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SOME PHYTOCOENOLOGICAL AND POPULATION STRUCTURE FEATURES OF *FRITILLARIA MELEAGRIS* L. IN THE UPPER ŞARD VALLEY (CLUJ COUNTY, ROMANIA)

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Abstract: The paper reveals the structure of a newly discovered *Fritillaria meleagris* population in a habitat from Cluj county, disturbed by drainage works started in the summer of 2003, after the acomplishment of the studies. The importance of the habitat is also highlighted by the presence of other red list species, like *Achillea ptarmica*, *Dactylorhiza incarnata, Gentiana pneumonanthe, Gladiolus imbricatus, Iris sibirica, Narcissus poeticus* ssp. *radiiflorus*, *Trollius europaeus*.

Phytocoenologicall records were performed in three plant communities, developed along a moisture gradient, from wet to mesic: *Caricetum acutiformis* Eggler 1933, *Cirsietum rivularis* Nowinski 1926 and *Junco-Molinietum* Preising 1951. Population density, spatial and age structure of *F. meleagris* were investigated along three transects laid out in these communities. Morphometric data (stem height and perianth length) of individuals were also recorded and correlation between them was calculated.

Introduction

Fritillaria meleagris L. (*Liliaceae*) is a perennial bulbous plant, occurring in fen meadows, flood plains and open moist forests of Europe. Its populations have been greatly affected by massive collection during flowering, but mainly by changes in agricultural practice, such as drainage, grazing and fertilization. *F. meleagris* is thus considered a rare or endangered species and is included in most European as well as Romanian red lists [5, 6, 7, 11, 13, 17, 18, 21, 25].

Its distribution in Romania is rather wide [3], but there is an urgent need to inventory the localities of occurrence, as the populations are endangered, due to fertilization and drainage practiced on the newly recovered private properties [10]. So far, the fritillary has been recorded mainly from open moist oak forests [3, 8, 14], bushes of *Salix cinerea* [3, 8, 24], but also from wet meadows issued on the place of former floodplain forests [8, 21, 24].

The present study was undertaken to obtain additional information on the ecology of *F. meleagris* on a plant community level and to reveal some features concerning the population structure (age structure and spatial distribution of individuals) and the morphometric characteristics (stem height and perianth length) of the species.

Also, the aim of this paper is to present a new, but disturbed site of *F. meleagris* from Romania, not mentioned until now in the literature. In fact, it seems to be the only population of this species from Cluj county, the previous mentions from Cheile Turzii [26] and Fânaţele Clujului [3] being probably due to confusions with *Fritillaria orientalis* Adams. The wet meadow described in this paper, beside an important population of *Fritillaria meleagris*, preserved until 2003 populations of other species from the Red List of Romania: *Achillea ptarmica*, *Dactylorhiza incarnata, Gentiana pneumonanthe, Gladiolus imbricatus, Iris sibirica, Narcissus poeticus* ssp. *radiiflorus*, *Trollius europaeus* [17].

Thus, the paper intends to document the botanical values of the study area, in the perspective of the habitat restoration and species conservation.

Materials and Methods

a. Study site

The study was performed in April 2001 and July 2003, in the upper part of Şard Valley (Someşului Hills, Transylvania), at 22 km NW from Cluj-Napoca (N 46° 53' and E 23° 21') (Fig. 1). The area is dominated by sedimentary rocks (clay, sand, cornish stone and marl), dating back to the late Oligocene age [15].

The fritillary grows at 450 m altitude, in a fen meadow with basic peaty soil (pH=6.4-7.2). The hills neighboring the area are covered by oak forests [19].

The ground water conditions within the study area are mainly governed by 2 sources: the main one, situated on the top of the valley and a second one, smaller, in its middle part. These sources generate 2 brooklets, which meander along the valley, determining a patchily distributed vegetation. As the topography of the site is slightly inclined, there are conditions for a soil moisture gradient.

The valley used to be mown during the summer and grazing was also practiced periodically.

Unfortunately, in the summer of 2003, technical drainage has been made on the study place. This kind of works were made 30 years ago in the valley, without affecting seriously at least the population of the fritillary, as the drainage channels were filled out gradually.

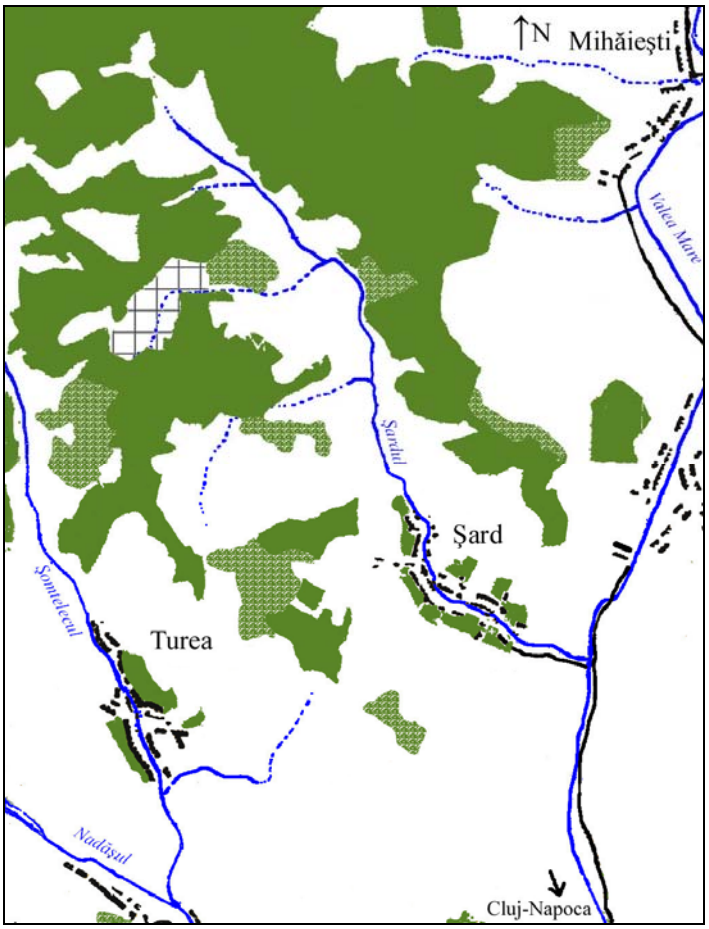

Fig. 1: The location of the study site – Reduced from 1:50.000
(Legend: - Forests - Plantations - Study site)

b. Sampling procedure

Three transects, each of 25 x 2 m, were installed in different community types, distinguished along a supposed moisture gradient, from wet to mesic. The sampling plots were delimited with a 1 m^2 frame, (subdivided in 10 x 10 cm sections), continuously laid out along the transects. The position of each individual was determined and mapped, using a coordinate system (Fig. 2).

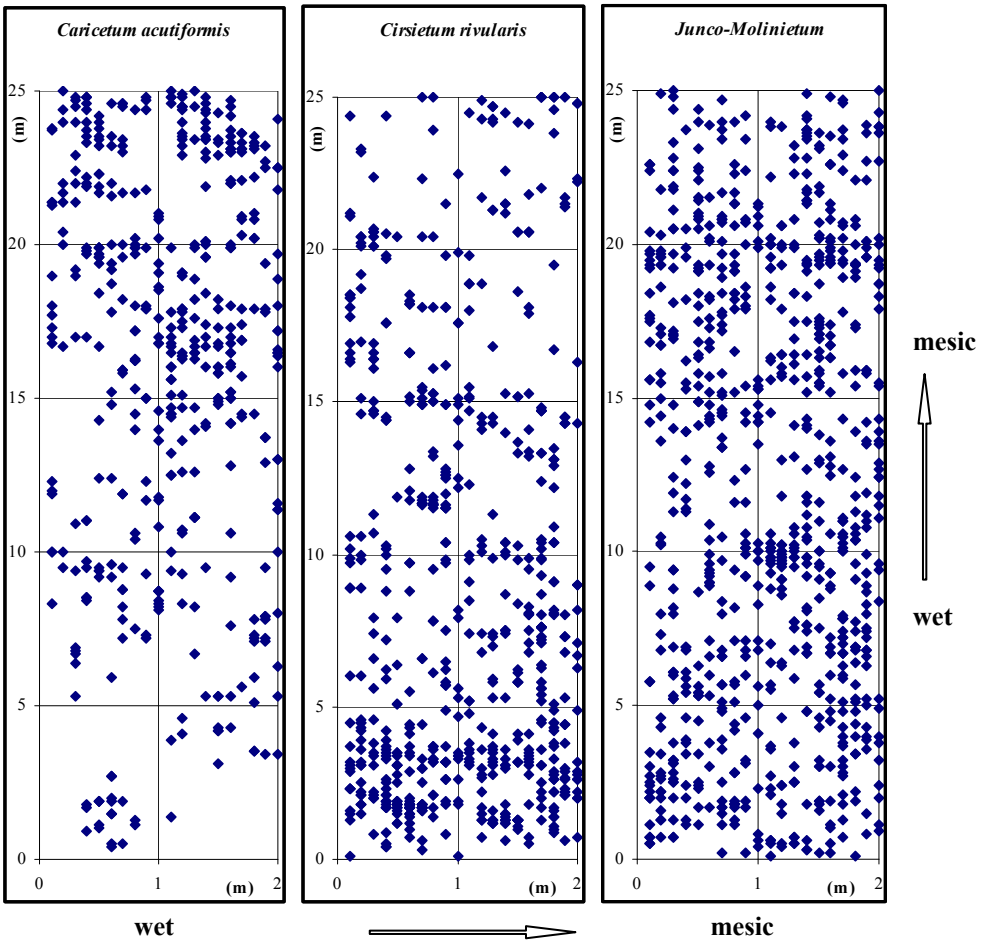

Fig. 2: Spatial distribution pattern of *Fritillaria meleagris* individuals along the three transects

Mean density of individuals was calculated for each transect. The plants recorded were assigned into different age-states: juveniles, vegetative and reproductive individuals, according to Zhang [27]. Seedlings were not given particular attention, since it was difficult to carry out a non-destructive search for them. Subadult and vegetative adult individuals were considered in the same category.

Stem height and perianth length were measured for each flowering individual.

In each vegetation type, two phytosociological records were performed, according to the method of Central European School [2]. The assignment to different associations was based on the presence of characteristic species. The nomenclature of plant taxa follows *Flora Europaea* [23].

c. Statistical analysis

Spatial distribution of individuals was assessed using Ripley's statistics [16]. The search was increased by 4 cm, up to a maximum of 1 m.

Correlations between the perianth length and stem height were calculated using the Pearson correlation coefficient [22].

Results and Discussion

a. Phytocoenological features

The following plant communities were identified in the study site: *Caricetum acutiformis* Eggler 1933 *(Magnocaricion), Cirsietum rivularis* Nowinski 1926 *(Calthion)* and *Junco-Molinietum* Preising 1951 *(Molinion)* (Tab. 1). *F. meleagris* was found more abundantly in *Junco-Molinietum* and *Cirsietum rivularis* associations. This finding is consistent with its overall phytosociological behaviour in Europe, where it is considered a characteristic species of *Molinio-Arrhenatheretea* [9, 12].

The recorded communities show distinct physiognomic characteristics, easily identifiable in springtime. Thus, in *Caricetum acutiformi*s community, which develops on the top of the valley, next to the source, a continuous bryophyte layer was observed, dominated by *Sphagnum* species. *Cirsietum rivularis*, which develops along the course of the brooklets, is characterized in the spring by tussocks of vegetation with 15-20 cm diameter, separated by flooded, barren interspaces. No bryophyte layer was recorded. *Junco-Molinietum* community has a closed, thick appearance, due to the good cover and homogeneity of the vegetation.

Among the Romanian red list species, *Achillea ptarmica*, *Dactylorhiza incarnata*, *Gladiolus imbricatus*, *Gentiana pneumonanthe* and *Trollius europaeus* were common in all recorded communities, while *Iris sibirica* and *Narcissus poeticus* ssp. *radiiflorus* occure only sparsely in *Junco-Molinietum* and *Cirsietum rivularis* community.

Table 1: Species composition of the three plant communities with *Fritillaria meleagris* in the study site

Number of records	**1**	**2**	**3**	**4**	**5**	**6**
Altitude (m a.s.l.)	**468**	**468**	**465**	**465**	**463**	**463**
Exposure	-	-	-	-	-	-
Slope (°)	-	-	-	-	-	-
Surface (m^2)	**25**	**25**	**25**	**25**	**25**	**25**
Cover (%)	**95**	**95**	**95**	**95**	**100**	**100**
Carex acutiformis	4	3-4	.	.	.	.
Cirsium rivulare	1-2	+-1	1-2	1-2	+	+
Molinia caerulea	.	.	+	.	3-4	3-4
Calthion						
Caltha palustris	1-2	+	+-1	.	.	+
Dactylorhiza incarnata	.	.	+	+	+	+
Lysimachia nummularia	.	+	+-1	+-1	+	+
Polygonum bistorta	.	+	+	+	.	.
Scirpus sylvaticus	.	.	+	+	+	.
Trollius europaeus	+	+-1	+	1-2	.	.
Molinion						
Carex flava	.	.	+	+	.	+
Carex tomentosa	+	+	.	+	.	.
Gentiana pneumonanthe	.	.	.	+	+	.
Iris sibirica	.	.	+	.	.	+
Juncus conglomeratus	+-1	+	1-2	1-2	+	+
Ranunculus polyanthemos	+	+	+	+	+	+
Serratula tinctoria	.	+	+	+	+	.
Stachys officinalis	.	.	+	+	+	.
Succisa pratensis	.	+	.	+	+	+

Veratrum album	+	+	+	+	+	+
Molinietalia						
Achillea ptarmica	+	+-1	+	+	+	+
Agrostis canina	.	.	+	+	2	2
Agrostis stolonifera	.	.	+	+	+	+
Carex ovalis	.	.	.	.	+	+
Deschampsia caespitosa	+	+	+	+	+	.
Equisetum palustre	+	+	.	.	.	.
Festuca rubra	.	.	.	+	.	.
Filipendula ulmaria	+	2	+-1	+	+	+
Fritillaria meleagris	**+-1**	**1**	**1**	**1**	**1-2**	**1-2**
Geranium palustre	+	.	.	.	.	.
Juncus atratus	.	.	.	+	+	.
Lychnis flos-cuculi	+	.	+	+	.	+
Lysimachia vulgaris	+	+	+	+	+	+
Lythrum salicaria	+	+	.	.	.	+
Mentha arvensis	+	.	.	.	.	.
Narcissus poeticus ssp. *radiiflorus*	.	.	.	.	.	+
Sanguisorba officinalis	.	.	+	+	+	+
Thalictrum lucidum	+	+	+	+	.	.
Valeriana officinalis ssp. *officinalis*	+	+	+	+	.	.
Arrhenatheretalia						
Cynosurus cristatus	.	.	+	.	.	+
Daucus carota ssp. *carota*	.	+	.	+	.	.
Gladiolus imbricatus	+	+	+	+	.	+
Phleum pratense	.	+	.	.	.	.
Molinio-Arrhenatheretea						
Anthoxanthum odoratum	.	.	+	.	+	+
Briza media	.	.	+	+	+	+
Campanula patula ssp. *patula*	.	.	.	.	+	.
Carex pallescens	.	.	3	3	.	.
Festuca pratensis	.	+	+	+	1	1-2
Galium mollugo	+	.	.	.	.	.
Holcus lanatus	.	.	.	+	+	+
Lathyrus pratensis	+	+	+	+	+	.
Leucanthemum vulgare	.	.	.	+	.	.
Lotus corniculatus	.	.	+	+	+	.
Luzula campestris	.	.	.	.	+	+
Nardus stricta	.	.	+	.	+-1	1
Ononis arvensis	.	+	.	.	.	.
Plantago lanceolata	.	.	+	+	+	+
Prunella vulgaris	.	.	+	+	+	+
Ranunculus acris	.	.	+	+	.	.
Stellaria graminea	.	.	.	+	.	.
Trifolium pratense	.	.	.	+	.	.
Vicia cracca	.	+	.	.	.	.
Vicia sepium	+	+	.	+	.	+
Other species: *Carex vulpina* +(5,6), *Clinopodium vulgare* +(1), *Cruciata glabra* +(1-4), *Filipendula vulgaris* +(3), +(4), *Galium verum* +(1,4), *Potentilla erecta* +(2,4,5,6), *Salix cinerea* +(1), *Trifolium montanum* +(3), *Sphagnum* sp.+(1)						
Place and date of records: Şard, 17 July 2003						

Legend: 1-2: ***Caricetum acutiformis*** Eggler 1933
3-4: ***Cirsietum rivularis*** Nowinski 1926
5-6: ***Junco-Molinietum*** Preising 1951

b. Population structure features

A relatively high number of individuals was recorded in all transects. The mean density of plants was the highest in the area with lower ground water level, in *Junco-Molinietum* community (16.34 individuals/m^2) (Fig. 2, 3). In wetter sites (*Cirsietum rivularis*, *Caricetum acutiformis*), the number of fritillaries decreases to 12.94 and 8.96 individuals/m^2, respectively, which suggests that soil-water conditions are important in influencing the establishment and survival of individuals. This result is consistent with other field observations [8, 27] and the known ecology of this species [1, 20]. The decrease in the number of individuals toward wetter sites might be due to limitations determined by waterlogging and anaerobic conditions in the soil [28].

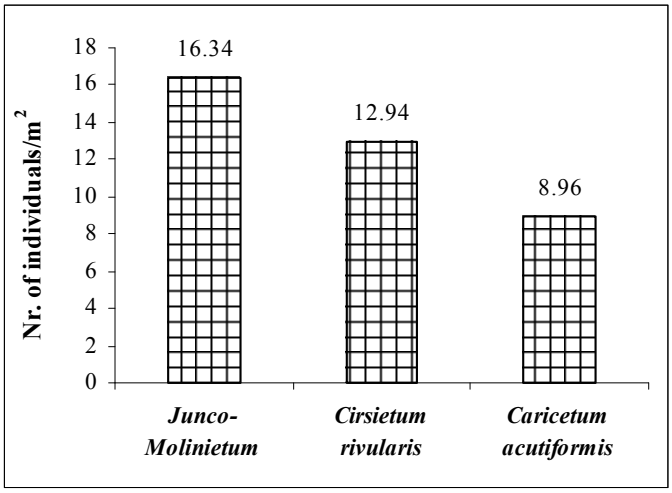

Fig. 3: Mean density of *Fritillaria meleagris* individuals in the studied plant communities

The number of juveniles, vegetative and reproductive individuals varied considerably from site to site (Fig. 4). Generally, the vegetative individuals far outnumbered the reproductive ones. The lowest percentage of reproductive individuals (5.32%) was recorded in *Junco-Molinietum*, compared with 9.86% and 11.35% in *Cirsietum rivularis* and *Caricetum acutiformis*, respectively. Conversely, the number of juveniles and vegetative individuals was higher in the *Junco-Molinietum* community. This outcome contradicts with other studies [27, 28], where a high and stable percentage of reproductive individuals was found in mesic conditions. However, the observed age-state structure is transitory, as it can change yearly (the plants renew their vegetative body completely each year and there is probably no gradual senescence of the plant in the strict sense of the term; the individuals are able to change from one age-state to another or they can remain in a bulb-state during one or more years) [27]. Thus, the dynamic of age-state structure in fritillary populations from distinct community types can be given only by analyzing the population demography along a few years. Nevertheless, the higher midsummer water stress in *Junco-Molinietum* community could possibly determine a shorter active growth period than in *Cirsietum rivularis* and *Caricetum acutiformis* communities, prolonging thus the juvenile and vegetative age state of the plants.

The spatial distribution of individuals shows a high aggregation tendency in wet areas, probably due to free reproduction niches available (bryophyte layer in *Caricetum acutiformis* or barren interspaces in *Cirsietum rivularis* community) (Fig. 2, 5). In *Junco-Molinietum*, a random distribution was registered at most of the scales, possibly determined by the homogeneity of the vegetation.

The seed weight (2.1–4 gr/100 seeds) [4], which could be contributory to the dissemination distance, seems to have minor influence on the spatial distribution pattern of the individuals at the observed scale.

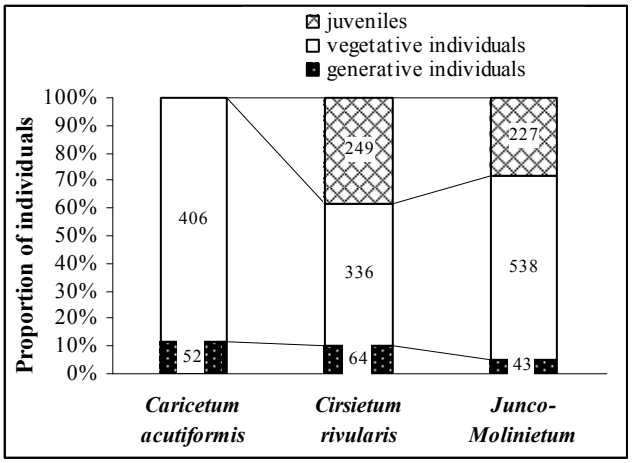

Fig. 4: Age structure of *Fritillaria meleagris* population in the studied plant communities (in *Caricetum acutiformis* community, juveniles were considered in the category of vegetative individuals)

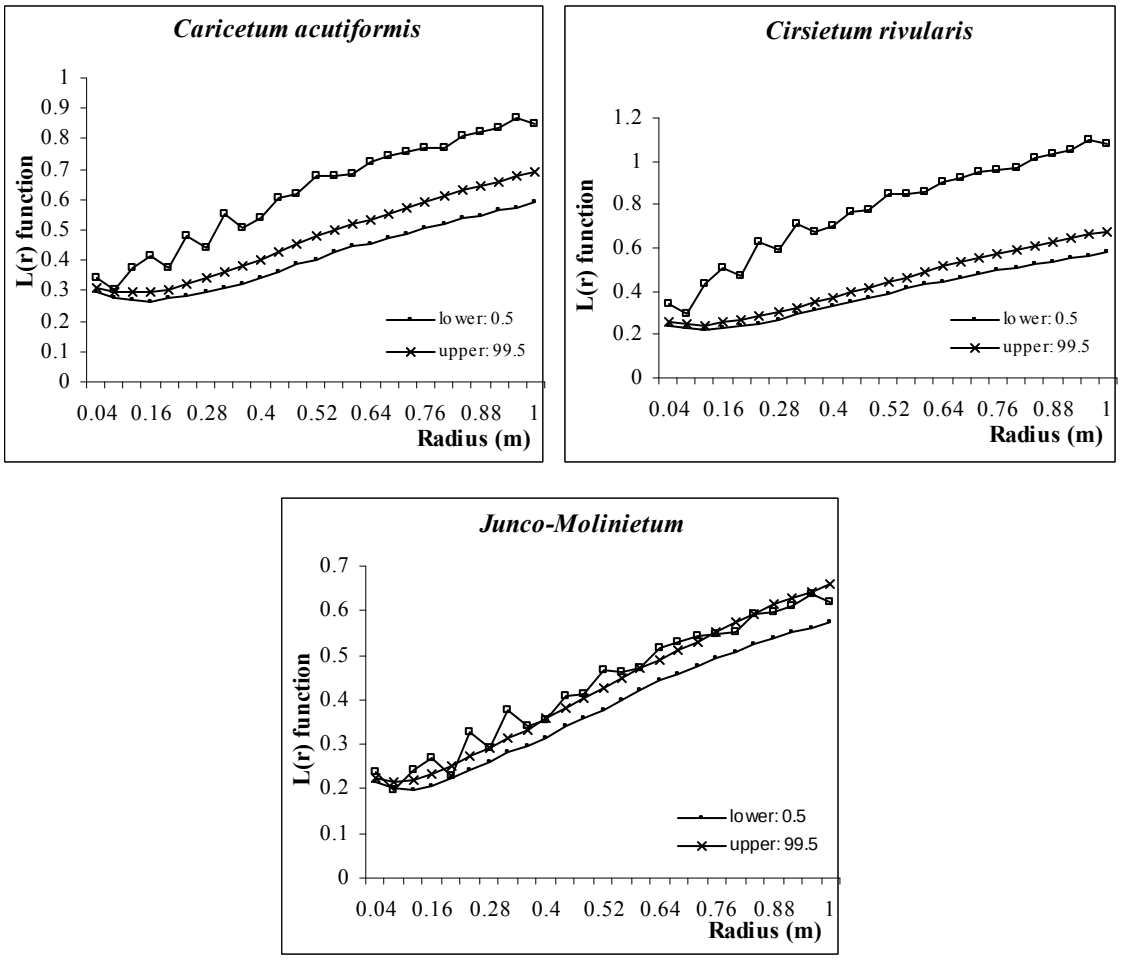

Fig. 5: Ripley's L distributions as a function of scale for the observed spatial distribution of *Fritillaria meleagris* individuals in different communities (legend: confidence limits)

Mean value of reproductive stem height of the recorded flowering individuals is 21.8 cm (n = 87) and that of the perianth length is 3.28 cm (n = 68). A moderate-strong positive correlation (Pearson correlation: r = +0.650; p < 0.01; n = 49) was found between these morphometric parameters, measured on individuals from *Caricetum acutiformis* community (fig. 6). In *Junco-Molinietum* no significant relationship was observed, which suggests that the low soil-water regime influences only the growth of the stem, while the perianth length remains rather constant. On the contrary, in moist conditions, where water stress is not constraining, higher stems develop larger flowers of fritillary.

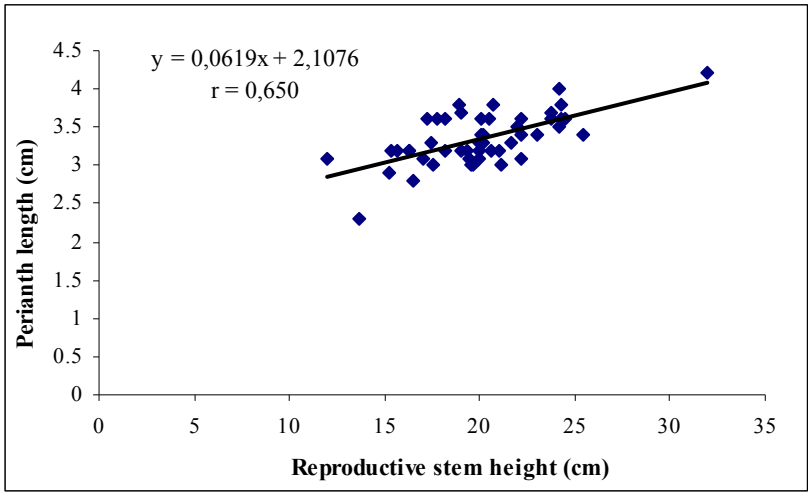

Fig. 6: Linear fit of perianth length as a function of stem height in *Caricetum acutiformis* community (Pearson r = +0.650, p < 0.01)

So far, the artificial drainage affected the area by the large ditches made to capture the water sources, and which extend along the valley. These works could seriously affect mainly the small populations of *Narcissus poeticus* ssp. *radiiflorus* and *Iris sibirica*, as bulbs and rhizomes could have been scaved out. Fragments of the larger populations of *Fritillaria meleagris*, *Achillea ptarmica*, *Dactylorhiza incarnata*, *Gentiana pneumonanthe, Gladiolus imbricatus* and *Trollius europaeus* were still found abundantly in the undigged patches of field. A more serious threat is the desiccation of the valley that will lead to a dramatic change in habitat and to the vanishing of certain species.

Taking into consideration the botanical importance of the wet meadow from the upper Şard Valley, supported by the present study, we propose the establishment of a nature reserve in this area.

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ASPECTE PRIVIND FITOCENOLOGIA ŞI STRUCTURA POPULAȚIEI DE *FRITILLARIA MELEAGRIS* L. DIN BAZINUL SUPERIOR AL VĂII ŞARD (JUD. CLUJ, ROMÂNIA)

(Rezumat)

În Valea Şard (Fig. 1) este semnalată o nouă localitate a speciei *Fritillaria meleagris* L., care adăposteşte singura populație sigură ca existând în județul Cluj. Din păcate, pajiştea înmlăştinită, înconjurată de cvercete, este afectată de lucrările de desecare efectuate în zonă în vara anului 2003. Pe lângă o importantă populație de *F. meleagris*, sunt amenințate cu reducerea efectivelor sau chiar cu dispariția şi populațiile altor

specii de pe lista roşie a cormofitelor din România: *Achillea ptarmica*, *Dactyorhiza incarnata*, *Gentiana pneumonanthe, Gladiolus imbricatus*, *Iris sibirica*, *Narcissus poeticus* ssp. *radiiflorus*, *Trollius europaeus*.

De-a lungul unui gradient descrescător de umiditate, au fost identificate fitocenoze aparţinând la trei asociaţii vegetale: *Caricetum acutiformis* Eggler 1933, *Cirsietum rivularis* Nowinski 1926 şi *Junco-Molinietum* Preising 1951, în care *F. meleagris* vegetează abundent (tab. 1). În cele trei transecte dispuse în aceste comunităţi (fig.2), au fost analizate câteva aspecte privind structura populaţiei (densitatea şi distribuţia spaţială a indivizilor, structura pe vârste a populaţiei) şi unele caracteristici morfometrice (înălţimea tulpinilor florifere, lungimea periantului) ale speciei *F. meleagris*.

S-a înregistrat un număr mare de indivizi în toate transectele analizate. Totuşi, densitatea indivizilor a fost mai ridicată în fitocenozele asociaţiei *Junco-Molinietum*, caracterizate printr-un nivel mai scăzut al apei freatice (16,34 indivizi/m^2), ea descrescând în fitocenozele mai umede (*Cirsietum rivularis* şi *Caricetum acutiformis*) la 12,94, respectiv 8,96 indivizi/m^2 (fig.3). Astfel, umiditatea solului pare să influenţeze apariţia şi supravieţuirea indivizilor de *F. meleagris*.

Numărul indivizilor în stadiu vegetativ a fost mai ridicat în fitocenozele aparţinând asociaţiei *Junco-Molinietum* (fig.4), probabil datorită reducerii perioadei active de creştere, ca urmare a stresului hidric mai îndelungat din perioada verii.

În *Caricetum acutiformis* şi *Cirsietum rivularis,* s-a evidenţiat o tendinţă de agregare a plantelor (fig. 2, 5), manifestată pe întreaga distanţă analizată (1 m). Aceasta s-ar putea datora existenţei unor nişe libere de reproducere (strat de muşchi vizibil şi respectiv interspaţii neacoperite de vegetaţie). Dimpotrivă, în *Junco-Molinietum* s-a observat o distribuţie aleatorie, datorată probabil omogenităţii fitocenozelor (acoperire ridicată şi aspect compact).

Valoarea medie a înălţimii tulpinilor florifere este de 21,8 cm (n = 87) iar cea a lungimii periantului de 3,28 cm (n = 68).

În condiţiile mai puţin umede ale fitocenozelor de *Junco-Molinietum*, înălţimea tulpinilor florifere nu influenţează creşterea periantului, care are dimensiuni relativ constante. În schimb, în *Caricetum acutiformis* (fig. 6) şi *Cirsietum rivularis*, aceşti parametri morfometrici variază proporţional.

Luând în considerare valoarea botanică a zonei studiate, este propusă constituirea unei arii protejate în bazinul superior al Văii Şard.