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Assessment of Herbaceous Plant Composition, Diversity, and Indicator Species in the *Juniperus drupacea* Forest Openings of the Mountain Parnonas in Greece

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Abstract: A significant challenge in community ecology is the establishment of ecological baselines, which permit the evaluation of the variations in ecological dynamics at different temporal and spatial scales. To our best knowledge, few studies have been conducted in the forest openings of Mt. Parnon to establish a baseline for future monitoring. Hence, a floristic study of the herbaceous plant species composition, diversity, cover, and biomass was conducted in the forest openings of the Mt. Parnon-Natura 2000 Site in Greece to develop an ecological baseline that could be utilized in decision making for conservation and the sustainable use of forest biodiversity and ecosystem services in the forest ecosystem of Mt. Parnon. In the spring season, a thorough floristic survey was performed on Mt. Parnon for two consecutive years, 2021 and 2022. Herbaceous plant composition, diversity, cover, biomass, and plant indicator species (indicator value analysis) in the forest openings of Mt. Parnon were assessed. In the studied area, 63 plant species belonging to 58 genera from 20 families were recorded. The most numerous families were Asteraceae and Poaceae, followed by Fabaceae. Variable plant diversity, herbaceous plant cover, and produced biomass were recorded in different sites. It is noteworthy that some plant species could be regarded as indicators of the sites in the study area [*Geranium molle* L., *Cerastium candidissimum* Correns, *Vicia villosa* Roth, *Euphorbia myrsinites* L., *Odontarrhena muralis* (Waldst. & Kit.) Endl., *Medicago lupulina* L., *Lotus corniculatus* L., *Crepis fraasii* Sch. Bip., *Bellis sylvestris* Cirillo, and *Trifolium stellatum* L.], and information about these indicators, including Ellenberg type indicator values, is also provided. This study contributes to the understanding of the relevant ecological topics and provides key elements that could be utilized in decision making for the conservation and sustainable use of forest biodiversity and ecosystem services on Mt. Parnon.

Keywords: forest; biodiversity; cover; biomass; Ind Val; Natura 2000; Greece

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1. Introduction

Greece sits at the intersection of three major continents (Europe, Asia, and Africa). It has a long coastline and a wide range of ecosystems and is host to a wide variety of landscapes that hold significant aesthetic and cultural significance. Over half of the country is covered in semi-natural ecosystems and habitats, with 33% of the total area covered by forests and wooded regions, 13% by grassland, and 21% by scrubland. Wetlands and water comprise 2% of the Greek land, while barren land comprises 3%. Croplands, which account for 24% of the terrestrial terrain, and built-up areas, which account for 3%, are the most extensively managed and exploited areas [1–4].

Greece has diverse ecosystems, landscapes, and a high biodiversity. According to Dimopoulos [5], 6811 taxa (plant species and their subspecies) are distributed across 1089 genera and 184 families in Greek flora. Flora of Greece is rich in endemic species, comprising 1278 endemic species (22.2% of all species), and 452 endemic subspecies (22.1% of all subspecies) [5].

Juniperus drupacea Labill. is the tallest species of juniper, forming a conical tree 10 to 25 m tall, exceptionally up to 40 m, and with a trunk up to 1 to 2 m thick. It is a plant species with an ecological, medicinal, and economic value which makes it an interesting research topic. The species, commonly referred to as Syrian juniper, belongs to the family Cupressaceae. Currently, the species is primarily distributed in southeast Turkey, western Syria, Israel, and Lebanon. In Europe, its natural populations are confined to the southeastern portion of the Peloponnese Peninsula in Greece [6–9]. Specifically, over 95% of the *J. drupacea* populations in Greece are found on Mt. Parnon [6], with a few recorded populations in tiny patches on Mt. Taygetos [7–9]. Due to its decay-resistant wood, *J. drupacea* was once utilized for carpentry and fuel in Greece. However, its status as an endangered species prevents its widespread use today as it belongs to natural habitat types of community interest whose conservation requires the designation of special conservation areas [10]. Based on the International Union for the Conservation of Nature (IUCN) [11], *J. drupacea* is a species of least concern (LC) on a global scale. In Europe, however, it is classified as endangered (EN) [12] based on the criteria B1ab(iii) + 2ab(iii) [11]. According to FEK 121D/1980 [13], its ecological value has been recognized in Greece since 1980, when *J. drupacea* forests were designated a "natural monument under preservation". In 1992, it was added to Annex I of Directive 92/43/EEC as a priority habitat type, and the summits of Mt. Parnon and Malevi Monastery were designated as special protected areas (code: GR 2520006) under Natura 2000 [10].

Mt. Parnon hosts numerous species that contribute to biodiversity. The dominant primary producers in forest ecosystems are vascular plants, which are highly accurate indicators of the abiotic environment in which they thrive. In the EU Habitats Directive [10], plants are assumed to serve as habitat indicators and conservation status indicators. The aggregation of plant indicator values (e.g., Ellenberg indicator values [14]) is a commonly used method to assess local conditions in vegetation studies (e.g., [15,16]). It is plausible that the distribution and abundance of plant species are constrained by several abiotic factors, primarily climatic conditions (e.g., light, temperature, and precipitation), and soil characteristics (e.g., nutrient content, pH, and chemical composition) [17–19]. Species' responses to these variables determine their ecological tolerance (the range of conditions under which they can persist) and optimum (the value that is optimal for the species' survival, development, growth, and reproduction) [19,20]. Additionally, biotic factors, such as functional diversity, may operate as a mediator in the relationship between productivity and the diversity of herbaceous species in natural ecosystems [21]. According to Cadotte et al. [22], great functional diversity may indicate high trait divergence among plant species.

Hence, the main objectives of this study were to investigate characteristics of *J. drupacea* forest openings on Mt. Parnon: (a) the vascular plant composition on Mt. Parnon; (b) the plant diversity (species richness, Shannon-Weiner index, and Simpson index) among the investigated sites; (c) the plant cover and biomass among the sites; and (d) the relationships between herbaceous plant species and sites by using indicator value analysis (IndVal) to identify possible indicator species for the specific sites. This study seeks to gather data to help address research gaps related to the importance of forest openings that create a micro-niche and new growth opportunities for a wider variety of plants that affect forest ecosystem services.

2. Study Site and Methods

2.1. Study Site

The present study was conducted on 10 sites (S1-S10) of Mt. Parnon (37°19′39.27″ N, 22°35′0.94″ E), a Natura 2000 site. The region (GR2520006) is located on the southeastern

Peloponnesian Peninsula and includes the mountain mass of Parnonas. The map of the study area was created in the software QGIS (Figure 1). Its total area is about 55,767.52 ha, and its maximum and minimum altitudes are 1920.0 and 99.0 m, respectively. Geologically, the Mt. Parnon range is a part of the Gavrovo-Tripoli zone and primarily comprises a calcareous substrate. The characteristics of the sites are presented in Table 1. It is one of Peloponnisos' oldest regions and, like Taygetos, was long secluded. Mt. Parnon combines natural landscapes of high aesthetic value with remarkable manmade landscapes, such as the traditional settlements, historic monasteries, and a traditional rural landscape. The conifer forests of *Abies cephalonica* Loudon and *Pinus nigra* subsp. *pallasiana* (Lamb.) Holmboe flourishes on its slopes. Castanea forests are also extant in good condition and cover a large area [6,13].

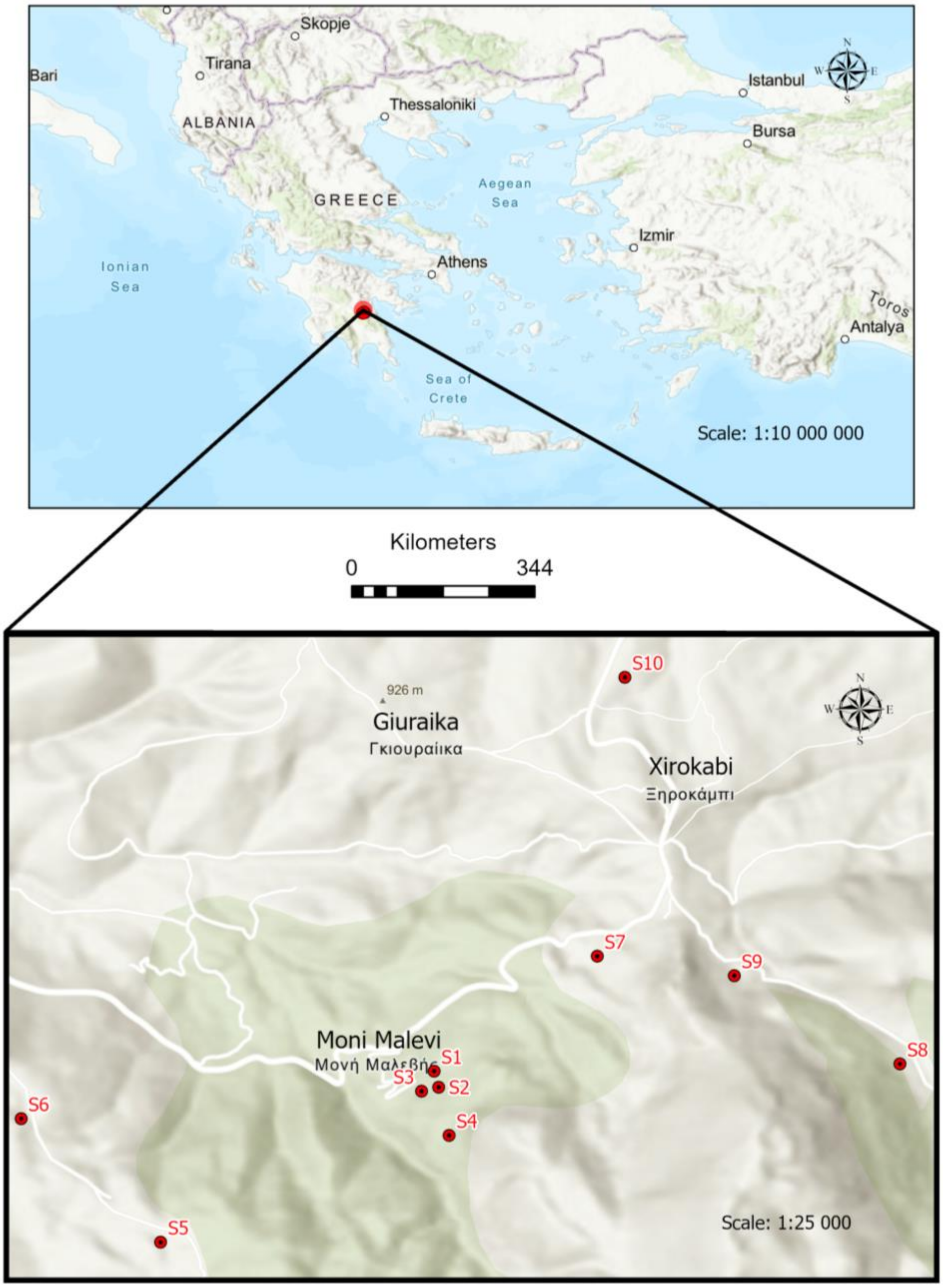

Figure 1. The study area (S1–S10 sampling sites) is located on Mt. Parnon (Peloponnesus, Greece).

Table 1. The characteristics of the sites on Mt. Parnon.

Sites	Latitude	Longitude	Altitude (m)	Soil Type	Slope (Degrees)	Aspect (Degrees)
S1	37°19′40.68″ N	22°35′2.45″ E	950	Loam	16.05	SW
S2	37°19′38.25″ N	22°35′3.14″ E	962	Loam	22.90	SW
S3	37°19′37.65″ N	22°35′0.54″ E	945	Loam	14.43	SW
S4	37°19′30.94″ N	22°35′4.72″ E	1011	Loam	15.00	SW
S5	37°19′14.73″ N	22°34′20.91″ E	1056	Loam	5.57	SW
S6	37°19′33.47″ N	22°33′59.74″ E	1030	Loam	10.84	SE
S7	37°19′58.15″ N	22°35′27.23″ E	937	Clay loam	9.98	NW
S8	37°19′41.79″ N	22°36′13.18″ E	1022	Clay loam	17.77	NE
S9	37°19′55.18″ N	22°35′48.03″ E	977	Clay loam	18.31	NE
S10	37°20′40.48″ N	22°35′31.42″ E	910	Clay loam	2.97	NE

The climate of the region is Mediterranean. From the data recorded at the nearest meteorological station at Malevi Monastery, total precipitation in spring 2021 was 52.1 mm, whereas it reached 105.4 mm in spring 2022. The mean daily air temperature ranged from 8°C to 24.5 °C in spring 2021 and from 6°C to 23.9 °C in spring 2022 (Figure 2).

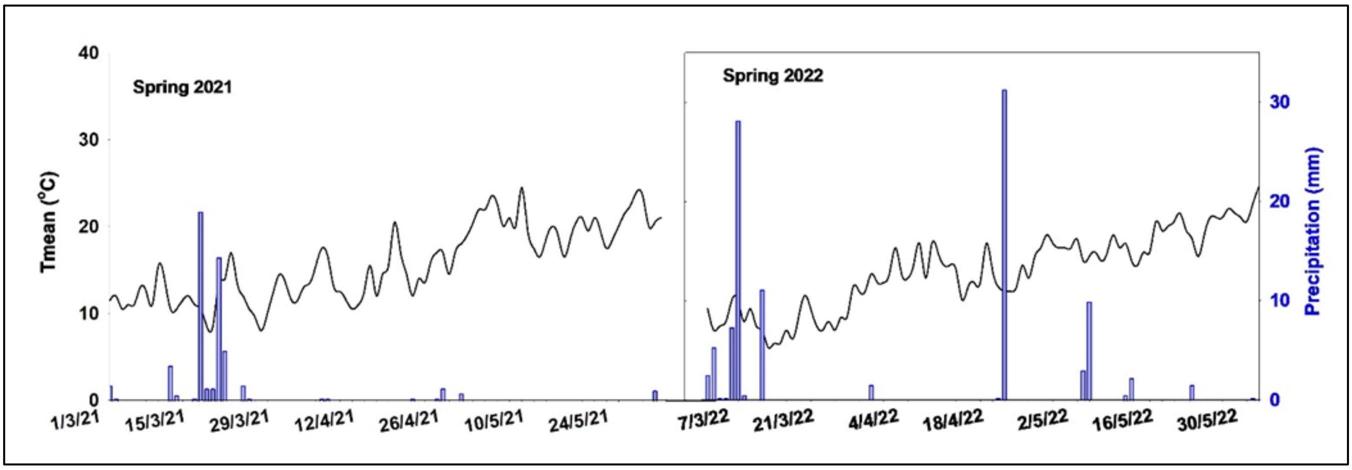

Figure 2. Variation of mean daily temperature and precipitation in the study area according to the data from the nearest meteorological station at Malevi Monastery.

2.2. Sampling

The sampling of herbaceous plant species was conducted at 10 sampling sites measuring 100 m^2 in forest openings that were accessible in the spring seasons of 2021 and 2022 (Figure 3a) because plants are in their flowering and the maximum of their productive capacity (plant biomass). At each sampling site, the plant species were recorded in nine 1 m^2 sub-quadrats within a 100 m^2 quadrat (Figure 3b), and the species richness and number of individuals of each plant species and the total percentage of plant cover were measured [23]. To determine the plant samples, the“Flora Europaea” [24,25], the “Flora Hellenica” [26], and the vascular plants of Greece:an annotated checklist [5] were used. Life form, chorology, and status categories of plant species follow the system of Dimopoulos et al. [5,9] and Raunkiaer 1934 [27]. A total surface cut of all above-ground plant parts of nine 1 m^2 sub-quadrats within a 100 m^2 quadrat at each sampling site was then conducted and transported to the laboratory. All the plant species of each of 1 m^2 sub-quadrat were placed in a drying oven (BINDER FED 400) at a temperature of 65 °C for 48 h, and the dry herbage biomass was then weighed on a precision balance to determine the dry weight [28].

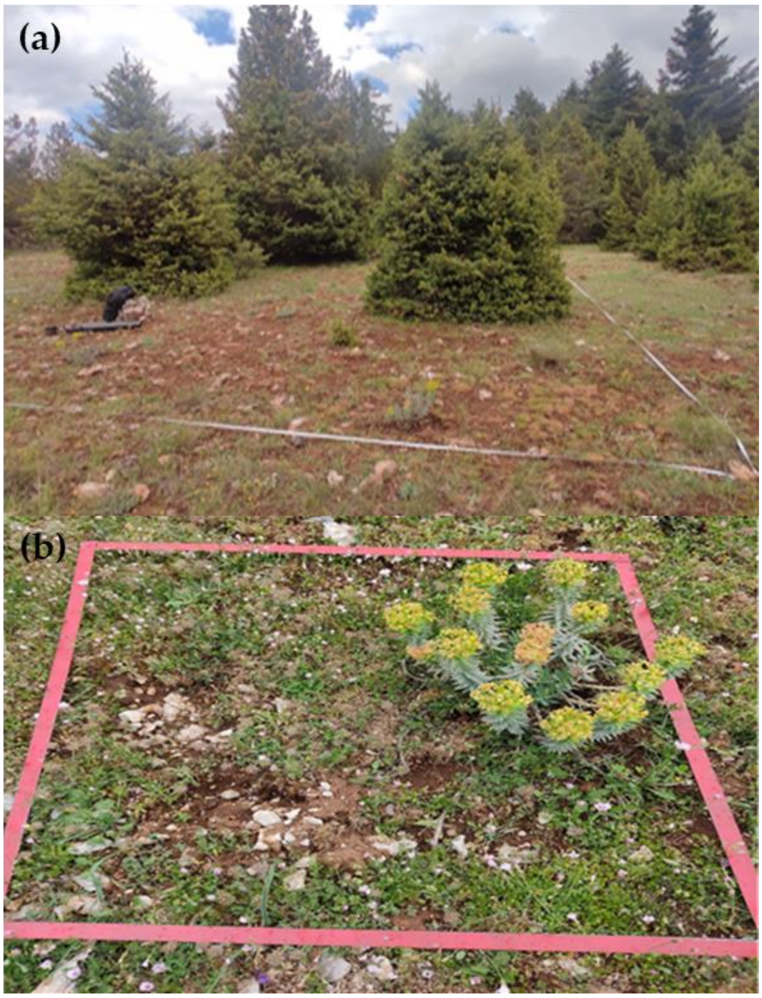

Figure 3. Example of the sampling plots comprising (**a**) 100 m^2 and (**b**) 1 m^2.

2.3. Statistical Analyses

The Kolmogorov–Smirnov and Shapiro–Wilk tests for the confirmation of the normal distribution of data were used. Plant diversity was assessed using the following biodiversity indices [29,30]:

- Species richness (*S*): It measures the number of species in a sampling site. The more species there are in a sample, the richer the sample is.
- The Shannon diversity index (*H*): The index considers the number of species present in the sample and the relative number of individuals present for each species. It is used to quantify specific biodiversity. Values less than 1.5 are interpreted as sites with relatively low species diversity, while those greater than 2.0 are high. Mathematically, the Shannon index is calculated by the following expression:

$$H' = -\sum_{i=1}^{s} P_i \text{In} P_i$$

where H' is the species diversity index, s is the number of species, and p_i is the proportion of individuals of each species belonging to the ith species of the total number of individuals.

- The Simpson dominance index (*D*) considers not only the number of observed species but also their degree of dominance. It is calculated using n_i as the abundance of a specific taxon in a specific sampling area, divided by the total number of taxa present in it. The value of the Simpson index (*D*) varies between 0 and 1. The higher the value of the index, the lower the diversity.

The Simpson index is given by the following formula:

$$D' = 1 - \sum_{i=1}^{s} \frac{n_i(n_i - 1)}{N(N-1)}$$

where N is the total number of individuals in the sampling plot, and n_i is the number of individuals belonging to species i.

All the above indexes were examined with the Species Diversity and Richness IV software [31].

Regarding the control of differences in the values of the biodiversity variables studied between the two sampling years, the method of repeated measures analysis of variance under the general linear model (ANOVA) was used. No statistically significant differences ($p > 0.05$) were detected between the two sampling years, and for this reason, the average was used to increase the robustness and generalization of the results, incorporate annual variation, and produce a logical basis on which their future trends could be analyzed [4].

To study changes in plant species composition in the biocommunity, the "Indicator Value-IndVal" method of Dufrene and Legendre [32] was used. This method assigns "indicator species" (IndVal > 50%) to each sampling area based on the relative abundance of the species and their frequency of occurrence in the samples. The IndVal index ranges between 0 and 100. A species is a perfect indicator of a particular area when the IndVal index equals 100. The calculation of the IndVal index values was conducted with the IndVal software [33]. Moreover, only for the "indicators species" that emerged from the IndVal method, the Ellenberg indicator values were used to express plant preferences for light indicator values (L), temperature indicator values (T), moisture indicator values (M), reaction indicator values (R), nutrient indicator values (N), and salinity indicator values (S). More information about the Ellenberg indicator values and related information can be found in Tichý [34]. All the above indicator values can be utilized in decision making for biodiversity conservation and management.

3. Results

3.1. Plant Composition, Diversity, Cover, and Biomass Dynamics J. drupacea Forest Openings in Mt. Parnon

In the studied area, 63 plant species belonging to 58 genera and 20 families were identified (Figure 4). The most numerous families were *Asteraceae* (20.63%), *Poaceae* (19.05%), and *Fabaceae* (9.52%). The sites with the greatest number of plant species were S1 (21 species), S2 (23), S3 (23), and S4 (19), while the site with the fewest plant species was S10 (10). In addition, 88.89% of plant species are native/non-range restricted, whereas 11.1% are native/range restricted. According to the life form spectrum of the vegetation, therophytes (40.32%) contributed the most to the total number of recorded species in the study area, followed by hemicryptophytes (37.09%) and phanerophytes (1.61%). The documented species' chorological spectrum revealed that Mediterranean species comprised 18.33% of the total flora, followed by paleotemperate species (13.33%). In addition, European–Southwest Asian (11.66%) and Mediterranean–Southwest Asian (11.66%) species were well represented. Appendix A (Tables A1–A11) presents the plant species recorded at each site (S1–S10) on Mt. Parnon.

In terms of herbaceous plant diversity (species richness, Shannon–Wiener, and Simpson), the randomization test of Solow (1993) revealed statistically significant differences ($p < 0.05$) between the sampling sites. Specifically, the highest plant diversity was recorded at the S1, S2, S3, and S4 sites, followed by the S5 and S6 sites, and the lowest plant diversity was recorded at the S7, S8, S9, and S10 sites (Table 2).

Figure 5 shows the mean herbaceous plant cover (%) on the S1–S10 sites. Significant statistical differences ($F = 113.44$ and $p = 0.00$) were detected in the percentage of herbaceous plant cover among the different sites of the study area. Specifically, the highest values were observed at S1, S2, S3, S4, S5, S6, S9, followed by S7 and S8, and the lowest values were observed at S10.

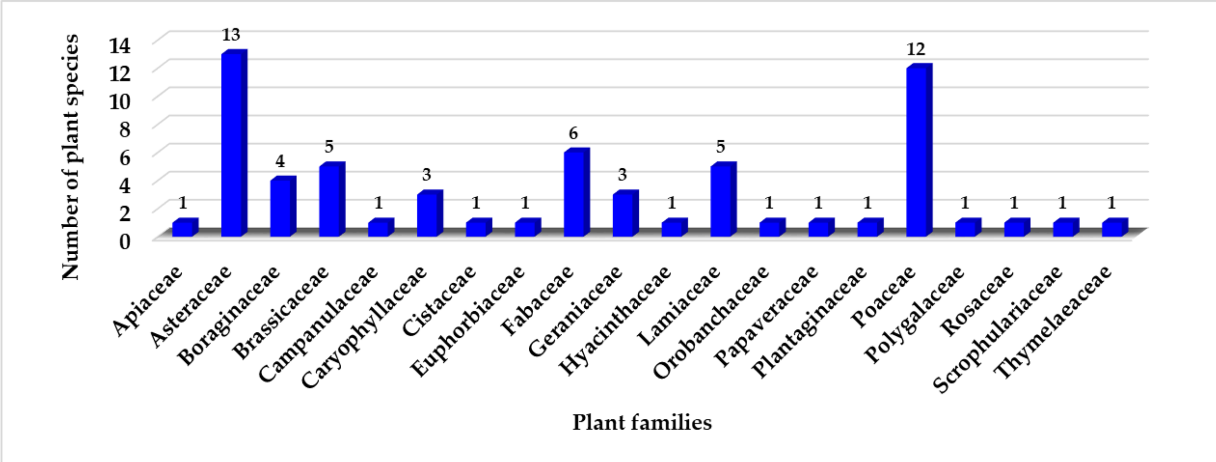

Figure 4. Distribution of plant species across families in the investigated *J. drupacea* forest openings in the Mt. Parnon.

Table 2. Plant diversity indexes in sites (S1–S10).

	Species Richness	Shannon-Wiener (H) (1)	Simpson (D) (2)
S1	21	2.67a *	0.33d
S2	23	2.71a	0.32d
S3	23	2.69a	0.34d
S4	19	2.60a	0.32d
S5	16	2.03b	0.39c
S6	15	2.02b	0.37c
S7	13	1.94c	0.67b
S8	14	1.97c	0.64b
S9	12	1.96c	0.65b
S10	10	1.89d	0.71a

* For all sites with the same letter, the difference between the means is not statistically significant.

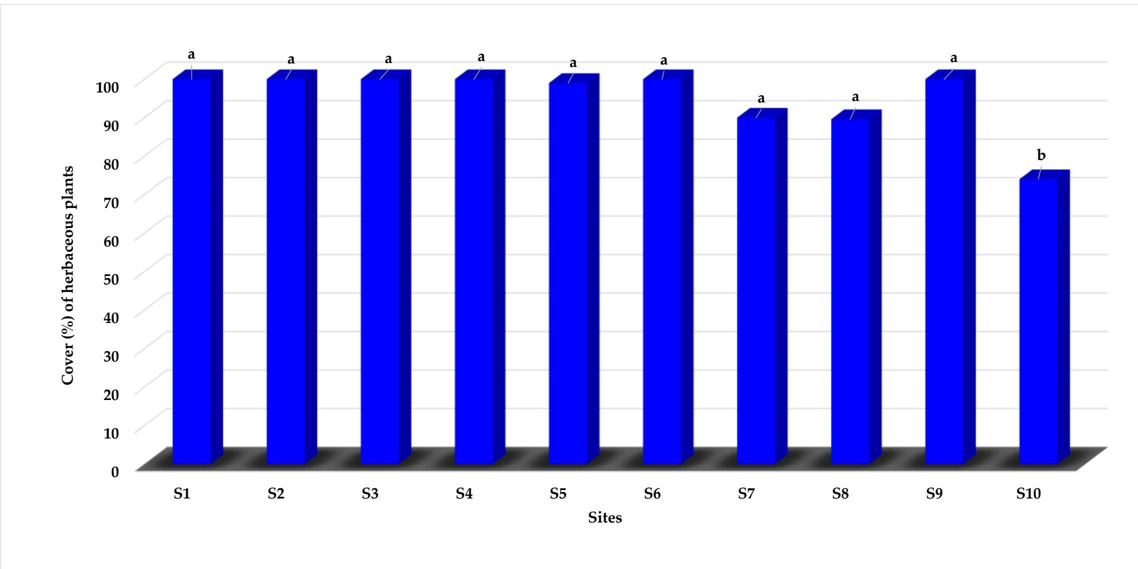

Figure 5. Mean cover (%) of herbaceous plants in the sampling sites (S1–S10). For all sites with the same letter, the difference between the means is not statistically significant.

Figure 6 shows the mean produced biomass of herbaceous plant species (g/m^2) on the S1–S10 sites. Significant statistical differences (F = 4.48 and p = 0.00) were detected in the produced biomass among the different sites of the study area. Specifically, the highest values were observed at S2, followed by S1, S3, S4, subsequently by S5, S6, and then by S7, S8, S9, while the lowest values were observed at S10.

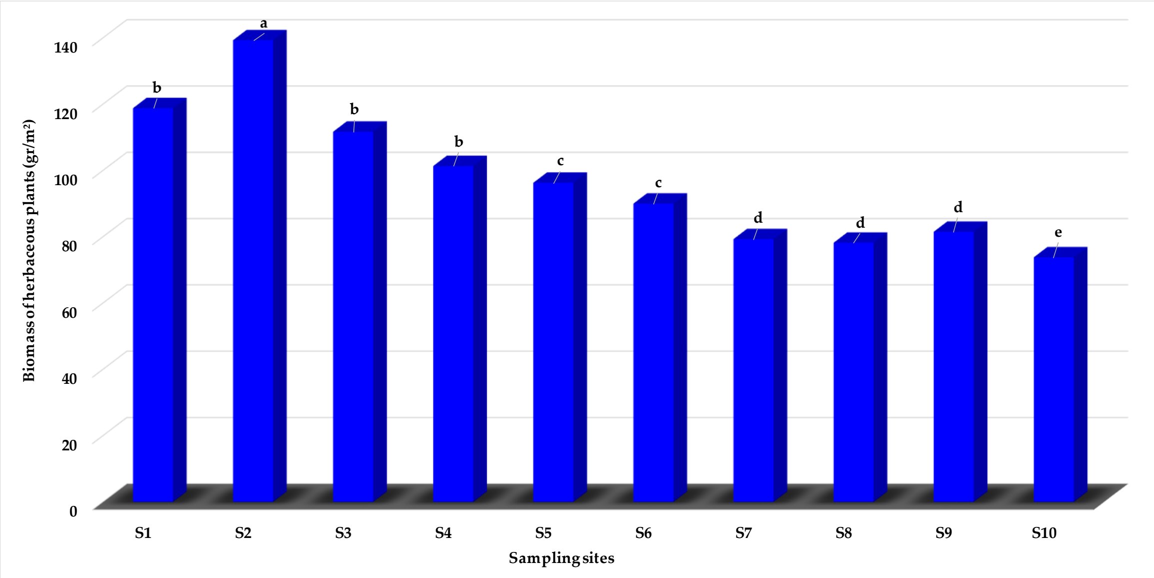

Figure 6. Mean biomass of herbaceous plants produced (g/m^2) in the sampling sites. For all sites with the same letter, the difference between the means is not statistically significant.

3.2. Identifying Indicator Plant Species

The IndVal procedure, which was used to evaluate possible indicator species in herbaceous plant communities, showed that one species (*Muscari neglectum*) could be regarded as eurytopic (Table 3). Additionally, several herbaceous plant species (IndVal > 50%)—*Geranium molle* (S1), *Cerastium candidissimum* (S2), *Vicia villosa* (S3), *Euphorbia myrsinites* (S4), *Odontarrhena muralis* (S5), *Medicago lupulina* (S6), *Lotus corniculatus* (S7), *Crepis fraasii* (S8), *Bellis sylvestris* (S9), and *Trifolium stellatum* (S10)—were recorded at each site. These species should be regarded as "characteristic indicator species" of each site. Ellenberg indicator values for the above plant species, providing a proxy measure of environmental conditions, are presented in Table 4.

Table 3. IndVal analysis for herbaceous plant species.

Species	Family	(IndVal > 50%)	Sites
Bellis sylvestris Cirillo	Asteraceae	81.1	S9
Cerastium candidissimum Correns	Caryophyllaceae	83.4	S2
Crepis fraasii Sch. Bip.	Asteraceae	68.9	S8
Euphorbia myrsinites L.	Euphorbiaceae	75.3	S4
Geranium molle L.	Geraniaceae	78.5	S1
Lotus corniculatus L.	Fabaceae	81.2	S7
Medicago lupulina L.	Fabaceae	67.5	S6
Muscari neglectum Ten.	Hyacinthaceae	92.5	All sites
Odontarrhena muralis (Waldst. & Kit.) *Endl.*	Brassicaceae	62.0	S5
Trifolium stellatum L.	Fabaceae	89.41	S10
Vicia villosa Roth	Fabaceae	72.3	S3

Table 4. Ellenberg-type indicator values only for "characteristic indicator species". Ecological indicators are in order: light (L), temperature (T), soil moisture (F), soil reaction (R), soil Nutrients (N), and salinity (S).

Plant Species	Light Indicator(L)	Temperature Indicator (T)	Soil Moisture Indicator (M)	Soil Reaction Indicator (R)	Nutrient Indicator(N)	Salinity Indicator (S)
Bellis sylvestris Cirillo	6.0	x *	x	6.0	4.0	0.0
Cerastium candidissimum Correns	NA **	NA	NA	NA	NA	NA
Crepis fraasii Sch. Bip.	3.7	NA	5.7	NA	4.3	0.0
Euphorbia myrsinites L.	9.0	6.0	3.0	7.0	NA	0.0
Geranium molle L.	x	x	4.0	7.0	6.0	0.0
Lotus corniculatus L.	NA	NA	NA	NA	NA	NA
Medicago lupulina L.	7.0	x	5.0	7.0	5.0	0.0
Muscari neglectum Ten.	7.0	x	5.0	8.0	6.0	1.0
Odontarrhena muralis (Waldst. & Kit.) *Endl.*	NA	NA	NA	NA	NA	NA
Trifolium stellatum L.	7.0	x	4.0	x	6.0	1.0
Vicia villosa Roth	7.0	x	4.3	7.0	6.0	0.0

x *: wide ecological range, NA **: non-available.

4. Discussion

4.1. Plant Composition, Diversity and Cover at the Sites

Our study showed that the most numerous families were Asteraceae and Poaceae, followed by Fabaceae, which reflects the prevailing situation in the Greek area, as these families are among the three most numerous families in Greece and the Mediterranean [9,35,36]. According to Gilliam [37], the understory is an important component of forest ecosystems; it influences energy flow and nutrient cycling, biodiversity, and regeneration ability. Furthermore, the understory responds quickly to both natural and manmade disturbances [38], such as avoiding erosion and creating favorable microenvironments for the development of other species [39], microenvironments, and stand conditions [40].

Plant diversity and cover were observed at high levels at most of the sites. This is probably due to the fact of the topographic diversity and the existing vegetation of Mt. Parnon [6]. Additionally, sufficient nutrients and water based on the soil type of the sites may have contributed to the development of rich vegetation and cover. Thus, species with high productivity rates and the ability to produce rich above-ground vegetation and cover are favored in plant communities of the forest openings [41,42].

The lower plant diversity and cover recorded at some sites may be a result of the increased degree of shading of the trees due to their high coverage, which decisively affects the available solar radiation for the plants (photosynthesis) growing in the understory [41,42]. The effect of tree shading on herbaceous plant composition, diversity, and cover is related to the different plant species present in the understory. Specifically, boreal Poaceae species are favored by light and moderate shading, while thermal species and almost all legumes are limited [43,44].

4.2. Herbaceous Plant Biomass at the Sites

Biomass is a basic characteristic of vegetation that reflects the fertility of soil re-sources used by specific plant species [45]. At most of the sites, the biomass production was recorded at satisfactory levels. It is documented that the amount of production in natural ecosystems is affected by the species, age, and density of the trees in the overlying stand, as well as the species and shade tolerance level of the herbaceous plants [46]. According to Wolters et al. [47], the production of herbaceous plants is directly affected by the quality and age of the trees in the upland, the available nutrients in the soil, and the management measures applied.

It is known that soil texture plays a key role in carbon storage and strongly influences nutrient retention and availability. Additionally, the plants of the Fabaceae family enrich the soil with nutrients, especially with nitrogen, increasing soil productivity. This is a possible reason for the plant biomass production of the sites. Halpern and Lutz [48] and McCarthy et al. [49] have highlighted the significance of topography for herbaceous understory vegetation [44,50–55].

4.3. Typical Herbaceous Plant Species

Researchers evaluate various management practices in terms of the environmental, social, and productive benefits that ecosystems must offer by recording the population fluctuations of specific organisms. The plant species are used as indicators in forested areas and play a particularly beneficial role in these ecosystems. A useful hypothesis to consider is that the minimum biodiversity necessary to maintain a particular ecosystem function may be represented by a single keystone species or a functional group [56].

According to IndVal analysis, the herbaceous plant species, *Muscari neglectum*, could be regarded as eurytopic and is characterized by its ability to live in a wide variety of sites and tolerate a wide range of environmental conditions. Therefore, it is present in all sites of the study area.

According to IndVal analysis, the herbaceous plant species, *Bellis sylvestris* (S9), *Cerastium candidissimum* (S2), *Crepis fraasii* (S8), *Euphorbia myrsinites* (S4), *Geranium molle* (S1), *Lotus corniculatus* (S7), *Medicago lupulina* (S6), *Odontarrhena muralis* (S5), *Trifolium stellatum* (S10), and *Vicia villosa* (S3), were recorded as "characteristic indicator species". Based on Tichý [34] and Zolotova [57], the plant species, *Bellis sylvestris*, is characterized by values of ecological indicators that interpret the ecological conditions in which it is adapted to grow. More specifically, it is a plant that generally prefers well-lit but also partially shaded positions. It is an indicator of slightly acidic conditions (pH 6–6.9), and it is found both in habitats that are more or less poor in nutrients and in habitats with moderate nutrient availability. *Crepis fraasii* is a plant that prefers partially shaded positions; it has moderate moisture requirements and is found both in habitats that are more or less poor in nutrients, as well as in habitats with moderate availability of nutrients. *Euphorbia myrsinites* is a plant that prefers well-lit and warm sites. It has moderate moisture requirements and is an indicator of weakly acidic to weakly basic conditions. *Geranium molle* prefers dry to cool habitats. It is an indicator of weakly acidic to weakly basic conditions and occurs both in habitats that are more or less rich in nutrients, as well as in habitats with moderate nutrient availability. *Medicago lupulina* prefers sunshiny but also partially shaded sites. It has moderate moisture requirements and is an indicator of biotopes with moderate availability of nutrients and weakly acidic to weakly basic conditions. *Trifolium stellatum* prefers partially shaded locations and is an indicator of dry to cool habitats that are moderate nutrient availability. *Vicia villosa* prefers full of light but also partially shaded locations. It is found in dry to cool habitats and is an indicator of weakly acidic to weakly basic conditions. *Vicia villosa* is an indicator of habitats that are richer in nutrients, as well as in habitats with moderate nutrient availability [58].

5. Conclusions

The present research highlights the importance of the *J. drupacea* ecosystem in terms of enhancing plant biodiversity on Mt. Parnon. On Mt. Parnon, moderate to high plant diversity, cover, and biomass of herbaceous plants were observed on most sites of the study area.

Moreover, the "indicator plant species" that have emerged at sites could be used to indicate the environmental conditions according to Ellenberg-type indicator values. This study gathers data to help address research gaps related to the importance of forest openings that create a micro-niche and new growth opportunities for a wider variety of plants that affect forest ecosystem services.

Future research should focus on the evaluation of the environmental impacts on the plant diversity of forest openings, which could be utilized in decision making for conservation and the sustainable use of forest biodiversity and ecosystem services on Mt. Parnon. Additionally, the comparison of forest openings with some other type of vegetation occurring in the habitat could be an important indicator of the ecosystem status for the relatively easy and inexpensive assessment of ground vegetation monitoring as well as constituting an acknowledged basis for ecosystem biodiversity assessment.

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Appendix A

Table A1. Herbaceous plant species at all sites of the study area.

Plant Species	Family	Status	Chorology	Life-Form
Aegilops neglecta Bertol.	Poaceae	Native/Non-Range Restricted	Mediterranean-SW Asian	Therophyte
Aira elegans Roem. & Schult.	Poaceae	Native/Non-Range Restricted	Mediterranean-SW Asian	Therophyte
Alkanna graeca Boiss. & Sprumer	Boraginaceae	Native/Non-Range Restricted	Greek endemic	Hemicryptophyte
Alyssum montanum L.	Brassicaceae	Native/Non-Range Restricted	European-SW Asian	Chamaephyte
Alyssum murale Waldst. & Kit.	Brassicaceae	Native/Non-Range Restricted	Mediterranean-European	Hemicryptophyte
Anchusa undulata Juss.	Boraginaceae	Native/Non-Range Restricted	Mediterranean	Hemicryptophyte
Anthemis tinctoria L.	Asteraceae	Native/Non-Range Restricted	European	Hemicryptophyte
Astragalus angustifolius Lam.	Fabaceae	Native/Non-Range Restricted	East Mediterranean	Chamaephyte
Avena barbata Link	Poaceae	Native/Non-Range Restricted	Mediterranean	Therophyte
Ballota acetabulosa (L.) Bentham	Lamiaceae	Native/Non-Range Restricted	Balkan-Anatolia	Chamaephyte
Bellardia latifolia (L.) Cuatrec.	Orobanchaceae	Native/Non-Range Restricted	Mediterranean-SW Asian	Therophyte
Bellis sylvestris Cirillo	Asteraceae	Native/Non-Range Restricted	Mediterranean	Hemicryptophyte
Bromus sterilis L.	Poaceae	Native/Non-Range Restricted	Mediterranean-SW Asian	Therophyte

Table A1. *Cont.*

Plant Species	Family	Status	Chorology	Life-Form
Bromus tectorum L.	Poaceae	Native/Non-Range Restricted	Paleotemperate	Therophyte
Campanula spatulata Sm.	Campanulaceae	Native/Non-Range Restricted	Balkan	Geophyte (Cryptophyte)
Capsella bursa-pastoris (L.) Medik.	Brassicaceae	Native/Non-Range Restricted	Cosmopolitan	Therophyte, Hemicryptophyte
Centaurea raphanina Sm.	Asteraceae	Native/Non-Range Restricted	Greek endemic	Hemicryptophyte
Cerastium candidissimum Correns	Caryophyllaceae	Native/Non-Range Restricted	Greek endemic	Hemicryptophyte
Crepis fraasii Sch. Bip.	Asteraceae	Native/Non-Range Restricted	East Mediterranean	Hemicryptophyte
Crepis neglecta L.	Asteraceae	Native/Non-Range Restricted	Balkan-Italy	Therophyte
Dactylis glomerata L.	Poaceae	Native/Non-Range Restricted	Paleotemperate	Hemicryptophyte
Erodium cicutarium (L.) L'Hér.	Geraniaceae	Native/Non-Range Restricted	Circumtemperate	Therophyte
Euphorbia myrsinites L.	Euphorbiaceae	Native/Non-Range Restricted	Mediterranean-European	Hemicryptophyte, Chamaephyte
Festuca pratensis Huds.	Poaceae	Native/Non-Range Restricted	European-SW Asian	Hemicryptophyte
Fumana thymifolia (L.) Webb	Cistaceae	Native/Non-Range Restricted	Mediterranean	Chamaephyte
Geranium molle L.	Geraniaceae	Native/Non-Range Restricted	Paleotemperate	Therophyte
Geranium rotundifolium L.	Geraniaceae	Native/Non-Range Restricted	Paleotemperate	Therophyte
Glebionis coronaria (L.) Spach	Asteraceae	Native/Non-Range Restricted	Mediterranean	Therophyte
Hordeum murinum L.	Poaceae	Native/Non-Range Restricted	Mediterranean-SW Asian	Therophyte
Hypochaeris achyrophorus L.	Asteraceae	Native/Non-Range Restricted	Mediterranean	Therophyte
Lactuca serriola L.	Asteraceae	Native/Non-Range Restricted	Paleotemperate	Therophyte, Hemicryptophyte
Lagurus ovatus L.	Poaceae	Native/Non-Range Restricted	Mediterranean	Therophyte
Lathyrus laxiflorus (Desf.) O. Kuntze	Fabaceae	Native/Non-Range Restricted	East Mediterranean	Hemicryptophyte
Lotus corniculatus L.	Fabaceae	Native/Non-Range Restricted	European-SW Asian	Hemicryptophyte
Malcolmia graeca Boiss. & Spruner	Brassicaceae	Native/Non-Range Restricted	Balkan	Therophyte
Medicago lupulina L.	Fabaceae	Native/Non-Range Restricted	Circumtemperate	Therophyte
Melica ciliata L.	Poaceae	Native/Non-Range Restricted	Mediterranean-SW Asian	Hemicryptophyte
Micromeria juliana (L.) Bentham ex Reichenb.	Lamiaceae	Native/Non-Range Restricted		Geophyte (Cryptophyte)

Table A1. *Cont.*

Plant Species	Family	Status	Chorology	Life-Form
Myosotis incrassata Guss.	Boraginaceae	Native/Non-Range Restricted	Mediterranean-European	Therophyte
Onopordum bracteatum Boiss. & Heldr.	Asteraceae	Native/Non-Range Restricted	East Mediterranean	Hemicryptophyte
Onosma graeca Boiss.	Boraginaceae	Native/Non-Range Restricted		Hemicryptophyte
Papaver rhoeas L.	Papaveraceae	Native/Non-Range Restricted	Paleotemperate	Therophyte
Plantago lanceolata L.	Plantaginaceae	Native/Non-Range Restricted	Cosmopolitan	Hemicryptophyte
Poa timoleontis Heldr. ex Boiss.	Poaceae	Native/Non-Range Restricted	East Mediterranean	Hemicryptophyte
Polygala cristagali Chodat	Polygalaceae	Native/Non-Range Restricted	Greek endemic	Hemicryptophyte
Ptilostemon afer (Jacq.) Greuter	Asteraceae	Native/Non-Range Restricted	Balkan-Anatolia	Hemicryptophyte
Salvia argentea L.	Lamiaceae	Native/Non-Range Restricted	Mediterranean	Hemicryptophyte
Sanguisorba minor Scop.	Rosaceae	Native/Non-Range Restricted	European-SW Asian	Hemicryptophyte
Scorzonera crocifolia Sibth. & Sm.	Asteraceae	Native/Non-Range Restricted	Greek endemic	Hemicryptophyte
Silene italica (L.) Pers.	Caryophyllaceae	Native/Non-Range Restricted	European-SW Asian	Hemicryptophyte
Sisybrium officinale L.	Brassicaceae	Native/Non-Range Restricted	[Cosmopolitan], Euro-Siberian	Therophyte
Sonchus asper (L.) Hill	Asteraceae	Native/Non-Range Restricted	Paleotemperate	Therophyte
Stellaria media (L.) Vill.	Caryophyllaceae	Native/Non-Range Restricted	Cosmopolitan	Therophyte, Hemicryptophyte
Teucrium aroanium Boiss.	Lamiaceae	Native/Non-Range Restricted	Greek endemic	Chamaephyte
Teucrium francisci-werneri Rech. Fil	Lamiaceae	Native/Non-Range Restricted	Greek endemic	Chamaephyte
Thymelaea tartonraira (L.) All.	Thymelaeaceae	Native/Non-Range Restricted	Mediterranean	Phanerophyte
Tordylium apulum L.	Apiaceae	Native/Non-Range Restricted	Mediterranean	Therophyte
Trifolium stellatum L.	Fabaceae	Native/Non-Range Restricted	Mediterranean	Therophyte
Tussilago farfara L.	Asteraceae	Native/Non-Range Restricted	Paleotemperate	Hemicryptophyte, Geophyte (Cryptophyte)
Veronica arvensis L.	Scrophulariaceae	Native/Non-Range Restricted	European-SW Asian	Therophyte
Vicia villosa Roth	Fabaceae	Native/Non-Range Restricted	European-SW Asian	Therophyte
Vulpia ciliata Dumort.	Poaceae	Native/Non-Range Restricted	Mediterranean-SW Asian	Therophyte

Table A2. Herbaceous plant species at the S1 site.

S1	Plant Species	Family
	Anthemis tinctoria L.	Asteraceae
	Avena barbata Link	Poaceae
	Bromus sterilis L.	Poaceae
	Bromus tectorum L.	Poaceae
	Campanula spatulata Sm.	Campanulaceae
	Centaurea raphanina Sm.	Asteraceae
	Crepis fraasii Sch. Bip.	Asteraceae
	Crepis neglecta L.	Asteraceae
	Dactylis glomerata L.	Poaceae
	Hordeum murinum L.	Poaceae
	Lotus corniculatus L.	Fabaceae
	Muscari neglectum Ten.	Hyacinthaceae
	Onopordum bracteatum Boiss. & Heldr.	Asteraceae
	Poa timoleontis Heldr. ex Boiss.	Poaceae
	Sanguisorba minor Scop.	Rosaceae
	Tordylium apulum L.	Apiaceae
	Trifolium stellatum L.	Fabaceae
	Tussilago farfara L.	Asteraceae
	Veronica arvensis L.	Scrophulariaceae
	Vicia villosa Roth	Fabaceae
	Vulpia ciliata Dumort.	Poaceae

Table A3. Herbaceous plant species at the S2 site.

S2	Plant Species	Family
	Aira elegans Roem. & Schult.	Poaceae
	Alyssum montanum L.	Brassicaceae
	Avena barbata Link	Poaceae
	Bellis sylvestris Cirillo	Asteraceae
	Bromus sterilis L.	Poaceae
	Bromus tectorum L.	Poaceae
	Campanula spatulata Sm.	Campanulaceae
	Cerastium candidissimum Correns	Caryophyllaceae
	Crepis fraasii Sch. Bip.	Asteraceae
	Crepis neglecta L.	Asteraceae
	Geranium molle L.	Geraniaceae
	Geranium rotundifolium L.	Geraniaceae
	Hordeum murinum L.	Poaceae
	Lactuca serriola L.	Asteraceae
	Lagurus ovatus L.	Poaceae
	Lathyrus laxiflorus (Desf.) O. Kuntze	Fabaceae
	Medicago lupulina L.	Fabaceae
	Melica ciliata L.	Poaceae
	Micromeria juliana (L.) Bentham ex Reichenb.	Lamiaceae
	Muscari neglectum Ten.	Hyacinthaceae
	Myosotis incrassata Guss.	Boraginaceae
	Scorzonera crocifolia Sibth. & Sm.	Asteraceae
	Trifolium stellatum L.	Fabaceae

Table A4. Herbaceous plant species at the S3 site.

S3	Plant Species	Family
	Anchusa undulata Juss.	Boraginaceae
	Anthemis tinctoria L.	Asteraceae
	Avena barbata Link	Poaceae
	Campanula spatulata Sm.	Campanulaceae
	Centaurea raphanina Sm.	Asteraceae
	Cerastium candidissimum Correns	Caryophyllaceae
	Crepis fraasii Sch. Bip.	Asteraceae
	Crepis neglecta L.	Asteraceae
	Dactylis glomerata L.	Poaceae
	Erodium cicutarium (L.) L'Hér.	Geraniaceae
	Festuca pratensis Huds.	Poaceae
	Hordeum murinum L.	Poaceae
	Hypochaeris achyrophorus L.	Asteraceae
	Muscari neglectum Ten.	Hyacinthaceae
	Myosotis incrassata Guss.	Boraginaceae
	Odontarrhena muralis (Waldst. & Kit.) Endl.	Brassicaceae
	Onopordum illyricum L.	Asteraceae
	Onosma graeca Boiss.	Boraginaceae
	Sisybrium officinale L.	Brassicaceae
	Tordylium apulum L.	Apiaaceae
	Trifolium stellatum L.	Fabaceae
	Vicia villosa Roth	Fabaceae

Table A5. Herbaceous plant species at the S4 site.

S4	Plant Species	Family
	Aegilops neglecta Bertol.	Poaceae
	Aira elegans Roem. & Schult.	Poaceae
	Campanula spatulata Sm.	Campanulaceae
	Centaurea raphanina Sm.	Asteraceae
	Crepis fraasii Sch. Bip.	Asteraceae
	Crepis neglecta L.	Asteraceae
	Euphorbia myrsinites L.	Euphorbiaceae
	Geranium molle L.	Geraniaceae
	Hordeum murinum L.	Poaceae
	Lathyrus sphaericus Retz.	Fabaceae
	Lotus corniculatus L.	Fabaceae
	Medicago lupulina L.	Fabaceae
	Muscari neglectum Ten.	Hyacinthaceae
	Onopordum illyricum L.	Asteraceae
	Papaver rhoeas L.	Papaveraceae
	Silene italica (L.) Pers.	Caryophyllaceae
	Trifolium stellatum L.	Fabaceae
	Vicia villosa Roth	Fabaceae
	Vulpia ciliata Dumort.	Poaceae

Table A6. Herbaceous plant species at the S5 site.

S5	Plant Species	Family
	Alkanna graeca Boiss. & Sprumer	Boraginaceae
	Astragalus angustifolius Lam.	Fabaceae
	Ballota acetabulosa (L.) Benth.	Lamiaceae
	Campanula spatulata Sm.	Campanulaceae
	Capsella bursa-pastoris (L.) Medik.	Brassicaceae
	Euphorbia myrsinites L.	Euphorbiaceae
	Glebionis coronaria (L.) Spach	Asteraceae
	Lathyrus laxiflorus (Desf.) O. Kuntze	Fabaceae
	Medicago lupulina L.	Fabaceae
	Micromeria juliana (L.) Bentham ex Reichenb.	Lamiaceae
	Muscari neglectum Ten.	Hyacinthaceae
	Odontarrhena muralis (Waldst. & Kit.) Endl.	Brassicaceae
	Onopordum bracteatum Boiss. & Heldr.	Asteraceae
	Onosma graeca Boiss.	Boraginaceae
	Ptilostemon afer (Jacq.) Greuter	Asteraceae
	Salvia argentea L.	Lamiaceae
	Sanguisorba minor Scop.	Rosaceae
	Scorzonera crocifolia Sibth. & Sm.	Asteraceae
	Sisybrium officinale L.	Brassicaceae
	Sonchus asper (L.) Hill	Asteraceae
	Stellaria media (L.) Vill.	Caryophyllaceae
	Tussilago farfara L.	Asteraceae
	Vulpia ciliata Dumort.	Poaceae

Table A7. Herbaceous plant species at the E6 site.

S6	Plant Species	Family
	Anthemis tinctoria L.	Asteraceae
	Capsella bursa-pastoris (L.) Medik.	Brassicaceae
	Cerastium candidissimum Correns	Caryophyllaceae
	Crepis neglecta L.	Asteraceae
	Geranium molle L.	Geraniaceae
	Geranium rotundifolium L.	Geraniaceae
	Medicago lupulina L.	Fabaceae
	Micromeria juliana (L.) Bentham ex Reichenb.	Lamiaceae
	Myosotis incrassata Guss.	Boraginaceae
	Odontarrhena muralis (Waldst. & Kit.) Endl.	Brassicaceae
	Papaver rhoeas L.	Papaveraceae
	Sisybrium officinale L.	Brassicaceae
	Stellaria media (L.) Vill.	Caryophyllaceae
	Trifolium stellatum L.	Fabaceae
	Veronica arvensis L.	Scrophulariaceae

Table A8. Herbaceous plant species at the E7 site.

S7	Plant Species	Family
	Aegilops neglecta Bertol.	Poaceae
	Anthemis tinctoria L.	Asteraceae
	Crepis neglecta L.	Asteraceae
	Hordeum murinum L.	Poaceae
	Lotus corniculatus L.	Fabaceae
	Medicago lupulina L.	Fabaceae
	Muscari neglectum Ten.	Hyacinthaceae
	Odontarrhena muralis (Waldst. & Kit.) Endl.	Brassicaceae
	Plantago lanceolata L.	Plantaginaceae
	Stellaria media (L.) Vill.	Caryophyllaceae
	Trifolium stellatum L.	Fabaceae
	Veronica arvensis L.	Scrophulariaceae
	Vicia villosa Roth	Fabaceae

Table A9. Herbaceous plant species at the S8 site.

S8	Plant Species	Family
	Bellardia latifolia (L.) Cuatrec.	Orobanchaceae
	Campanula spatulata Sm.	Campanulaceae
	Cerastium candidissimum Correns	Caryophyllaceae
	Crepis neglecta L.	Asteraceae
	Euphorbia myrsinites L.	Euphorbiaceae
	Fumana thymifolia (L.) Webb	Cistaceae
	Micromeria juliana (L.) Bentham ex Reichenb.	Lamiaceae
	Polygala cristagali Chodat	Polygalaceae
	Salvia argentea L.	Lamiaceae
	Stellaria media (L.) Vill.	Caryophyllaceae
	Teucrium francisci-werneri Rech. Fil.	Lamiaceae
	Thymelaea tartonraira (L.) All.	Thymelaeaceae
	Trifolium stellatum L.	Fabaceae
	Veronica arvensis L.	Scrophulariaceae

Table A10. Herbaceous plant species at the S9 site.

S9	Plant Species	Family
	Anchusa undulata Juss.	Boraginaceae
	Crepis neglecta L.	Asteraceae
	Erodium cicutarium (L.) L'Hér.	Geraniaceae
	Euphorbia myrsinites L.	Euphorbiaceae
	Geranium molle L.	Geraniaceae
	Medicago lupulina L.	Fabaceae
	Muscari neglectum Ten.	Hyacinthaceae
	Odontarrhena muralis (Waldst. & Kit.) Endl.	Brassicaceae
	Salvia argentea L.	Lamiaceae
	Stellaria media (L.) Vill.	Caryophyllaceae
	Tordylium apulum L.	Apiaceae
	Trifolium stellatum L.	Fabaceae

Table A11. Herbaceous plant species at the S10 site.

S10	Plant Species	Family
	Ballota acetabulosa (L.) Bentham	Lamiaceae
	Crepis neglecta L.	Asteraceae
	Hordeum murinum L.	Poaceae
	Malcolmia graeca Boiss. & Spruner	Brassicaceae
	Muscari neglectum Ten.	Hyacinthaceae
	Onopordum bracteatum Boiss. & Heldr.	Asteraceae
	Papaver rhoeas L.	Papaveraceae
	Teucrium francisci-werneri Rech. Fil	Lamiaceae
	Tordylium apulum L.	Apiaceae
	Trifolium stellatum L.	Fabaceae

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