diversity

MDPI

Article

Evaluation of the *Spiranthes spiralis* Population's Phenotypic Density in the Plant Community of *Medicagini minimae–Festucetum valesiacae* Meadows in the Natura 2000 Jiului Corridor Site, Romania (ROSCI0045)

Mariana Niculescu [1], Ovidiu Florin Păniță [1,*], Paula Iancu [1,*] and Marius Mirodon Făgăraș [2]

[1] Agricultural and Forestry Sciences Department, Faculty of Agronomy, University of Craiova, 200583 Craiova, Romania; mniculescum67@gmail.com or mariana.niculescu@edu.ucv.ro

[2] Biology Department, Faculty of Natural Sciences and Agricultural Sciences, Ovidius University Constanța, 900470 Constanta, Romania; marius_fagaras@yahoo.com

* Correspondence: ovidiu.panita@edu.ucv.ro (O.F.P.); paula.iancu76@gmail.com or paula.iancu@edu.ucv.ro (P.I.)

Abstract: There are few reports related to the presence of *Spiranthes spiralis* in the Oltenia region in southern Romania. This study develops the information concerning the presence of this type of orchid in Gorj County. The studies on the populations of this orchid species have been conducted in the Natura 2000 site of the Community ROSCI0045 Jiului Corridor. In the researched territory, during the investigations, twelve populations of *Spiranthes spiralis* were sampled for the first time. In 2022–2023, we studied the distribution of this species and assessed its population densities. Our observations indicate that it is a relatively widespread species in the studied area and its populations are more abundant in meadows, in the *Medicagini minimae–Festucetum valesiacae* plant community.

Keywords: population; density; phenotypic characters; *Spiranthes spiralis*; plant community; coenology; undesirable species

Citation: Niculescu, M.; Păniță, O.F.; Iancu, P.; Făgăraș, M.M. Evaluation of the *Spiranthes spiralis* Population's Phenotypic Density in the Plant Community of *Medicagini minimae–Festucetum valesiacae* Meadows in the Natura 2000 Jiului Corridor Site, Romania (ROSCI0045). *Diversity* **2024**, *16*, 1. https://doi.org/10.3390/d16010001

Academic Editor: Panayiotis Dimitrakopoulos

Received: 24 November 2023
Revised: 11 December 2023
Accepted: 13 December 2023
Published: 19 December 2023

1. Introduction

The *Orchidaceae* family is one of the richest families in the plant kingdom and it includes approximately 28.000 species and 880 genera [1]. The species and subspecies of this family are present on all continents, the most important centers of their diversity being Indochina, Southwest Australia, Europe, Northern Asia, and North America [2]. About 250 species and subspecies of 35 orchid genera have been identified in Europe [3], but they are not uniformly distributed throughout the area. The plant is widely distributed in Southern Europe, in the Mediterranean region, where it can be found in suitable open habitats. In Romania, 58 species of wild orchid exist, all terrestrial, widespread in meadows, swamps, forest edges, and clearings [4].

Spiranthes spiralis (L.) Chevall. is a small, beautiful, pleasant-smelling perennial orchid, included in the National Red List as a rare plant since 1994 [5]. It is a perennial geophytic species, with a height of 10–20 cm, rare in the sessile oak and beech forests' grassy layer, in meadows, and the edge of the woods [4]. In the NATURA 2000 site Sighişoara–Târnava Mare (ROSCI0027), it was identified for the first time in Mălâncrav (Laslea commune, Sibiu County, at the end of June 2011), in two types of dry meadows [6,7]. *Spiranthes spiralis* occasionally occurrs in the meadows in Gheboieni, Gorgota, Bucani, and Mija [8]. In floristic investigations conducted in the Grădiştea Muncelului Cioclovina Natural Park, we identified 30 species of orchids belonging to 11 genera, including *Spiranthes spiralis* [9]. The species is rare in the Moldova province, being recorded in the Neamț and Bacău counties (Cașin Monastery) [10]. In the Oltenia, *Spiranthes spiralis* has a limited spread: in the Olteț river basin, it was only collected from Gârnicet Şuieşti village [11] and near Cărbunari village, from overgrazed meadows along the edge of the forests [4]. Orchids are known for their complex ecology and ability to occupy almost all terrestrial ecosystems [2].

The aim of the study is to investigate the distribution of Spiranthes spiralis in the southwestern part of Romania, in the Natura 2000 Jiului Corridor site, to assess the population densities in meadows in the plant community *Medicagini minimae–Festucetum valesiacae* and to perform a statistical analysis of some of its morphological characteristics.

2. Materials and Methods

The analyzed population of *Spiranthes spiralis* was identified in the southern part of Gorj County, in the administrative territory of the Urdari locality, an integral part of the protected area of the Jiului Corridor (ROSCII0045) (Figure 1).

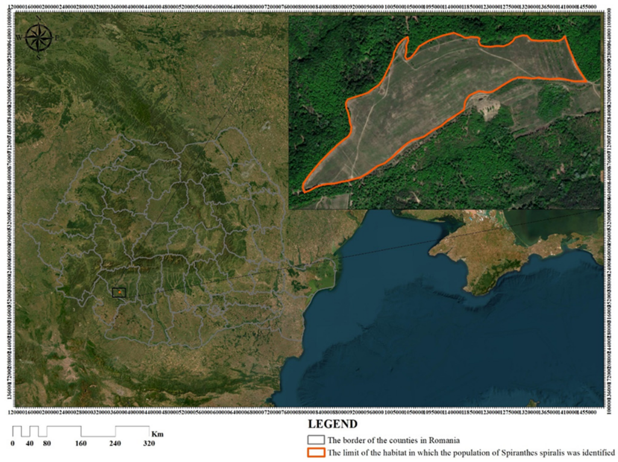

Figure 1. Location of the *Spiranthes spiralis* habitat.

The investigated area was located in the continental biogeographical region, which is located in the Getic Piedmont region, on the hills of Gorj and Bran, in the middle third of the Jiu river basin, in the Jiului hills unit.

The soils of the investigated area have loess pseudogley brown and pseudogley white lovisol inclusions. The climate is transitional temperate with Mediterranean influences, with 190 frost-free days. The mean annual temperature is 10.2 °C and the mean annual precipitation is about 925 mm/year. In the summer, the heat is accentuated, with average temperatures exceeding 20 °C in the months of July and August. Monthly, the highest level of precipitation occurs in June, approximately 100 mm, and the lowest is 60 mm. In this area, the number of days with rain is, on average, 100 per year, and those with snow are 20 per year [12].

According to the Corine Land Cover (2018), the investigated area falls under category 211 (non-irrigated arable land)) [13].

The identification of taxa was based on *Flora Europaea*, vol. I–V (1964–1980) [14] and Euro + Med PlantBase [15]. An analysis of the plant communities was performed according to the Central European Phyto-Sociological School methodology, based on the methods of Braun–Blanquet [16].

The plant communities were identified according to the characteristic, edifying, dominant and differential species. For syntaxonomical aspects, we used synthesis papers from the Romanian [17,18] and EuroVegChecklist databases of the European Vegetation Survey [19–21]. The size of the sampled areas was determined according to the type of meadow vegetation: 25 m^2. The synthetic tables of the described plant community contained information referring to the number of relevés, altitude (m.s.l), exposure, inclination (in degrees), vegetation cover (%), and analyzed surface (m^2). The vertical arrangement of the phytosociological tables was performed according to the coenotaxonomic criteria.

The Syn-Tax 2000 program was used for the statistical analysis of the floristic richness of plant communities in which *Spiranthes spiralis* was found. The calculation of the correlation quantitative index was ben performed by the group average method (UPGMA) and dendrograms according to Podani (2001) [22].

To analyze the variability of the populations, observations and determinations of the individuals were performed in the field, such as height of the vegetation where it was found, plant height, and inflorescence length.

Statistical data were analyzed using IBM SPSS software and an analysis of variance (ANOVA) was used. The significance of the differences was estimated with the LSD multiple comparison test at the $p \leq 0.05$ level. The correlation coefficients between characters were also calculated, their significance being determined by Pearson's values. A correlation analysis of the bi-plot graphical display was also performed.

3. Results

3.1. Plant Coenology

Spiaranthes spiralis populations identified at the Natura 2000 Jiului Corridor site (ROSCI0045) were first analyzed from a phytocoenotic point of view. Based on the field study, the coenotaxonomic affiliation of this orchid species was determined, allowing us to create a phytosociological table in which all the species from the floristic composition of the phytocoenoses and their abundance–dominance were presented, including species that were inventoried for each relevée performed on land, for each population. Thus, following the field studies, it was found that all populations of the *Spiranthes spiralis* species belonged to the meadow plant community *Medicagini minimae–Festucetum valesiacae* Wagner 1941 [23] (Table 1) (Figure 2). From a conservative point of view, the edifying plant community is of particular importance, because it supports an important meadow habitat in the protected area where the studies are carried out. The studied orchid species is found in all phytocoenoses of the plant community, having different abundance–dominance values, depending on the state of conservation of these grasslands. Its associated phytocoenoses develop on flat or slightly inclined lands.

Table 1. The floristic composition of the Medicagini minimae–Festucetum valesiacae Wagner 1941 [22] plant community.

No. of Relevée	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Canopy (%)	7	-	5	5	-	-	-	5	5	3	-	-
Coverage of herbaceous layer (%)	100	100	95	95	100	100	100	100	100	100	100	95
Area (m^2)	100	100	100	100	100	100	100	100	100	100	100	100
Character species of plant community												
Festuca valesiacae	4	4	3–4	4	4	4	3–4	4	3–4	4	4	4
Medicago falcata	1	1	+	1	1	+	+	1	+	1	1	1
Medicago lupulina	+	+	+	+	-	+	+	+	+	+	+	+
Medicago minima	+	-	+	+	-	+	-	-	+	+	-	+
Festucion valesiacae and Festucetalia valesiacae												
Artemisia absinthium	+	+	+	+	-	-	-	+	-	+	+	+
Cynoglossum officinale	+	+	+	+	-	-	+	+	-	+	+	+
Salvia austriaca	+	+	-	+	-	-	+	+	+	+	+	+
Knautia arvensis	+	+	+	+	+	+	+	+	+	+	+	+

Table 1. *Cont.*

No. of Relevée	1	2	3	4	5	6	7	8	9	10	11	12
Reseda lutea	+	-	+	+	-	-	+	+	-	-	+	+
Falcaria vulgaris	-	-	-	-	-	+	+	-	-	-	-	-
Lotus corniculatus	-	+	-	-	-	+	+	+	-	+	+	-
Thymus pannonicus	+	+	+	+	-	-	+	+	+	+	+	+
Astragalus onobrychis	+	+	+	+	+	+	+	+	+	+	+	+
Senecio jacobaea	-	-	-	-	-	+	-	-	-	-	-	-
Achillea setacea	-	+	-	-	-	+	+	+	-	+	+	-
Onobrychis viciifolia	-	-	-	-	-	+	-	-	-	-	-	-
Muscari tenuiflorum	-	-	-	-	-	+	+	-	-	-	-	-
Linum perenne	+	+	+	+	-	-	+	+	+	+	+	+
Fragaria viridis	+	+	+	+	-	-	-	+	+	+	+	+
Anthemis tinctoria	+	+	+	+	-	-	+	+	+	+	+	+
Chamaecytisus austriacus	+	+	+	+	-	-	+	+	+	+	+	+
Potentilla arenaria	+	+	+	+	+	+	+	+	+	+	+	+
Medicagi minima	+	+	+	+	-	-	-	+	+	+	+	+
Festuco–Brometea												
Galium verum	+	+	-	+	-	-	-	+	-	+	+	+
Echium vulgare	+	+	+	-	+	+	+	-	-	-	-	+
Stachys germanica	+	+	+	+	-	+	+	+	+	+	+	+
Coronilla varia	+	+	+	+	-	-	-	+	+	+	+	+
Berteroa incana	-	+	-	-	-	+	+	+	-	+	+	-
Potentilla argentea	+	+	-	+	-	+	-	+	-	+	+	+
Eryngium campestre	+	-	-	+	-	+	+	-	-	-	-	+
Agrimonia eupatoria	+	-	-	+	-	+	+	-	-	-	-	+
Scabiosa ochroleuca	+	-	-	+	-	+	-	-	-	-	-	+
Asperula cynanchica	+	-	-	+	+	-	-	+	+	+	+	+
Hypericum perforatum	+	+	+	+	-	+	+	+	+	+	+	+
Euphorbia cyparissias	+	+	+	+	-	-	-	+	+	+	+	+
Hieracium pilosella	+	-	+	-	+	-	+	+	-	-	+	+
Trifolium campestre	+	-	+	+	-	+	+	-	-	-	-	-
Salvia verticillata	+	+	-	+	-	-	+	-	-	-	-	+
Achillea collina	-	-	+	+	+	-	+	-	-	-	-	-
Potentilla recta	-	-	+	+	-	+	-	-	+	-	-	-
Agrostis capillaris	-	+	-	-	+	-	-	+	-	+	+	-
Molinio–Arrhenatheretea												
Spiranthes spiralis	+	+	$+-1$	$+-1$	1	1	1–2	1–2	2	2–3	2–3	2–3
Vicia carcca	-	-	-	-	-	+	+	-	-	-	-	-
Trifolium repens	+	-	-	+	-	-	+	-	-	-	-	+
Taraxacum officinale	-	-	-	-	+	+	+	-	+	+	-	-
Lolium perenne	-	-	+	-	+	+	-	-	+	-	-	-
Poa pratensis	-	+	-	+	+	-	-	+	-	+	+	+

Table 1. *Cont.*

No. of Relevée	1	2	3	4	5	6	7	8	9	10	11	12
Dactylis glomerata	+	-	+	+	-	+	-	-	+	-	-	+
Cichorium intybus	-	-	+	+	-	+	+	-	-	-	-	-
Plantago lanceolata	+	-	-	+	-	-	+	-	+	-	-	+
Ononis arvensis	-	-	+	+	+	-	+	-	-	+	+	-
Rhinanhus minor	+	+	+	-	+	+	+−1	-	+	+−1	+	+
Achillea millefolium	-	+	-	-	-	-	-	+	-	+	+	-
Ranunculus repens	+	+	-	-	-	+	-	-	-	-	-	-
Trifolium fragiferum	-	-	-	-	-	+	-	-	-	-	-	-
Prunella vulgaris	+	+	+	+	-	+	+	-	+	+	-	-
Veronica chamaedrys	+	-	-	+	-	-	+	+	+	-	-	+
Centaurea indurata	+	+	+	+	-	-	+	-	-	+	+	-
Verbena officinalis	-	+	+	-	-	+	-	-	-	-	-	-
Leucanthemum vulgare	+	+	+−1	+	+−1	-	+	+	+	+	+	+
Potentilla reptans	-	+	+	+	-	+	-	+	+	+	-	+
Stachys officinalis	+	+	+	+	-	-	-	+	+	+	+	+
Inula britannica	+	+	+	+	-	-	+	+	+	+	+	+
Eryngium planum	-	+	+	+	-	+	-	-	-	-	-	-
Polygonum aviculare	+	+	+	+	-	-	-	+	+	+	+	+
Stellarietea mediae												
Lathyrus tuberosus	+	+	+	+	-	-	+	+	-	-	-	-
Anagallis arvensis	+	+	-	-	+	-	-	-	-	-	-	-
Carduus acanthoides	-	-	-	-	-	+	+	-	-	-	-	-
Matricaria perforata	+	-	-	+	-	-	+	-	-	-	-	+
Linaria vulgaris	-	+	+	+	-	-	+	-	-	-	-	-
Bromus arvensis	-	-	+	-	-	+	-	-	+	-	-	-
Xanthium strumarium	-	+	-	-	+	-	-	+	-	+	+	-
Cardaria draba	+	-	+	+	-	+	-	-	+	-	-	+
Consolida ragalis	-	-	-	-	-	+	+	-	-	-	-	-
Picris hieracioides	+	-	-	+	-	-	+	-	+	+	-	+
Lepidium campestre	-	-	+	+	+	-	+	-	-	-	-	-
Erodium cicutarium	+	+	+	+	-	-	-	+	+	+	+	+
Lappula squarrosa	+	+	+	+	-	-	+	+	+	+	+	+
Lactuca serriola	+	+	+	+	+	+	+	+	+	+	+	+
Malva sylvestris	-	-	-	-	-	+	-	+	+	+	-	-
Capsella bursa-pastoris	+	+	+	+	-	-	-	+	+	+	+	+
Senecio vernalis	+	+	+	+	-	-	+	+	+	+	+	+
Stellaria media	-	-	-	+	+	+	-	-	-	+	+	+
Varaiae Syntaxa												
Dianthus armeria	+	+	+	+	+	+	+	+	+	+	+	+
Cirsium canum	-	-	+	-	-	+	+	+	+	-	-	-
Rubus canescens	3	3	2–3	2–3	2	1–2	1–2	1–2	1	1	1	1

Table 1. *Cont.*

No. of Relevée	1	2	3	4	5	6	7	8	9	10	11	12
Rosa canina	-	+	-	-	+	+	+	+	-	+	+	-
Crataegus mpnogyna	-	+	+	+	-	-	-	+	-	+	+	-
Xanthium orientale	-	+	-	-	+	+	+	+	-	+	+	-
Althaea officinalis	-	+	-	-	-	-	-	+	+	+	+	-
Ambrosia artemisiifolia	1	1	+−1	-	-	-	+	+−1	+	+	+	+
Erigeron annuus	-	+	-	1	+	+	+	+	1	+	+	-
Conyza canadensis	+	+	+	+	+	+	3	3	3	-	-	-
Pyrus pyraster	+	+	+	-	1	1	+	+	+	+	+	+
Prunus spinosa	+	+	+	-	-	-	1	1	1	+	+	+

Place and data of the relevées: Hill of Bran, Urdari, 23.V.2021; 12.VI.2022; 18.VII.2023. Source: performed by the authors based on their own research.

Figure 2. *Spiranthes spiralis* in meadows, from Urdari © Mariana Niculescu.

In addition to the characteristic species of the plant communities *Festuca valesiaca*, *Medicago lupulina*, *M. falcata*, and *M. minima*, most species belong to the classes of Festuco–Brometea, Molinio–Arrhenatheretea, and Stellarietea mediae. This plant community belongs to an important Natura 2000 grassland habitat: the 6240* Sub-Pannonic steppe grasslands [24].

In the structure of the phytocoenoses analyzed, many plants were ruderal, segetal, and invasive, providing them with an anthropophilic character. Among the invasive species identified in the phytocoenoses floristic composition, the most frequently encountered were *Xanthium orientale*, *Erigeron annuus*, *Ambrosia artemisiifolia*, and *Conyza canadensis*.

A number of species are considered undesirable and affect the conservation status of these meadows, such as *Rosa canina* (Figure 3), *Pyrus pyraster* (Figure 3), *Rubus canescens*, and *Cratagus monogyna*. In particular, *Rubus canescens* (Figure 4) presented exacerbated development within the analyzed phytocoenoses; it had a high abundance–dominance values and it affected both the conservation status of the meadow and populations of *Spiranthes spiralis*. Thus, in the phytocoenoses where *Rubus canescens* was established and developed excessively, the populations of *Spiranthes spiralis* were very low, with a maximum of six individuals. *Rubus canescens* developed in some phytocoenoses to such a great extent that it formed a tangle of branches that could not be penetrated by the other species. Also, in the structure of phytocoenoses, other shrubby species, such as *Rosa canina*, *Pyrus pyraster*, and *Crataegus monogyna*, influenced the development and conservation state of the plant community indirectly of the habitat. This can be explained by the lack of mowing and maintenance work required for these meadows and their abandonment by the locals. Regarding the phytocoenoses of the meadows under study, they are located on soils that lack moisture during summer and they develop in conditions of xerophytism with temperatures that can frequently reach up to 40 °C during summer, favoring high evaporation rates of surface water. The lack of mowing and the abandonment of these meadows has led to the establishment of bushes and a syndynamic evolution into forest vegetation. These results, corroborated with the lack of necessary studies on these meadows, overgrazing, the presence of invasive species, and the frequent use of all-terrain vehicles by the locals, have led to the irreversible degradation of the habitat and the populations of *Spiranthes spiralis* (Figure 5). Although the populations of this species are still high, the gradual degradation of the habitat, especially through the installation of *Rubus canescens* thickets, can destroy them.

Figure 3. *Rosa canina* and *Pyrus pyranthes* in the habitat of *Spiranthes spiralis*, Urdari © Mariana Niculescu.

Figure 4. *Rubus canescens* in the habitat of *Spiranthes spiralis*, Urdari © Mariana Niculescu.

Figure 5. *Spiranthes spiralis* overwhelmed by *Rubus canescens*, Urdari © Mariana Niculescu.

From a coenotic point of view, from the analyzed phytocoenoses, it can be seen that this species shows abundance–dominance results that vary according to the ecological conditions, in close correlation with the anthropogenic factors. In some phytocoenoses, the undesirable species *Rubus canescens* influences the abundance–dominance of *Spiranthes spiralis* (Figure 6). We can also observe the grouping of two clusters: in the first cluster, the relevées 1, 2, 3, and 4 (REL_01, REL_02, REL_03, and REL_04, respectively) are highlighted, based on the greater abundance–dominance of the species *Rubus canescens* in correlation with the low abundance–dominance of the studied species *Spiranthes spiralis*. The relevées 10, 11, and 12 are differentiated by the greater abundance–dominance of the species *Spiranthes spiralis.* Also, the relevées 7, 8, and 9 are differentiated by the great abundance–dominant of the invasive species *Conyza canadesnsis* and the undesirable shrub species *Prunus spinosa* that invade the meadow and suffocate the valuable species in the floristic structure, including *Spiranthes spiralis*.

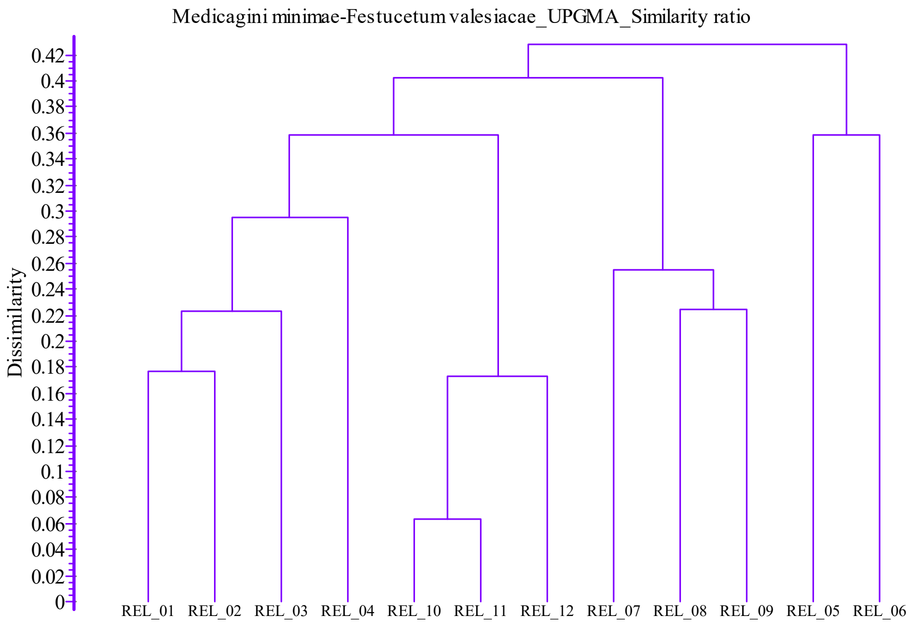

Figure 6. Dendrogram of the *Medicagini minimae–Festucetum valesiacae* plant community; similarity ratio coefficients.

The second cluster was formed by separating two relevées, 5 and 6 (REL_05, REL_06, respectively), based on the abundance of the larger dominant shrub species *Pyrus pyraster*.

The analysis conducted highlighted the negative impact of shrub and shrub species as well as invasive species on *Spiranthes spiralis* populations and also on the meadow community where it was found.

3.2. Statistical Analysis of the Morphological Traits of Spiranthes spiralis

The studies were conducted taking into account the correlation with the population density.

In relation to the height of the plant, the highest mean value was recorded in the surfaces smaller than 15 pl./m^2, which was significantly distinguished from all other mean values. The second-highest mean value was recorded at densities of 25–35 pl./m^2, which was still significantly higher than those found at densities ranging from 40 to 100 pl./m^2 (Table 2).

Table 2. Analysis of the influence of the density of pl./m^2 on the variability of *Spiranthes spiralis*'s morphometric characteristics. LSD (0.05) Least significant difference at 5% probability level, values with same letters are statistically insignificant for the same variable.

Characteristic / Density (pl./m^2)	Vegetation Height (cm)	Vegetation Height (cm)	Mean Inflorescence Length (cm)	Mean Plant and Inflorescence Length/Height Ratio
>100 pl./m^2	16.019 ^{bc} ± 2.51	10.701 ^{b} ± 1.25	5.150 ^{d} ± 0.22	0.72 ^{a} ± 0.05
45–55 pl./m^2	15.071 ^{c} ± 2.75	12.321 ^{b} ± 1.29	5.782 ^{c} ± 0.21	0.661 ^{b} ± 0.04
25–35 pl./m^2	21.047 ^{b} ± 3.27	15.66 ^{a} ± 1.14	6.573 ^{b} ± 0.25	0.619 ^{b} ± 0.04
<15 pl./m^2	47.502 ^{a} ± 5.11	16.267 ^{a} ± 1.34	7.521 ^{a} ± 0.33	0.476 ^{c} ± 0.04
LSD 5%	5.48	2.31	0.59	0.058

Regarding the characteristic of the mean length of inflorescence, the highest value was recorded on surfaces smaller than 15 pl./m^2, this being 7.52 cm, a value that was significantly higher than all the others. The second average value was recorded on the surfaces with of 25–35 pl./m^2, a value that was also significantly higher than the others. A significant difference was recorded for the last two value averages calculated for surfaces of 45–55 pl./m^2 and those larger than 100 pl./m^2.

For the analysis of the inflorescence length and total height ratio index, the highest mean was recorded at densities greater than 100 pl./m^2, which was significantly greater than the means at other densities.

Certain correlations were seen for the height of the plant and the height of *Spiranthes* (Figures 7–10). Thus, the highest value was calculated for a density of 15 pl./m^2. In other words, increasing the height of the plant resulted in an increase in the height of the *Spirantes* plants; basically, tall vegetation caused the *Spirantes* plants to etiolate or elongate in their search for light. In other instances, the values of the correlation coefficients were lower, the lowest value being calculated for a density of 105 pl./m^2.

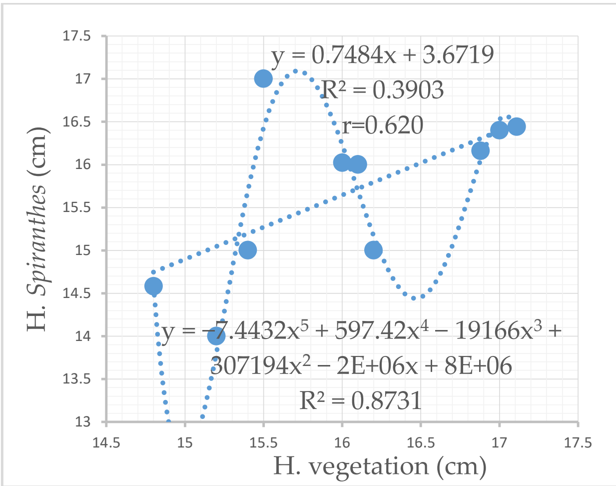

Figure 7. The correlation between plant height and *Spiranthes* height (density higher than 100 pl./m^2).

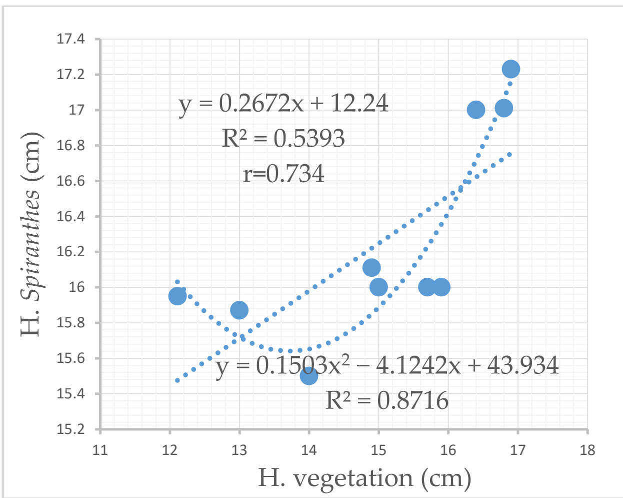

Figure 8. The correlation between plant height and *Spiranthes* height (density between 45 and 55 pl./m^2).

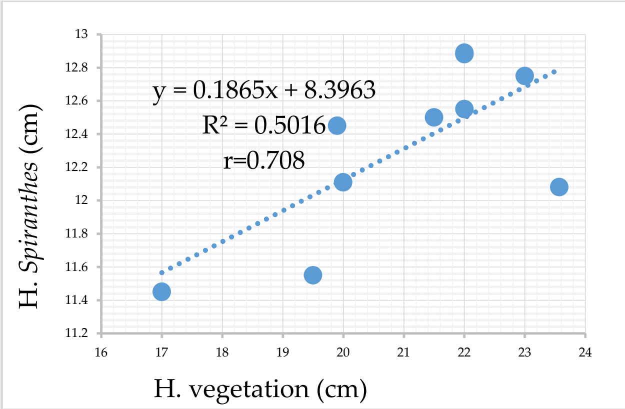

Figure 9. The correlation between plant height and *Spiranthes* height (density between 25 and 35 pl./m^2).

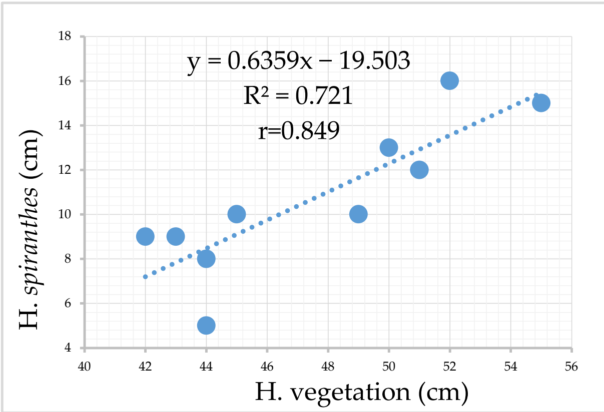

Figure 10. Correlation plant height and *Spiranthes* height (density of plants up to 15 pl./m^2).

At densities higher than 100 pl./m^2, the correlation between *Spiranthes* height and inflorescence length was 0.868. We assumed that, for this density, there was a very strong connection between the two traits. In other words, at a high density, over 100 pl./m^2, the increase in the height of the plant also resulted in an increase in inflorescence. The calculated coefficient of determination was as high as 0.753, so the regression model based on the simple linear equation was a valid one. Thus, the regression coefficient was equal to 0.743, which meant that when the plant grew by 1 cm in height, the inflorescence increased by 0.743 cm (Figure 11).

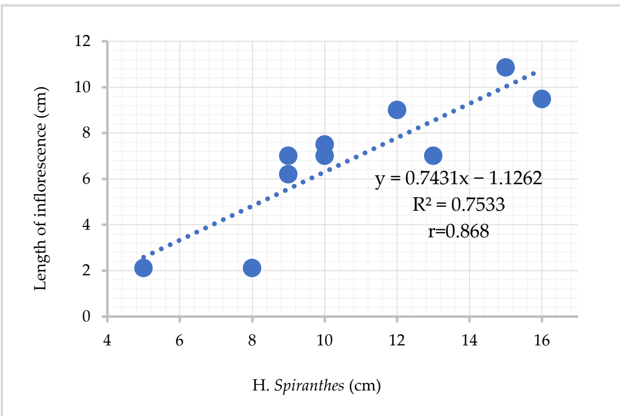

Figure 11. The correlation of inflorescence length and plant height (density higher than 100 pl./m^2).

At densities between 45 and 55 pl./m^2, the correlation coefficient was 0.703, a value that expressed a strong link between the two traits, but without being able to establish a trend model based on the simple linear equation, with the value of the coefficient of determination being 0.499 (Figure 12).

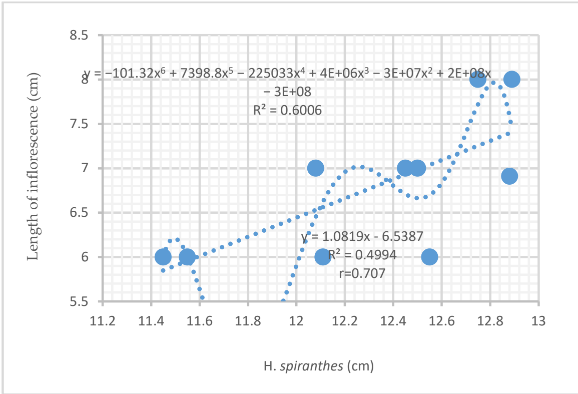

Figure 12. The correlation of inflorescence length and plant height.

In the case of surfaces with densities between 25 and 35 pl./m^2 and lower than 15 pl./m^2, the correlation coefficients of the two traits presented values of 0.034 and 0.255, respectively, values much too low to be able to express a link between the two traits (Figures 13 and 14).

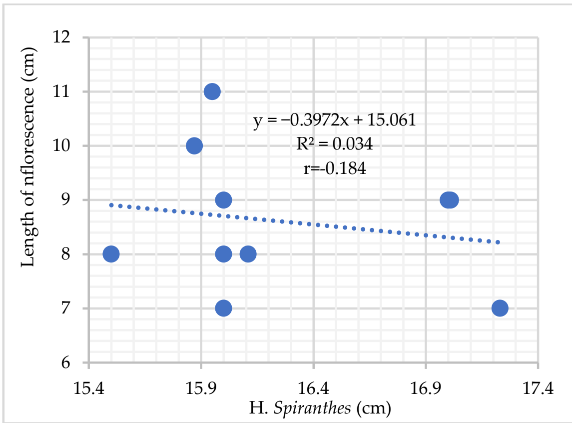

Figure 13. The correlation of inflorescence length and *Spiranthes* height (plant density between 25 and 35 pl./m^2).

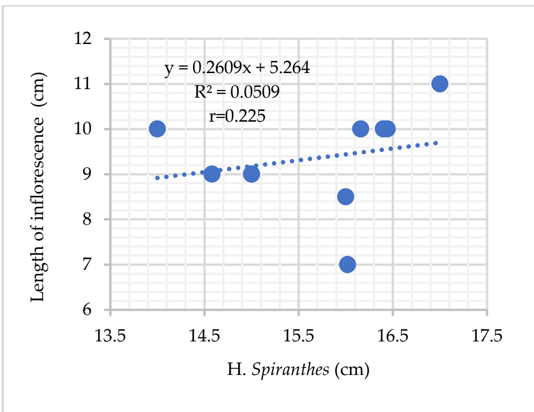

Figure 14. The correlation of inflorescence length and *Spiranthes* height (plant density up to 15 pl./m^2).

4. Discussion

The density of *Spiranthes* had a significant influence on the mean height of the vegetation. Thus, on surfaces with high and very high densities of *Spiranthes*, the vegetation had heights that were comparable with *Spiranthes* plants, while on surfaces with low and very low densities of *Spiranthes*, the average height of the vegetation was much higher than the height of the *Spiranthes* plants. Tall (and dense) herbaceous vegetation competes with orchids [25], which can be detrimental for the *Spiranthes* population.

The density of *Spiranthes* (pl./m^2) also influences the correlation between the mean height of the vegetation and the height of individual *Spiranthes* plants. Thus, at low densities, the height of *Spiranthes* plants correlates very well with the height of the vegetation, in the sense that the increase in the height of the vegetation determines the increase in the height of *Spiranthes* plants. At high densities, the correlation between the two indices decreases, in the sense that the *Spiranthes* compete with each other, but less so with the vegetation.

Related to the average length of the inflorescences, this is strongly influenced by the height of the plant; tall plants usually have longer inflorescences. However, the correlation coefficient between the two traits is high, especially at high densities of *Spiranthes*, where the mean value of the inflorescence is low. The result is supported by the analysis of the ratio between the height of the inflorescence and the total height of the plant. Thus, shorter plants tend to form larger inflorescences compared to their total height, these plants being found at high densities. The density of the orchids on grassland patches correlates with the vegetation height [26]. However, regardless of the density of *Spiranthes*, the length of the inflorescence is more susceptible to modifications than the total height of the plant, this being a characteristic that is influenced by both the density of *Spiranthes* and the height of the vegetation. Thus, in low-density *Spiranthes* areas, tall vegetation determines the height of *Spiranthes* plants, which produces tall inflorescences compared to the inflorescences of shorter plants.

5. Conclusions

The structure and floristic composition of the *Medicagini minimae–Festucetum valesiacae* plant community as well as its conservation status have a direct influence on the population size of the *Spiranthes spiralis* species, but also on the development of individual plants, especially their height and vitality, and also on the state of conservation of the populations of orchid we studied.

With the abandonment of traditional agro-pastoral practices in recent decades, these meadows have degraded and natural landscapes have lost their value.

The scrubs of *Rubus canescens* and also those of the *Pruno-Crataegetum* type occupy larger areas, together with Turkey oak and sessile oak forests encroaching very rapidly on the deep eutric soils at the edge of grasslands.

Author Contributions: Conceptualization, M.N. and P.I.; methodology, O.F.P.; software, O.F.P.; validation, M.N. and O.F.P.; formal analysis, P.I.; investigation and resources, M.N.; data curation, M.N.; writing—original draft preparation, M.N. and P.I.; writing—review and editing, P.I. and M.M.F.; visualization, M.M.F.; supervision, M.N. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Givnish, T.J.; Spalink, D.; Ames, M.; Lyon, S.P.; Hunter, S.J.; Zuluaga, A.; Doucette, A.; Caro, G.G.; McDaniel, J.; Clements, M.A.; et al. Orchid historical biogeography, diversification, Antarctica and the paradox of orchid dispersal. *J. Biogeogr.* **2016**, *43*, 1905–1916. [CrossRef]
2. Swarts, N.D.; Dixon, K.W. Conservarea orhideelor terestre în epoca extincției. *Ann. Bot.* **2009**, *104*, 543–556. [CrossRef] [PubMed]
3. Popescu, G. Flora şi vegetaţia Bazinului Jilţ între localităţile Negomir şi Turceni, Jud. Gorj. *Acta Bot. Horti Bucur.* **2001**, *29*, 171–197.
4. Ciocârlan, V. Illustrated flora of Romania. In *Pteridophyta et Spermatophyta*, 3rd ed.; Ceres: Bucharest, Romania, 2009; p. 1141, ISBN 9734004956. (In Romanian)
5. Oltean, M.; Negrean, G.; Popescu, A.; Roman, N.; Dihoru, G.; Sanda, V.; Mihăilescu, S. Lista roșie a plantelor superioare din România. In *Studii Sinteze Documentatii Ecol*; Academia Română: Bucharest, Romania, 1994.
6. Ardelean, C.; Ardelean, A.; Nicolin, A.L.; Arsene, G.G. Wild orchid diversity within the Nera Gorges-Beuşniţa National Park habitats. *Res. J. Agric. Sci.* **2015**, *47*, 271–281.
7. Oroian, S. Orhideea *Spiranthes spiralis*. *Gaz. Nat. 2000* **2011**, *2*, 2.
8. Dumitru, M. Considerații asupra diversității orhideelor din județul Dâmbovița. In *Studii și Comunicări*; Științele Naturii, Muzeul Olteniei Craiova: Craiova, Romania, 2005; Volume XXI.
9. Rovină, A.; Neblea, M.; Rovină, L. Specii de orhidee identificate în Parcul Natural Grădiştea Muncelului Cioclovina. In *Marisia Studii şi Material*; Ştiinţele Naturii: Târgu Mureș, Romania, 2019; pp. 38–39.
10. Chifu, T.; Mânzu, C.; Zamfirescu, O. *Flora si Vegetatia Moldovei (România)*; Alexandru Ioan Cuza University (Universitatea "Alexandru Ioan Cuza"): Iași, Romania, 2006; p. 367.
11. Răduțoiu, D. Endemic species and species of floristic interest identified in the Cerna of Olteţ river basin. *Bul. Grădinii Bot. Iaşi* **2006**, *13*, 109–111.
12. Available online: https://www.cjgorj.ro/Date%20site/PATJ/Raport%20de%20mediu_PATJ%20Gj_12.2011.pdf (accessed on 23 November 2023).
13. Waterman, R.J.; Bidartondo, M.I. Deception above, deception below: Linking pollination and mycorrhizal biology of orchids. *J. Exp. Bot.* **2008**, *59*, 1085–1096. [CrossRef] [PubMed]
14. Tutin, T.G.; Heywood, V.H.; Burges, N.A.; Moore, D.M.; Valentine, D.H.; Walters, S.M.; Webb, D.A. (Eds.) *Flora Europaea*; Cambridge University Press: Cambridge, UK, 1980; Volume 5.
15. Euro + Med PlantBas. Available online: https://www.emplantbase.org/home.html (accessed on 27 October 2023).
16. Braun-Blanquet, J.; Jenny, H. Vegetations-Entwicklung und Bodenbildung. In *Denkschr. der Schweiz. Naturforsch. Gesellsch*; Springer: Zürich, Switzerland, 1939; p. 63.
17. Coldea, G.; Sana, V.; Popescu, A.; Stefan, N. Les associations vegetales de Roumanie. In *Les Associations Herbacees Naturelles*; Presses Universitaires de Cluja: Cluj, Romania, 1997; p. 261, ISBN 9739261302.
18. Sanda, V.; Popescu, A.; Stancu, D. *Coenotic Structure and Ecological Characterization of the Phytocoenosis of Romania*; Vergiliu Publishing House: Bucharest, Romania, 2001; p. 365, ISBN 9739845509.
19. Mucina, L.; Bültmann, H.; Dierßen, K.; Theurillat, J.-P.; Raus, T.; Čarni, A.; Šumberová, K.; Willner, W.; Dengler, J.; García, R.G.; et al. Vegetation of Europe: Hierarchical floristic classification system of vascular plant, bryophyte, lichen, and algal communities. *Appl. Veg. Sci.* **2016**, *19* (Suppl. 1), 3–264. [CrossRef]
20. Rodwell, J.S.; Schaminée, J.H.J.; Mucina, L.; Pignatti, S.; Dring Moss, J.D. *The Diversity of European Vegetation—An Overview of Phyto-Sociological Alliances and Their Relationships to EUNIS Habitats*; Report No. EC-LNV 2002(054); National Reference Centre for Agriculture, Nature and Fisheries: Wageningen, The Netherlands, 2002.
21. European Vegetation Survey. Available online: https://euroveg.org/eva-database (accessed on 27 October 2023).
22. Podani, J. SYN-TAX 2000. In *Computer Programs for Data Analysis in Ecology and Systematics*; User's Manual; Scientia: Budapest, Hungary, 2001.
23. Wagner, H. Die Troekenrasengesellschaften an Alpenostrand. *Vegetation* **1941**, *104*, 81.
24. Gafta, D.; Mountford, O. *Romanian Manual for Interpretation of EU Habitats*; Risoprint: Cluj-Napoca, Romania, 2008; p. 101.
25. Janečková, P.; Wotavová, K.; Schödelbauerová, I.; Jersáková, J.; Kindlmann, P. Relative effects of management and environmental conditions on performance and survival of populations of a terrestrial orchid, *Dactylorhiza majalis*. *Biol. Conserv.* **2006**, *129*, 40–49. [CrossRef]
26. Paušič, I.; Kaligarič, M.; Bakan, B. Late seasonal mowing enhances central European *Spiranthes spiralis* (L.) Chevall. (Orchidaceae) population viability. *Bot. Lett.* **2017**, *164*, 401–412. [CrossRef]