	.	+	.	*Quercus castaneaefolia*
4	1.2	2.2	+	1.1	*Pistacia palaestina*
1	.	.	.	+	*Pistacia atlantica*
1	2.2	.	.	.	*Asparagus acutifolius*
4	+	1.1	1.1	1.1	*Crataegus azarolus*
2	.	+	+	.	*Cyclamen persicum*
3	1.1	2.2	1.1	.	*Phillyrea media*
2	+	1.1	.	.	*Rhamnus palaestina*
2	+	+	.	.	*Osyris alba*
4	+	+	+	+	*Bromus syriaca*
1	+	.	.	.	*Laurus nobilis*
2	+	+	.	.	*Ruscus aculeatus*
3	1.1	1.1	1.1	.	*Clematisflammula*
4	+	1.1	1.1	1.1	*Smilax aspera*
2	+	1.1	.	.	*Jasminumfruticans*
2	1.1	.	.	1.1	*Rhus coriaria*
2	+	1.1	.	.	*Eryngium falcatum*
3	+	+	.	+	*Ceterachofficinarum*
3	+	+	.	+	*Ephedra campylopoda*
2	+	+	.	.	*Ajuga laevigata*
2	+	+	.	.	*Umbilicus intermedius*
2	+	.	+	+	*Ajuga chia*
2	1.1	+	.	.	*Olea europaea*
2	1.1	.	.	1.1	*Styrax officinalis*
2	+	.	.	+	*Tamus communis*
2	+	.	.	+	*Rhus cotinus*
3	+	.	+	+	*Clematis vitalba*
4	1.1	1.1	1.1	3.2	*Quercus infectoria*
3	+	.	1.1	+	*Phlomis longifolia*
3	+	.	+	+	*Calycotomevillosa*
4	1.1	+	1.1	+	*Daphne oleoides*
3	1.1	+	1.2	.	*Asphodelusmicrocarpus*
1	+	.	.	.	*Genista acanthoclada*
4	+	+	+	+	*Origanum syriacum*
1	+	.	.	.	*Micromeriamyrtifolia*
2	+	+	.	.	*Teucrium polium*
2	+	.	+	.	*Fumana arabica*
2	+	+	.	.	*Hyparrheniahirta*
2	+	.	.	+	*Thymbra spicata*
1	+	.	.	.	*Thymus syriacus*
2	1.1	.	.	+	*Paliurus spina-christi*
2	+	+	.	.	*Dactylis glomerata*

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1	+	.	.	.	*Phlomis longifolia*
1	+	.	.	.	*Salvia grandiflora*
2	+	.	+	.	*Stipa bromoides*
2	+	+	.	.	*Galium aparine*
1	1.1	.	.	.	*Rumex bucephalophorus*
1	+	.	.	.	*Chryzopogongryllus*
2	+	+	.	.	*Hordeum bulbosum*
1	+	.	.	.	*Fibigiaeriocarpa*
1	+	.	.	.	*Psoraliabituminosa*
1	+	.	.	.	*Bromus lancelatus*
3	+	+	1.1	.	*Arum hygrophilum*

Abbreviations: Frequency of presence PR: Presence; - None Nèant: -; Parent rock and soil: Hard limestone Calcaire dur: C.d.; Cretaceous limestone (Cretaceous rock) Cretaceous: Cret.

3.3.3 Scattered areas:

These scattered sites are organized in Table (5).

3.3.3.1 Jabal al-Zawiya area:

It is a triangular block with its head in the north and its base in the south, starting from the east of the al-Roj plain and southwest of Idlib heading southward with increasing width, and overlooking the al-Ghab depression from the west, while it is lost in the east with a gentle undulating surface connected to the Aleppo and Idlib plateaus. The maximum length of Jabal al-Zawiya is 45 km, and the widest part of it is approximately 30 km, and its average height is 750 m, and its highest point is the volcanic summit of Mount Nabi Ayoub 940 m above sea level, and its surface is characterized by its low slope towards the east and south, and its richness in holes, and successive closed basins, with the presence of elevations separating them, with some volcanic remains, in contrast, its western surface forms a cliff with a slope of 90 degrees in some parts, extending from north to south in the form of a wall, and bordering the al-Ghab plain, and what increases the prominence of the steep slope of these western slopes is the large difference in height between the level of the al-Ghab depression Located at an average altitude of 170-190 m above sea level, the level of the peaks of Jabal al-Zawiya, and the tops of its western slopes located at an average altitude of up to 800 m, i.e. a difference of more than 600 m, and it appears to the viewer from the Ghab Plain towards the east in the form of an impregnable wall, devoid of paths and crossings, except for some narrow and short valleys, which were drawn by the torrent valleys. As for the vegetation, Jabal al-Zawiya was until recently covered with trees *Quercus calliprinos, Q. aegilops, Q. infectoria, C. azarolus, Philyrea media Rhus coriaria, Rhus cotinus*, and others. Now, the natural vegetation cover has disappeared, or is almost extinct, and the soil has been exposed to water and wind erosion, leaving bare rocky surfaces, except for some scattered shrubs, which have penetrated the soil of the rocky cracks. Inventory surveys were conducted in Jabal al-Zawiya, where this area is the original habitat of hawthorn, which was previously widespread but has diminished and deteriorated because of repeated violations and the conversion of forest lands into orchards planted with fruit trees.

- **Al-Rami site:**

This site is located at an altitude of 724 m, the soil is red Mediterranean terra-rosa emerging on hard limestone rocks, the plants found on the borders of agricultural orchards, and the remaining forest and pastoral lands in the area were studied, there are many dry plant species, including *Amygdalus orientalis*, C. azarolus var.*aronia*, *Asparagus acutifolius*, *Rhus coriaria*, *Capparis spinosa*, and others. Survey No. (R8) was conducted.

- **Marayan site:**

An exploration was conducted at a site within the town of Marayan at an altitude of 810 m. The soil is hard limestone, and the rocks are terra-rosa. Hawthorn can occupy rocky lands with little soil, and there are remains of natural plants on the edges of roads, in stony rocky lands, and on the borders of orchards. It consists of all the following: *Quercus calliprinos, Rhamnus palaestina, Phillyrea media, Pistacia palaestina, Rhus coriaria, C. azarolus*. Survey No. (R9) was conducted.

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- **Bazabour site:**

This site is located at an altitude of 705 m, where forest plants are found on the borders of agricultural lands. This site is one of the sites belonging to the Oaks region, as the soil is hard. Hawthorn is found with several species, including *Quercus calliprinos*, *Pistaciapalaestina*, *Rhuscoriaria*, *Phillyreamedia*, *C.azarolus*, *Pyrus syriaca*, *Thymus syriacus*. Survey No. (R10) was conducted.

- **Ariha area (Arbaeen Mount):**

A survey was conducted on the road that connects the city of Ariha o to Arbaeen Mount on one of the upper slopes of Arbaeen Mount, at an altitude of 465 m above sea level. The soil is aggregated because it is on the edges of the roads, where *C. azarolus* can occupy those soils with other species, such as *Rhus coriaria Thymus syriacus*, and others. Survey No. (R11) was conducted.

- **Muhambal site:**

It is an artificial afforestation site established in 1978 AD, located at an altitude of 352 m, on the edges of roads, and stony rocky lands, the soil is of the Terra Rosa type, red, Mediterranean, arising on hard limestone rocks, the main plants: *Pinus pinea*, *Pinus brutia*, *Cupressus sempervirens*, and a little *Eucalyptus camaldulensis*. Some shrubs of *C. azarolus*, *Olea europaea*, *Quercus calliprin*,and*Phillyrea media* grow naturally in some gaps. Survey No. (R12) was conducted.

3.3.3.2 Harem area:

- **Harem Mountains:**

They are three low and similar ranges in their north-south axes, and they are separated from each other by valleys named locally after the neighboring villages, such as Ghor Sardin, which separates Barisha from Al-Ala, and the Armnaz Plain, which separates Jabal Al-Ala from Jabal Al-Wasitani. These ranges run along the eastern edge of the Orontes Valley, and they are:

- **The first range:** In the east, Jabal Barisha, which extends from the borders of the Iskenderun district in the north and extends south for a length of 15 km and a width of 4-5 km, with an average height of 550 m and the highest peak of 657 m.
- **The second range:** To the west of Barisha, Jabal Al-Ala is located, and they are separated by the Sardin depression, which is 450 m above sea level and 2-4 km wide. The average height of Jabal Al-Ala is 625 m above sea level, and its highest peak is 819 m. The slopes of Barisha and Al-Ala overlook the Sardin basin with steep slopes and rocky cliffs, and Jabal Al-Ala extends from Harem in the north to Hafsarjah in the south.
- **The third range:** The furthest of these chains from the west is Mount Al-Wasitani, which lies between the Orontes Valley to the west, and the Al-Roj Plain, which separates it from the highest mountain to the east. It extends from Salqin in the north to the beginning of the Al-Ghab Plain to the south, with a length of 40 km and a width of 3-4 km. It consists of the merging of three narrow strips: Al-Duwaili, Al-Marasras, and Al-Wasitani. Its average height is 550-600 m, and its eastern slopes are moderately steep on the Al-Roj Plain, and its western slopes are very steep on the Orontes Valley. As for the plant aspect, the forest jungle grows in the Harim Mountains with very different and varying densities, sometimes being non-existent and sometimes reaching more than 90% or more. The most important of these species are *Quercus calliprinos, Q. infectoria, Q. aegilops, Olea europaea, Phillyrea media, Rhus coriaria, Styrax officinalis, Laurus nobilis,* and the rare presence of *Ceratonia siliquia, Rhamnus palaestinus, Osyris alba*, and others.

- **Armanaz (Biatis) site:**

This site is located at an altitude of 285 m above sea level, at the eastern foot of Mount Al-Wasitani, in the cemetery of Biatas, as this cemetery contains huge trees. This cemetery is almost deserted, but it is exposed to grazing. The soil is terra-rosa, most likely washed from the neighboring mountains and collected in it. Within the cemetery, there are remains of the natural vegetation that was prevalent in the area, such as *Quercus calliprinos, Phillyrea media, Pistacia palaestina, Ephedra campylopoda, Asparagus acutifolius, Anagyrisfoetida, Lyciumbarbarum*. Survey No. (R13).

- **Aqaba site:**

It is located at an altitude of 390 m above sea level, its soil is red terra-rosa, arising on hard limestone rocks, a deteriorated site due to overgrazing and firewood harvesting, due to the presence of sheep breeders, a landfill, and the expansion of the road, but

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firewood harvesting played a major role in the deterioration, the site was dominated by *Quercus calliprinos*, *Phillyrea media*, *Styrax officinalis*, and is a first-class natural habitat for *Olea europaea*, and the extension of this mountain towards Harem is dominated by some scattered trees, and very rare Ceratonia siliqua, and sometimes some spots of *Pinus brutia*normally appear within the area, spread on the Marin limestone soils, especially towards the village of Isqat in the countryside of Salqin. Survey No. (R14) was conducted.

Table (5): Botanical surveys that contributed to the identification of hawthorn in various locations

	Al-Rami	Marayan	Bzabour	Ariha	Mahmbal	Armanaz	Aqaba	
	8	**9**	**10**	**11**	**12**	**13**	**14**	Survey No.
	724	810	705	465	352	285	390	Height above sea level (m)
	20	20	30	40	30	20	60	Slope (%)
	S	W	N	W	E	N	N	Exposure
PR	20	20	10	25	20	60	20	Percentage of vegetation cover (%)
	1.5	2	1.5	1.5	3	10	1	Average tree height (m)
	C.d.	C.d.	C.d.	C.d.	C.d.	C.d.	C.d.	Type of parent rock
	100	100	100	100	100	100	100	Survey area (m²)
	6/2024	6/2024	6/2024	5/2024	5/2022	5/2023	5/2023	Survey date
7	1.1	2.1	1.1	1.1	1.1	3.2	2.2	*Quercus calliprinos*
2	.	.	+	.	.	1.1	.	*Quercus. aegilops*
5	.	+	+	1.1	.	1.1	1.1	*Q. infectoria*
1	.	.	.	.	4.3	.	.	*Pinus brutia*
1	.	.	.	.	4.4	.	.	*Pinus pinea*
1	.	.	.	.	2.1	.	.	*Cupressus sempervirens*
1	.	.	.	.	1.1	.	.	*Eucalyptus camaldulensis*
1	.	.	.	.	.	.	+	*Ceratonia siliqua*
7	1.1	1.1	1.1	+	+	+	+	*Pistacia palaestina*
4	+	+	+	.	.	+	.	*Asparagus acutifolius*
7	+	+	+	+	+	+	+	*Crataegus azarolus*
7	+	1.1	1.1	1.1	+	1.1	1.1	*Phillyrea media*
7	1.1	+	+	+	+	+	+	*Rhamnus palaestina*
5	+	+	+	.	+	+	.	*Osyris alba*
3	1.1	+	+	.	.	.	.	*Amygdalus orientalis*
4	+	1.1	1.1	+	.	.	.	*Prunus mahaleb*
2	.	+	+	.	.	.	.	*Crataegus azarolus* var*clorocarpa*
3	1.1	+	+	.	.	.	.	*Pyrus syriaca*
2	1.1	.	.	+	.	.	.	*Pistacia atlantica*
4	1.1	1.1	+	+	.	.	.	*Echinopsspinosissimus*subsp. *bithynicus*
7	1.1	1.1	1.1	+	+	+	+	*Avena fatua*
7	1.1	1.1	1.1	+	+	+	+	*Avena barbata*
5	+	+	+	+	+	.	.	*Centaurea calcitrapa*
2	.	+	.	+	.	.	.	*Foeniculum vulgare*
3	.	+	+	+	.	.	.	*Hypericum triquetrifolium*
2	.	+	.	+	.	.	.	*Plantago lanceolata*
2	.	+	.	+	.	.	.	*Arum orientale*
5	+	+	+	+	+	.	.	*Ficus carica*
3	.	+	+	.	.	.	1.1	*Olea europaea*
2	.	.	+	.	.	.	1.1	*Styrax officinalis*
3	+	.	+	+	.	.	.	*Capparis spinosa*
4	+	+	+	.	.	+	.	*Anagyrisfoetida*
2	.	.	.	+	.	+	.	*Lyciumbarbarum*
2	.	.	+	+	.	.	.	*Bromus syriaca*
1	.	.	+	.	.	.	.	*Aristolochia altissima*
2	.	.	+	+	.	.	.	*Clematis flammula*
2	.	+	+	.	.	.	.	*Jasminumfruticans*
7	1.1	1.1	1.1	2.2	+	+	+	*Rhus coriaria*
3	.	+	+	+	.	.	.	*Eryngium falcatum*
2	.	+	.	.	.	.	+	*Ceterachofficinarum*
2	.	+	+	.	.	.	.	*Teucrium polium*
3	.	+	+	.	.	+	.	*Ephedra campylopoda*

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2	.	.	.	+	.	+	.	*Umbilicus intermedius*
1	.	.	.	+	.	.	.	*Ajuga chia*
1	.	.	.	+	.	.	.	*Tamus communis*
3	.	+	.	.	.	+	+	*Rhus cotinus*
4	.	.	+	+	.	+	+	*Clematis vitalba*
2	.	.	+	+	.	.	.	*Rosa glutinosa*
5	+	+	+	+	.	.	+	*Phlomisviscosa*
4	+	+	+	.	.	.	1.1	*Calycotomevillosa*
6	+	+	+	+	+	.	1.1	*Poterium spinosum*
3	.	+	+	+	.	.	.	*Asphodelusmicrocarpus*
1	.	.	.	+	.	.	.	*Bryonia multiflora*
2	.	+	+	.	.	.	.	*Origanum syriacum*
3	.	+	+	+	.	.	.	*Micromeriamyrtifolia*
2	.	+	.	.	.	.	+	*Teucrium polium*
1	.	.	+	.	.	.	.	*Lavatera punctata*
6	+	+	+	+	+	.	+	*Thymbra spicata*
2	.	.	+	+	.	.	.	*Thymus syriacus*
2	.	.	+	+	.	.	.	*Dactylis glomerata*
4	+	+	+	+	.	.	.	*Phlomis longifolia*
5	+	+	+	+	+	.	.	*Hordeum bulbosum*
2	.	.	.	+	+	.	.	*Tragopogon buphtalmoides*
2	+	+	.	.	.	.	.	*Bromus lancelatus*
5	+	+	+	+	+	.	.	*Phalaris minor*
3	+	.	+	+	.	.	.	*Sinapis arvensis*
2	.	+	+	.	.	.	.	*Salvia officinalis*

Abbreviations: Frequency of presence PR: Presence; - None Nèant: -; Parent rock and soil: Hard limestone Calcaire dur: C.d.; Cretaceous limestone (Cretaceous rock) Cretaceous: Cret.

The climatic study, which is the results of the bioclimatic analysis of Emberger, showed that the hawthorn genus was able to extend within multiple bioclimatic structures, as it extends in each of the humid temperate structures, the sub-humid temperate structures, the sub-humid frais, the semi-arid temperate structures, and the semi-arid frais. It was also shown through the botanical surveys and the inventories that were conducted, that the hawthorn plant is environmentally flexible, and that the hawthorn did not constitute a characteristic species, but was always an accompanying species, as it was considered one of the species accompanying the Syrian forests, including the sites that were studied, and it does not rise to the level of distinct species that are included in the designation of its plant communities.

Also, through this study, it was shown that the *Crataegus monogyna* species belongs to the order *Quercetaliapubescentis*, which belongs to the class *Querceteapubescentis*, whose components are within the plant alliance *Quercioninfectoriae*, which includes deciduous oak forests, as it belongs to the Supra-Mediterranean structure, and is a component of it, noting that it seeps into the Eu- Mediterranean structure and Mountainous -Mediterranean structure, as we noticed that it spreads at an altitude of 700 m and above, and to a lesser extent at lower altitudes, within the bridge areas, which are close to the Mediterranean Sea, and its presence is linked to the height above the ground, but it is not found in the deeper interior areas, while the species *C. azarolus* belongs to the order *Quercetaliailicis*, which belongs to the class *Querceteailicis*, whose components are within the plant alliance *QuorcionCalliprini*. Which belongs to the Eu- Mediterranean structure, noting that it seeps into the Supra-Mediterranean structure,and the Thermos-Mediterranean plant structure.

IV. CONCLUSION

The study's results revealed that the hawthorn plant is environmentally flexible and does not form a characteristic species. Instead, it consistently appears as an accompanying species in Syrian forests and the studied sites. It does not reach the level of a characteristic species included in the designation of their plant communities.

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