

RESEARCH CONCERNING THE POPULATIONS OF *ASPENIUM* SPECIES IN THE VÂLSAN VALLEY PROTECTED AREA

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Abstract. The in situ conservation of plants needs close monitoring of the state of the respective populations. The basic methods of monitoring include recording the standard observations, conducting the surveillance of the various elements, taking pictures in fixed points etc. Also, populational studies are useful when investigating a species' response to the changes in its habitats. Long-term populational observations in pteridophytes are scarce. The aim of the present paper was to identify the populations of the *Asplenium* species in the Vâlsan Valley protected area, with a view to making up a database necessary for the long-term monitoring of the populations. In the area studied so far, four species of the genus *Asplenium* were met: *A. ruta-muraria*, *A. scolopendrium*, *A. trichomanes*, and *A. viride*. The research showed that the species *A. scolopendrium* and *A. trichomanes* had populations with a large number of individuals, and it was demonstrated that these populations include the gametophyte, sporeling and juvenile stages, which proves the fact that these species reproduce sexually.

Keywords: *Asplenium* L., Vâlsan Valley, populations, reproduction.

Rezumat. Cercetări privind populațiile speciilor de *Asplenium* din aria protejată Valea Vâlsanului. Conservarea in situ a plantelor necesită monitorizarea stării populațiilor. Metodele de bază ale monitoringului includ înregistrarea observațiilor standard, realizarea de supravegheri ale diferitelor elemente, realizarea de fotografii din puncte fixe ș.a. De asemenea, studiile populaționale sunt utile când se investighează răspunsul unei specii la schimbările din habitatul său. Observațiile populaționale pe termen lung la pteridofite sunt rare. Scopul acestei lucrări a fost identificarea populațiilor speciilor de *Asplenium* din aria protejată Valea Vâlsanului pentru realizarea unei baze de date necesară monitorizării pe termen lung a populațiilor. În arealul cercetat până în prezent au fost determinate patru specii ale genului *Asplenium*: *A. ruta-muraria*, *A. scolopendrium*, *A. trichomanes* și *A. viride*. Populații cu număr mare de indivizi au fost localizate la speciile *A. scolopendrium* și *A. trichomanes*, și tot la acestea, s-a constatat prezența în populație a stadiilor de gametofit, plantule și juvenili din ciclul de viață, ceea ce dovedește faptul că speciile se înmulțesc și pe cale sexuală.

Cuvinte cheie: *Asplenium* L., Valea Vâlsanului, populații, reproducere.

INTRODUCTION

An important aspect of the management of protected areas is monitoring the various components of biological diversity. The basic methods of monitoring include recording the standard observations, conducting surveillances of the various elements, taking photos from fixed points a.s.o. (DANIELSEN et al., 2000; PRIMACK et al., 2008). The *in situ* conservation of plants needs monitoring the condition of the respective populations. Also, populational studies are useful when investigating a species' response to the changes in its habitats (OOSTERMEIJER et al., 1996; JONGEJANS & DE KROON, 2005; LEHTILÄ et al., 2006). Especially long-term populational studies can reveal how populations respond to abiotic and biotic changes in their environment (ØKLAND, 1997). Long-term populational observations in pteridophytes are scarce (CINQUEMANI KUEHN & LEOPOLD, 1992; RUMSEY et al., 2005; BREMER & JONGEJANS, 2009). In Romania's flora, the genus *Asplenium* (LINNAEUS 1753) presents 11 different species. Three of them have 2 subspecies each. Among these, 4 are frequent species, 4 are sporadically met species, and the other three are rare species (CIOCÂRLAN, 2009). *Asplenium adulterinum* (MILDE 1865) is a species mentioned in the Habitat Directive, Annex IIb, and in the European Red List. DIHORU & NEGREAN (2009) note that the species *Asplenium adulterinum* (MILDE 1865) subsp. *adulterinum* and *A. lepidum* (C. PRESLEY 1836) subsp. *lepidum* are critically endangered species, while *A. onopteris* (LINNAEUS 1753) is an endangered species. The aim of the present paper has been to identify the populations of the *Asplenium* species in the protected area of the Vâlsan Valley, in order to make up a database necessary to carry on a long-term monitoring of these populations. The research conducted is part of an ampler study, which aims at identifying all the pteridophyte populations in the respective area.

MATERIAL AND METHODS

The research studies were done in August 2009 and the studied area ranged from Brădet Chalet, up to the Vâlsan Glades. The GPS location was determined for each population of *Asplenium* species, then the number of individuals in the population was estimated; observations were made regarding the *in situ* reproduction. Within their life cycle four stages were identified: gametophyte, sporelings (small plants that emerge from the gametophyte), juveniles (plants with leaves which have not sporulated yet in their life) and adults (plants with at least one mature frond bearing ripe sori). The other pteridophyte species found in the located sites were identified using the following determiners: Flora Europaea (1993), CIOCÂRLAN (2009). In order to show the abundance of each species, the Dafor scale was used. The Dafor scale is an internationally recognized abundance scale for counting wildlife and other populations. The

following is a quantitative definition of frequency: D-dominant: >250; A-abundant: 51-250; F-frequent: 21-50; O-occasional: 6-20; rare: 1-5; absent 0.

RESULTS AND DISCUSSIONS

As a result of the trips in the field, populations of the following *Asplenium* species were identified: *A. ruta-muraria* (LINNAEUS 1753), *A. scolopendrium* (LINNAEUS 1753), *A. trichomanes* (LINNAEUS 1753), and *A. viride* (HUDSON 1762).

1. *Asplenium ruta-muraria* – a species frequently met from the forest-steppe region up to the subalpine level (OPREA, 2005; CIOCĂRLAN, 2009). Three populations with a small number of individuals were located in the studied area. The presence of the gametophyte or of the sporelings was not noticed (Table 1). *Asplenium ruta-muraria* is a mainly inbreeding, autotetraploid fern. Enzyme electrophoresis, cytological investigations and spore measurements revealed that outbreeding depression occurs in natural populations when two different genotypes cross. Crossing results in irregularities in meiosis and reduced spore fertility (SCHNELLER, 1995).

Table 1. *Asplenium ruta-muraria* populations.
Tabel 1. Populațiile de *Asplenium ruta-muraria*.

No.	Location	Altitude (m)	Dafor	In situ reproduction
1 (064)	N 45°20,680' E 024°44,026'	874	R	-
2 (071)	N 45°19,687' E 024°44,788'	742	R	-
3 (074)	N 45°20,056' E 024°44,351'	975	R	-

Alongside *Asplenium ruta-muraria*, nine other pteridophyte species, were found; *Asplenium scolopendrium*, *Athyrium filix-femina* (L.) ROTH and *Cystopteris fragilis* (L.) BERNH were found in all the three located sites (Table 2).

Table 2. Other pteridophyte species in the sites with *Asplenium ruta-muraria*.
Tabel 2. Alte specii de pteridofite din siturile cu *Asplenium ruta-muraria*.

No.	Species	064	071	074
1	<i>Asplenium scolopendrium</i> L.	+	+	+
2	<i>A. trichomanes</i> L.	-	+	+
3	<i>A. viride</i> HUDS.	+	+	-
4	<i>Athyrium filix-femina</i> (L.) ROTH	+	+	+
5	<i>Cystopteris fragilis</i> (L.) BERNH.	+	+	+
6	<i>Dryopteris filix-mas</i> (L.) SCHOTT	+	-	+
7	<i>Polypodium vulgare</i> L.	+	+	+
8	<i>Polystichum setiferum</i> (FORSSK.) WOYNAR	-	-	+
9	<i>Selaginella helvetica</i> (L.) SPRING	+	-	+

2. *Asplenium scolopendrium* – a sporadically met species, ranging from the sublevel of the holm oak up to that of the beech (OPREA, 2005; CIOCĂRLAN, 2009). In the studied area, the species forms populations in which the number of individuals varies between 20 and 400, so that, for the eight populations, the abundance on the Dafor scale varies from “occasional” to “dominant”. The presence of the gametophyte and sporelings was observed in three out of the six populations (Fig. 1). These populations were made up of numerous individuals (Table 3).

Table 3. *Asplenium scolopendrium* populations.
Tabel 3. Populațiile de *Asplenium scolopendrium*.

No.	Location	Altitude (m)	Dafor	In situ reproduction
1 (059)	N 45°19,570' E 024°44,728'	802	O	-
2 (060)	N 45°19,640' E 024°44,755'	874	A	Gametophyte and sporelings
3 (064)	N 45°20,680' E 024°44,026'	874	D	Gametophyte and sporelings
4 (071)	N 45°19,687' E 024°44,788'	742	F	Gametophyte and sporelings
5 (072)	N 45°19,709' E 024°44,805'	874	O	-
6 (074)	N 45°20,056' E 024°44,351'	975	F	-

Besides *A. scolopendrium*, eleven other species were met. In five of the six studied sites, the species *A. trichomanes* and *Cystopteris fragilis* were discovered; these species are usually found on rocky terrains, like *Asplenium scolopendrium* (Table 4).

3. *Asplenium trichomanes* – a species frequently found from the region of the oak forests up to the Boreal level (OPREA, 2005; CIOCĂRLAN, 2009). Eight populations were identified; three of them had over 100 individuals. In the latter, the presence of sporelings (Fig. 2) was noticed (Table 5). For the eight populations, the abundance on the Dafor scale varies from “occasional” to “frequent”. Fourteen other species were met besides *A. trichomanes*. *Cystopteris fragilis* was identified (Table 6) in seven out of the eight located sites.

Table 4. Other pteridophyte species in the sites with *Asplenium scolopendrium*.
Table 4. Alte specii de pteridofite din siturile cu *Asplenium scolopendrium*.

No.	Species	059	060	064	071	072	074
1	<i>Asplenium ruta-muraria</i> L.	-	-	+	+	-	+
2	<i>A. trichomanes</i> L.	+	+	-	+	+	+
3	<i>A. viride</i> L.	-	-	+	+	-	-
4	<i>Athyrium filix-femina</i> (L.) ROTH	-	+	+	+	-	+
5	<i>Cystopteris fragilis</i> (L.) BERNH.	-	+	+	+	+	+
6	<i>Dryopteris</i> sp. ADANS.	-	-	-	-	+	
7	<i>D. filix-mas</i> (L.) SCHOTT	-	-	+	-	-	+
8	<i>Polypodium vulgare</i> L.	-	+	+	+	-	+
9	<i>P. sp.</i> ROTH	-	-	-	-	+	
10	<i>Polystichum setiferum</i> (FORSSK.) WOYNAR	-	+	-	-	-	+
11	<i>Selaginella helvetica</i> (L.) SPRING	-	-	+	-	-	+

Table 5. *Asplenium trichomanes* populations.
Tabel 5. Populațiile de *Asplenium trichomanes*.

No.	Location	Altitude (m)	Dafor	In situ reproduction
1 (058)	N 45°19,513' E 024°44,841'	799	F	-
2 (059)	N 45°19,570' E 024°44,728'	802	O	-
3 (060)	N 45°19,640' E 024°44,755'	874	A	Sporelings and juveniles
4 (062)	N 45°20,679' E 024°44,331'	800	O	-
5 (071)	N 45°19,687' E 024°44,788'	742	A	Sporelings and juveniles
6 (072)	N 45°19,709' E 024°44,805'	874	O	-
7 (074)	N 45°20,056' E 024°44,351'	975	A	Sporelings and juveniles
8 (075)	N 45°20,159' E 024°44,239'	987	O	-

Table 6. Other pteridophyte species in the sites with *Asplenium trichomanes*.
Tabel 6. Alte specii de pteridofite din siturile cu *Asplenium trichomanes*.

No.	Species	058	059	060	062	071	072	074	075
1	<i>Asplenium ruta-muraria</i> L.	-	-	-	-	+	-	+	-
2	<i>A. scolopendrium</i> L.	-	+	+	-	+	+	+	-
3	<i>A. viride</i> HUDS.	-	-	-	+	+	-	-	+
4	<i>Athyrium filix-femina</i> (L.) ROTH	-	-	+	+	+	-	+	+
5	<i>Cystopteris fragilis</i> (L.) BERNH.	+	-	+	+	+	+	+	+
6	<i>Dryopteris</i> sp. ADANS.	-	-	-	-	-	+	-	-
7	<i>D. filix-mas</i> (L.) SCHOTT	-	-	-	-	-	-	+	-
8	<i>Equisetum hyemale</i> L.	-	-	-	-	-	-	-	+
9	<i>Gymnocarpium sp.</i> NEWMAN	+	-	-	-	-	-	-	+
10	<i>Phegopteris connectilis</i> (MICHX.) WATT	-	-	-	-	-	-	-	+
11	<i>Polypodium vulgare</i> L.	-	-	+	-	+	-	+	+
12	<i>Polystichum sp.</i> ROTH	-	-	-	-	-	+	-	-
13	<i>P. setiferum</i> (FORSSK.) WOYNAR	-	-	+	-	-	-	+	-
14	<i>Selaginella helvetica</i> (L.) SPRING	-	-	-	+	-	-	+	-

4. *Asplenium viride* – a species frequently met from the holm oak sublevel up to the boreal level (OPREA, 2005; CIOCĂRLAN, 2009). In the studied area it forms four populations with a small number of individuals (Table 7). Therefore, the abundance on the Dafor scale shows occasional presence. Sporelings were identified in only one population.

Table 7. *Asplenium viride* populations.
Tabel 7. Populațiile de *Asplenium viride*.

No.	Location	Altitude (m)	Dafor	In situ reproduction
1 (062)	N 45°20,679' E 024°44,331'	800	O	-
2 (064)	N 45°20,680' E 024°44,026'	874	O	-
3 (071)	N 45°19,687' E 024°44,788'	742	O	juveniles
4 (075)	N 45°20,159' E 024°44,239'	987	O	-



Figure 1. *Asplenium scolopendrium* - sporelings and juveniles (original).
Figura 1. *Asplenium scolopendrium* - plantule și juvenili (original).



Figure 2. *Asplenium trichomanes* – sporelings and juveniles (original).
Figura 2. *Asplenium trichomanes* – plantule și juvenili (original).

Besides *A. viride* ten other species were met, *Athyrium filix-femina* and *Cystopteris fragilis* being present in all four sites (Table 8).

Table 8. Other pteridophyte species in the sites with *Asplenium viride*.
Tabel 8. Alte specii de pteridofite din siturile cu *Asplenium viride*.

No.	Species	062	064	071	075
1	<i>Asplenium ruta-muraria</i> L.	-	+	+	-
2	<i>A. scolopendrium</i> L.	-	+	+	-
3	<i>A. trichomanes</i> L.	+	-	+	+
4	<i>Athyrium filix-femina</i> (L.) ROTH	+	+	+	+
5	<i>Cystopteris fragilis</i> (L.) BERNH.	+	+	+	+
6	<i>Dryopteris filix-mas</i> (L.) SCHOTT	-	+	-	-
7	<i>Equisetum hyemale</i> L.	-	-	-	+
8	<i>Phegopteris connectilis</i> (MICHX.) WATT	-	-	-	+
9	<i>Polypodium vulgare</i> L.	-	+	+	+
10	<i>Selaginella helvetica</i> (L.) SPRING	+	+	-	-

CONCLUSIONS

In the area studied so far, four species of the genus *Asplenium* were determined: *A. ruta-muraria*, *A. scolopendrium*, *A. trichomanes*, and *A. viride*. Populations with a large number of individuals were located for the species *A. scolopendrium* and *A. trichomanes*. In the populations of the same species the presence of the gametophyte and sporeling stages in their life cycle was found, which proves the fact that those species also reproduce sexually.

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REFERENCES

- BREMER P., JONGEJANS E. 2010. *Frost and forest stand effects on the population dynamics of Asplenium scolopendrium*. Population Ecology. **52**(1): 211-222.
- CINQUEMANI KUEHN DIANE M. & LEOPOLD D. J. 1992. *Long term demography of Phyllitis scolopendrium (L.) newm. var americana fern in central New York*. Bulletin of the Torrey Botanical Club. **119**(1): 65-76.
- CIOCÂRLAN V. 2009. *Flora Ilustrată a României. Pteridophyta et Spermatophyta*. Edit. Ceres București: 78-106.
- DANIELSEN F., BALETE D. S., POULSEN M. K., ENGHOF M., NOZAWA C. M., JENSEN A. E. 2000. *A simple system for monitoring biodiversity in protected areas of a developing country*. Biodiversity and Conservation. **9**: 1671-1705.
- DIHORU GH. & NEGREAN G. 2009. *Cartea roșie a plantelor vasculare din România*. Edit. Academiei Române București: 77-79.
- JONGEJANS E., DE KROON H. 2005. *Space versus time variation in the population dynamics of three co-occurring perennial herbs*. J. Ecol. **93**: 681-692.
- LEHTILÄ K., SYRJANEN K., LEIMU R., GARCIA M. B., EHLÉN J. 2006. *Habitat change and demography of Primula veris: identification of management targets*. Conserv. Biol. **20**: 833-834.
- ØKLAND R. H. 1997. *Population biology of the clonal moss Hylocomium splendens in Norwegian boreal spruce forest. III. Six-year demographic variation in two areas*. Lindbergia **22**: 49-68.
- OOSTERMEIJER J. G. B., BRUGMAN M. L., DE BOER E. R., DEN NIJS H. C. M. 1996. *Temporal and spatial variation in the demography of Gentiana pneumonanthe, a rare perennial herb*. J. Ecol. **84**: 153-166.
- OPREA A. 2005. *Lista critică a plantelor vasculare din România*. Edit. Universității „Alexandru Ioan Cuza” Iași: 9-25.
- PRIMACK R. B., PĂTROESCU MARIA, ROZYLWICZ L., IOJĂ C. 2008. *Fundamentele conservării diversității biologice*. Edit. Agir București: 443-444.
- RUMSEY F. J., BARRETT J. A., GIBBY M., RUSSELL S. J., VOGEL J. C. 2005. *Reproductive strategies and population structure in the endangered pteridophyte Trichomanes speciosum (Hymenophyllaceae: Pteridophyta)*. Fern Gaz. **17**(4): 205-215.
- SCHNELLER F. L. S. 1995. *Outbreeding depression in the fern Asplenium ruta-muraria L.: Evidence from enzyme electrophoresis, meiotic irregularities and reduced spore viability*. Biological Journal of the Linnean Society. **59**(3): 281-295.
- SĂVULESCU T., NYARADY E. I., ALEXANDRESCU M., BELDIE A., BUIA A., GEORGESCU C. C., GRINȚESCU G., GUȘULEAC M., GRINȚESCU I., MORARIU I., PRODAN I., ȚOPA E. 1952. *Flora României*. Edit. Academiei Române București. **1**: 21-154.

TUTIN T. G., BURGES N. A., CHATER A. O., EDMONSON J. R., HEYWOOD V. H., MOORE D. M., VALENTINE D. H., WALTERS S. M., WEBB D. A. (eds, assist. By J. K. AKEROYD & M. E. NEWTON). *Flora Europaea*. 2nd ed. **1**. *Psilotaceae* to *Platanaceae*. Cambridge: Cambridge University Press: 581 pp.

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