Present or Absent? About a Threatened Fern, 
*Asplenium adulterinum* Milde, in South-Eastern Carpathians (Romania)

Attila BARTÓK1, Irina IRIMIA2*

1Atatii, 11 Ion Mihalache Blvd, 011171, Bucharest, Romania; bartok.attila@gmail.com
2Alexandru Ioan Cuza University, Faculty of Biology, 20A Carol I Blvd, 700506, Iași, Romania; iblig2002@yahoo.com (*corresponding author)

Abstract

*Asplenium adulterinum* Milde is one of the rarest and most threatened representatives of the *Aspleniaceae* family in the Carpathians. Botanical literature mentioned the ladder spleenwort in many localities in South-Eastern Carpathians in the past, but during the last decades the species has not been collected and deposited in public herbaria by any botanist. All existing herbarium material in Romanian herbaria (including *Asplenium cuneifolium*, *A. ruta-muraria*, *A. septentrionale*, and *A. lepidum*) was revised and all available information from botanical literature was critically compiled in order to clarify the distribution of *Asplenium adulterinum* in the South-Eastern Carpathians. After almost 80 years since the first mention of the species in the Carpathians, this paper reports the recent identification of *Asplenium adulterinum* in three new localities in South-Eastern Carpathians (Ţesna Valley, Vătăriroaia Waterfall and Şugăului Gorges).

Keywords: *Aspleniaceae*, chorology, endangered species, flora, Red Book, threatened species

Introduction

*Asplenium* L. is a relatively large genus of *Aspleniaceae* family with about 700 species. They are also one of the most widespread fern groups and occur in temperate and tropical regions of all continents, except Antarctica (Schneider et al., 2004). Thirty-one species of this genus are present in European flora (Crabbe et al., 1993), ten of these species occurring in Romanian flora (*Asplenium solandrium* L., *A. septentrionale* (L.) Hoffm., *A. trichomanes* L., *A. trichomanes-ranunculoides* L., *A. adulterinum* Milde, *A. ruta-muraria* L., *A. lepidum* C. Presl, *A. cuneifolium* Viv., *A. adiantum-nigrum* L., *A. onopterus* L.) (Sărbu et al., 2013).

Some fern species of *Asplenium* genus (*Asplenium adulterinum*, *A. adiantum-nigrum* and *A. cuneifolium*) are often called serpentine ferns, because their occurrence is almost strictly related to serpentine rocks (Hayek, 1916). Serpentinities is a rock composed of one or more serpentine group minerals. Serpentinization is a geological low-temperature metamorphic process involving heat and water, in which low-silica mafic and ultramafic rocks are oxidized and hydrolyzed with water into serpentine. Serpentine is formed from olivine via several reactions, some of which are complementary (Sleep et al., 2004).

Serpentinities have a limited number of characteristic plants, which are confined exclusively to magnesium silicates or carbonates (serpentine, magnesite) and these species may be considered strictly serpentine species. In Europe, serpentinities occur in the Alps, Carpathians, Balkan Peninsula, Southeast Portugal and Great Britain (Roberts and Proctor, 1992). In Romania they grow in South-Eastern Carpathians (Southern Carpathians and Apuseni Mountains, less in the Eastern Carpathians) (Corvin Papiu, 1963). Serpentine ferns are extremely rare and have been declining at an alarming rate.

The present study focuses on *Asplenium adulterinum* Milde, one of the rarest and most threatened plant species in the Romanian flora. *Asplenium adulterinum* was included in the list of species as an extension to Annex II of the Habitat Directive (Directive 92/43/EEC) so that its protection requires the designation of a Special Area of conservation. It was also listed together with *Asplenium cuneifolium* in Annex IV of The Convention of European Wildlife and Natural Habitats (Bern Convention) concerning plant species demanding strict protection in all European Union countries.

*Asplenium adulterinum* was considered to be an European endemic species (Holderegger, 1994) before it was found on Vancouver Island, Canada (Klinkenberg, 2008). Also, the species is considered a glacial relict (Holderegger, 1994). The first description of the species was made by Milde (1865). *Asplenium adulterinum* is considered a natural hybrid between *A. trichomanes* and *A. trichomanes-ranunculoides* (Lovis and Reichstein, 1968; Reichstein, 1984). *Asplenium adulterinum* is a vascular cryptogam whose roots are not proliferous. Stems are short-crooping, mainly unbranched; scales are black or with narrow pale borders, narrowly lanceolate (with dimensions 1.5-3 × 0.2-0.4 mm), with entire margins. Leaves are monomorphic. Petiole is dark reddish brown (1-4 mm). Blade is linear, 1-pinnate (2.5-14 × 0.5-1.2 cm), thick (in open habitat) to herbaceous (in shaded, moist habitat), essentially glabrous; base is somewhat tapered; apex is obtuse, not rooting. Rachis is reddish brown in proximal 1/2-4/5 part and green in distal part, lustrous, glabrous. Pinnae are in 10-30 pairs, ovate to rhombic to ovate-oblong (with dimensions of 2.5-11 × 2.6 mm), very short petiolated;

Received: 01.04.2015. Received in revised form: 30.06.2015. Accepted: 14.09.2015. Published online: 24.09.2015.
Results and Discussion

Asplenium adulterinum (Braun-Blanquet, 1932).

The species occurs on ledges and crevices of ultrabasic rocks (serpentine, magnesite) or rarely on basic rocks. Asplenium adulterinum Milde subsp. preslanense Mokry, Rasbach & Reichst. occurs in North of Italy and South of Switzerland on limestone or mica-schist (Crabbe et al., 1993).

In the Romanian botanical literature Asplenium adulterinum is considered a rare species (Boșcaiu et al., 1994; Oltean et al., 1994; Oprea, 2005) or placed in the "Insufficiently Known" (K) sozological category (Dihoru and Dihoru, 1994). The species was included in the Red Book of Vascular Plants of Romania (Dihoru and Negrean, 2009). Inclusion in a sozological category of species in Romania was difficult, considering that the fern has not been seen by botanists in recent decades. Since 1931 no botanist has collected Asplenium adulterinum from the Romanian Carpathians and deposited in a public herbarium (in reality there is a single herbarium voucher in BUCA Herbarium (BUCA no. 004147), whereas the plant was collected by Grieșescu on 3 July 1931, near Bâile Herculane, but the data have never been published.

According to the Red Book of Vascular Plants of Romania (Dihoru and Negrean, 2009) it seems that there is also a specimen deposited in the CL herbarium: "Custura Mătărițic, 12 VII 1964, N. Boșcaiu [CL]." The authors hereby checked this information in CL herbarium (on 15 and 16 January 2015) and did not find any specimens of Asplenium adulterinum.

Materials and Methods

The investigations were based on recent field studies and analysis of herbarium material stored at CL, BUCA, BUCF, BVS, SIB, IJAGB, IASI, B, W, WU, P, CRAI (acronyms according to Thiers, 2015), as well as literature data. All existing herbarium material (including Asplenium trichomanes and A. trichomanes-ramosum) was revised and all available information from botanical literature was critically compiled in order to clarify the distribution of Asplenium adulterinum in the South-Eastern Carpathians.

Several field surveys were made between 2004 and 2014 in Almajului Mts., Aninei Mts., Mehedinți Mts., Țarcu Mts., Ceahlău Mts., Călimani Mts., Rarău Mts. (South-Eastern Carpathians) where the species was reported.

Physiosociological characteristics of possible sites with Asplenium adulterinum were studied according to the Braun-Blanquet approach (Braun-Blanquet, 1932).

The collected material has been lodged in the personal herbarium of A. Bartók.

Results and Discussion

Distribution of Asplenium adulterinum Milde in South-Eastern Carpathians

Rarău Mountains, Eastern Carpathians

Pietrele Doamnei (Lady’s Stones) and their surroundings represent maybe the most intensively investigated region by the botanists, considering the whole range of Rarău Mountains.

In this mountain range the presence of Asplenium adulterinum was reported by some authors (Mititelu et al., 1989; Oprea and Sârbu, 2012, 2013; Bădarău, 2013), but without exact localisation and never confirmed by herbarium material. The main botanists (Morariu, 1965; Raclaru, 1973, 1976) who investigated in detail the mountain and subalpine flora of Rarău Mountains did not mention Asplenium adulterinum; they both refer only to Asplenium trichomanes-ramosum and Asplenium trichomanes.

During the current research surveys, the species was not found near Pietrele Doamnei or in other parts of this mountain group (Bartók A, pers. obs. 2007, 2010, 2011, 2014). It can be said that certainly it was confused here with Asplenium trichomanes-ramosum or Asplenium trichomanes, since these two species are frequently encountered in the region.

Călimani Mountains, Eastern Carpathians

Neither Csűrös (1951) nor Höhn (1998a) mentioned Asplenium adulterinum in the area of Călimani Mountains. However, Mititelu et al. (1986) and Chifu et al. (2008) reported ladder spleenwort in the flora of this mountain range, but without exact localisation or citation. Although Höhn (1998a) did not mention Asplenium adulterinum in the flora of Călimani Mountains, the same author highlights in another publication (Höhn, 1998b) (according to personal observations) that species with affinity for basic soils (e.g. Asplenium adulterinum Milde, Carex sempervirens L., Phyteuma orbiculare L., Saxifraga ascends L.) do not occur on the south part of Călimani Mountains, but on the north face.

Yet, the most recent checklist of Călimani National Park (ICB Iaşi, 1994) does not mention Asplenium adulterinum in Călimani Mountains. Since it is known that the list of Mititelu et al. (1986) is partly based on older literature without citations, Asplenium adulterinum could not be observed in the field (Bartók A, pers. obs. 2007, 2010, 2011) and therefore it can be concluded that is was confused with Asplenium trichomanes-ramosum or Asplenium trichomanes, since these two species are frequently encountered in this region. There are no herbarium specimens of Asplenium adulterinum from the floristically well explored Călimani Mountains, in all herbaria checked.

Bistriţei Mountains, Eastern Carpathians

Asoltani (2007) listed Asplenium adulterinum in this mountain range from Șaru Bucovinei and Șeștină, but it was not confirmed by herbarium voucher. Seghedin in his thesis and in floristically synthesis of Suceava County (Seghedin, 1985, 1987) did not mention Asplenium adulterinum, but Asplenium trichomanes-ramosum and Asplenium trichomanes instead, in this mountain group. Also Mardari (2008) in a floristical synthesis of Bistriței Mountains flora could not confirm the presence of ladder spleenwort in this area.

The flora of this mountain range is not well studied, and the presence of Asplenium adulterinum remains doubtful (there was no herbarium voucher in all checked herbaria).

Hășmaș Mountains, Eastern Carpathians

Asplenium adulterinum was first listed in this mountain group by Nechita and Mititelu (1996) and Nechita (2000) in two separate physiosociological papers, in composition of two plant associations: Asplenietum trichomanes-rutae-muravieae Kuhn 1937, Tx. 1937 (in Bicăj Gorges and Piatra Singuratca Mts., Hășmaș Mountains, Eastern Carpathians) and Asplenio-
Mountains (Nechita, 2003) did not include the relevés where Asplenium adulterinum was present.

Asplenium adulterinum was listed by Nechita (2003) in Suhardul Mic Mountains, but unfortunately the citation was erroneously based on Soó publication (Soó, 1940); the cited paper was probably confused with another one (Nagy, 1942) in which Asplenium × breynii Retz. (Asplenium trichomanes × Asplenium septentrionale) was mentioned, not Asplenium adulterinum.

The flora of Hăşmaş Mountains and Bicazului Gorges was well explored and other floristical or phytosociological publications (Guşuleac, 1932; Nyárády, 1937; Soó, 1940, 1943; Ștefan et al., 2007) did not mention the occurrence of Asplenium adulterinum in this mountain range. Horeanu (1979) did not mention Asplenium adulterinum in the floristical paper regarding flora of Munticelu-Cheile Șugăului Nature Reserve, but Asplenium trichomanes-ramosum or Asplenium trichomanes instead.

However, Nechita and Bliderişanu (2006) listed ladder spleenwort in Bicazului Mts. but without exact locality or citation. The species was reticently mentioned to appear in Stânişoarei Mountains (Oprea and Sârbu, 2008, 2009). It might be supposed that the mentioned coronim (Bicazului Mts.) refers to the Northeastern part of Hăşmaş Mountains, which is situated near Stânişoarei Mountains. Bădărău (2013) mentioned Asplenium adulterinum in “Cheile Bicazului-Hăşmaș” (ROSCI 0027) Natura 2000 network, but without exact locality or citation. Also, ladder spleenwort is listed in the Management Plan of Cheile Bicazului-Hăşmaș National Park, but without exact locations or citation. There are no herbarium vouchers of Asplenium adulterinum in all checked herbaria.

Moreover, ladder spleenwort was recently reported on Munticelu-Cheile Șugăului Nature Reserve near Șugăului Gorges by Associate Professor Dr. Ioana Popescu (Fig. 1, photo A). Herbarium material was not collected, but in the pictures taken it is clear that the colour of rachis is green in distal part. Asplenium adulterinum is growing here in a non-typical habitat on limestone rocks (the studied area does not include serpentine rocks) (Corvin Papiu, 1963).

Ceahlău Mountains, Eastern Carpathians

Grecescu in his floristical monograph (Grecescu, 1906) did not mention Asplenium adulterinum in Ceahlău Mountains, but Asplenium trichomanes-ramosum or Asplenium trichomanes instead. Neither later studies in this mountain range (Pașu, 1911; Grințescu, 1923; Nyárády, 1924; Papp, 1931; Borhidi, 1958; Burduja, 1962; Horeanu and Borcea, 1982) did not mention ladder spleenwort from the floristically well explored Ceahlău Mountains. In more recent publications (Chifu et al., 1987; Manoliu et al., 2002), the authors mentioned Asplenium adulterinum in “Ceahlău” (ROSCI 0024) Natura 2000 network, but without exact data or citation.

Ladder spleenwort is listed in the Management Plan of Ceahlău National Park, but without exact data. There are no herbarium specimens of Asplenium adulterinum from the floristically well explored Ceahlău Mountains in all checked herbaria.

Evenmore, Asplenium adulterinum could not be found in this mountain group (Bartók A. pers. obs. 2004, 2005, 2006, 2007, 2009, 2011). Similar as in other mountain range in the Eastern Carpathians, Asplenium adulterinum was probably confused with the omnipresent Asplenium trichomanes-ramosum or Asplenium trichomanes, which are well documented (Grecescu, 1906; Papp, 1931; Manoliu et al., 2002) as proved by numerous vouchers in I, IAGB or IASI.

Mehedinți Mountains, Southern Carpathians

This mountain range was not well explored floristically; only Domogled Peak with its surroundings and Șesna Valley were studied more rigorously from the botanical point of view. Borbás (1874) and Simkóvics (1878) followed by Degen (1901) studied the flora of Domogled Massif, without any report about the occurrence of Asplenium adulterinum in this mountain group, but Asplenium trichomanes-ramosum and Asplenium trichomanes instead. Nor the more recent research of Resmeriţă (1970, 1971, 1972) did not demonstrate the occurrence of ladder spleenwort in the floristically explored Șesna Valley. Neither Georgescu (1934) nor Buia (1959) or Bujorean and Popescu (1966) mentioned Asplenium adulterinum for the Mehedinti Mountains.

In the document compiled by Faculty of Biology and Geography - Babeș-Bolyai University Cluj-Napoca -” Research about flora and vegetation of the parcels with Banat black pine from the Domogled-Valea Cernei National Park” (2006) the occurrence of Asplenium adulterinum was mentioned in this mountain range, but without any specific locality or citation. Moreover, the authors of this publication recognized the absence of the species on field. Bădărău (2013) mentioned Asplenium adulterinum in “Domogled-Valea Cernei” (ROSCI 0069) Natura 2000 network, but without exact locality or citation.
A previously unknown citation about a population of *Asplenium adulterinum* was noted in Mehedinți Mountains (Southern Carpathians) on 1 June 2013, referring to the middle part of the Țesna Valley, in semi shady rocky place, exposed to the north, at approximately 600 m a.s.l. *Asplenium adulterinum* was growing there in a non-typical habitat: on limestone rocks, in crevices of rocks, not far from the tourist path. Although the authors of the current study researched in detail a great part of the area, a single individual was found. Accordingly, it may be supposed there was a very small population in that place. Because a single specimen was found, herbarium material was not collected. This discovery was documented by photos (Fig. 1. B, C).

Additionally, it is worth mentioning that only one voucher specimen of *Asplenium adulterinum* from Romanian Carpathians was found in all herbaria consulted (BUCA no. 004147). The plant was collected by Grințescu on 3 July 1931 near Bâile Herculane (in humid rock crevices), the only specimen previously known from the Romanian Carpathian, but the data have never been published.

Mehedinți Mountains are one of the few mountains in Romanian Carpathians wherein the presence of this rare fern was confirmed.

**Cernei Mountains, Southern Carpathians**

The area of Arjana Peak and Vânturăoarea Waterfall from Cernei Mountains, shelter a very interesting flora, with rare species e.g. *Minuartia graminifolia* (Ard.) Jv. subsp. *hungarica* Jáv., considered endemic for Southern Carpathians (Conti, 2003). There are no previous collected herbarium specimens of *Asplenium adulterinum* or floristic data about this species in the Cernei Mountains.

During the current study field research, a population of *Asplenium adulterinum* was identified on 27 April 2014, near Vânturăoarea Waterfall, in adunarul rocky place, exposed to the north, at 550 m a.s.l. *Asplenium adulterinum* was growing there in a non-typical habitat: on limestone rocks, in crevices of rocks. The area is protected; it is included in Domogled-Cerna National Park. The population was poor, counting only three specimens of plants. The population was probably more numerous, but it was not possible to examine the whole area in detail. The collected material was lodged in the personal herbarium of A. Bartók.

**Țărâu Mountains, Southern Carpathians**

This area was studied by Borbás (1874) and Simkovics (1878) who did not report the occurrence of the fern. The first mention of the presence of *Asplenium adulterinum* in Țărâu Mountains was signalled by Boșcau (1971) who investigated the flora and vegetation of this mountain range. Boșcau (1971) reported *Asplenium adulterinum* population in Țărâu Mountains, near Custura Mătâniei at an altitude of 1,750 m a.s.l., slope 80°, on a surface of 9 m², in a single phytosociological relevé (*Asplenietum trichomano-trichomanoidum* Kuhn 1937, Tx. 1937). Bădăru (2013) mentioned *Asplenium adulterinum* in “Munții Țărâu” (ROSCI 0126) Natura 2000 network, but without exact locality or citation. Based on this publication, *Asplenium adulterinum* was included in Management Plan of “Munții Țărâu” (ROSCI 0126) Natura 2000 protected area.

There are no herbarium specimens from the Țărâu Mountains in all checked herbaria. Moreover, the authors could not find *Asplenium adulterinum* in the area of Custura Mătâniei nor in other parts of this mountain range (Bartók A, pers. obs. 2013, 2014), but *Asplenium trichomanes-ramosum* instead.

Unfortunately, the occurrence of *Asplenium adulterinum* in Țărâu Mountains remains doubtful.

**Almășului Mountains, Western Romanian Carpathians, Banat Mountains**

The flora of Almășului Mountains was relatively well studied, but the presence of *Asplenium adulterinum* was not yet demonstrated by herbarium material.

Volume I of Romanian flora (Grințescu, 1952) mentioned the occurrence of ladder spleenwort in Danube Gorges on the serpentinite massif between Poiana Macronia and Baia Nouă, but without any specific location or citation. It is curious that Grințescu did not specify Cernei-valley coronin in Flora of Romania, although he collected herbarium material in 1931. There is no publication (before 1952) which listed the presence of this rare fern in that mountain range.

Matacă (2005) mentioned the occurrence of *Asplenium adulterinum* in Porțile de Fier Nature Park, but she only cites the Romanian flora (Grințescu, 1952). Other publications (Borbás, 1874; Simkovics, 1878; Hayek, 1916; Borza, 1931; Resmeriță et al., 1968; Csúrós et al., 1968; Pop et al., 1969; Dihoru et al., 1972) did not list the presence of ladder spleenwort in this mountain group. Bădăru (2013) mentioned *Asplenium adulterinum* in “Porțile de Fier” (ROSCI 0206) Natura 2000 network, but without exact locality or citation.

The area of “Cazanele Mari” is dominated by serpentinite rocks (the ideal substrate for *Asplenium adulterinum*) and in the authors’ opinion this is the explanation for undocumented citation of this rare fern in the mountain group.

*Asplenium adulterinum* could not be found near Cazanele Mari nor in other parts of this mountain range (Bartók A, pers. obs. 2009, 2010, 2011, 2012, 2013, 2014), but *Asplenium trichomanes* instead.

**Aninei Mountains, Western Romanian Carpathians, Banat Mountains**

In this mountain range, the presence of *Asplenium adulterinum* was reported once (Peia, 1982) in a short floristical paper; the author only listed a few species and specified their locations (e.g. *Asplenium adulterinum* on rocks in Rudăriei Gorges). New floristical and phytocenological papers (Grigoriu et al., 2005; Imbrea et al., 2014) highlighted that ladder spleenwort was listed in older literature (Peia, 1982), but it was not recently identified in the field. Bădăru (2013) mentioned *Asplenium adulterinum* in “Cheile Rudăriei” (ROSCI 0032) Natura 2000 network, but without exact locality or citation. Floristical and phytocenological research in Nerei Gorges (Anina Mountains) (Schröt, 1968, 1969, 1972, 1996) did not demonstrate the occurrence of *Asplenium adulterinum* in this mountain group. Peia (1978) did not mention ladder spleenwort in other floristically interesting area of Aninei Mountains, Minișului Gorges. Also Nicolin, in her publications regarding Minișului Gorges and Izvorul Bigă protected area (Nicolin and Iimbrea 2007, 2009) did not mention the occurrence of *Asplenium adulterinum* in those areas.

Ladder spleenwort could not be found in Aninei Mountains (Bartók A, pers. obs. 2011, 2013). There are no herbarium specimens of *Asplenium adulterinum* from that mountain range in all checked herbaria.
Asplenium trichomanes occurs in alpine part of Ţarcu Mountains, habitat description of Asplenium adulterinum Milde

Habitat description of Asplenium adulterinum Milde in Romanian Carpathians

According to the Romanian phytosociological literature, Asplenium adulterinum is a species that grows on rocks (Chifu, 2014), characteristic for Tortulo-Cymbalarietalia and Asplenietalia septentrionalis orders. Boșcaiu (1971) comprises Asplenium adulterinum in Asplenietum ruta-murariae plant association which occurs in alpine part of Țarcu Mountains (e.g. gabbroic breccia from Custura Mătăcinei) together with: Asplenium trichomanes-ramosum L., Cystopteris fragilis

Table 1. Associations of Asplenio-Silenetum petraeae Boșcaiu 1971

| Relevé no. | Surface (m²) | Slope (degrees) | Altitude (m, a.s.l.) | Exposition | North | North |
|-----------|--------------|----------------|----------------------|------------|-------|-------|
| 1         | 1            | 80°            | 600                  |            | 85°   | 550   |
| 2         | 2            |                |                      |            |       |       |
| 3         | 3            |                |                      |            |       |       |
| 4         | 4            |                |                      |            |       |       |
| 5         | 5            |                |                      |            |       |       |
| 6         | 6            |                |                      |            |       |       |
| 7         | 7            |                |                      |            |       |       |
| 8         | 8            |                |                      |            |       |       |
| 9         | 9            |                |                      |            |       |       |
| 10        | 10           |                |                      |            |       |       |
| 11        | 11           |                |                      |            |       |       |
| 12        | 12           |                |                      |            |       |       |
| 13        | 13           |                |                      |            |       |       |

Field observations

During the botanical trips in the Mehedinti and Cernei Mountains (2013 and 2014, respectively) very rare and endangered species in Romanian flora were recorded on limestone rocks and screes, in two small phytocoenoses (1-2 m²) of the association Asplenio-Silenetum petraeae Boșcaiu 1971 (Table 1). The location of the two populations of Asplenium adulterinum identified in these mountains and their phytosociological context are as follows:

1) Romania, Southern Carpathians, Mehedinti Mountains, Țesna valley, alt. 600 m a.s.l., on limestone rocks and screes (27.V.2014), the occurrence of this endangered species in Romanian flora were recorded on limestone rocks and screes (27.V.2014).

Fig. 2. Chorological map of Asplenium adulterinum distribution in South-Eastern Carpathians; the white star represents certain location, the blue star represents possible locations, the yellow star represents uncertain locations of A. adulterinum in the Romanian Carpathians Legend: 1-Răutău Mountains; 2-Bistrița Mountains; 3-Calimani Mountains; 4-Dealul Bucegi Mountains; 5-Dealul Făgărăș Mountains; 7-Țarcu Mountains; 8-Cernei Mountains; 9-Mehedinți Mountains; 10,11- Anicin Mountains; 12-Almăjului Mountains; 13-Codru-Moma Mountains.

Codru-Moma Mountains, Western Romanian Carpathians, Aпосен Mountains

In the area of Codru-Moma Mountains, Asplenium adulterinum was mentioned in Izbeu Brook (Brăeni village) by Burescu and Păscuț (2010) in a phytosociological paper. The authors only mentioned the presence of ladder spleenwort within Asplenium trichomanos-rutae murariae Kuhn 1937 association, but without other comments of this important biogeographical and floristical finding. In this plant association, the ladder spleenwort would be present together with Poa nemoralis L. and Doronicum columnae Ten.

The flora of this mountain group was studied by Păcuț (1936, 1941a, 1941b), but the occurrence of this rare fern was not mentioned. There are no herbarium specimens of Asplenium adulterinum from that mountain group in all checked herbaria.

In contrast, Asplenium trichomanes coming from this mountain range was well documented in the Romanian botanical literature.
Asplenium adulterinum (L.) Krock. etc.

Boşcaiu N (1971). Flora şi vegetaţia Munţişor Țarcu, Godeanu şi Cernei, [The flora and vegetation of Țarcu, Godeanu and Cernei Mountains]. Editura Academiei Republicii Socialiste România, Bucureşti.

Boşcaiu N, Coldea G, Horeaun C (1994). Lista Roşă a vegetaţiei din Romania, [The catalogue of habitats, plants and Natura 2000 sites in Romania]. Fundaţia Centrul Naţional pentru Dezvoltare Durabilă, SC Exclus Prod SRL & RA Monitorul Oficial, Bucureşti.

Borhád A (1958). Gypsophilion petraeae foed. nova et contributions à la végétation du Mont Ceahlău (Carpathes Orientales), [Gypsophilion petraeae foed. nova et contributions to the vegetation in the Ceahlău Mountains (Eastern Carpathians)]. Acta Botanica Academiae Scientiarum Hungaricae 4(3-4):211-231.

Borsa Z (1931). Botanischer führer durch die umgebung von Bâile Herculane [Botanical guide about surroundings of Bâile Herculane area to the Danube]. In: Borza A (Ed), Guide de la sixième excursion phytogéographique internationale, Roumanie, [Guide of the Sixth International Phytogeographic Excursion, Romania]. Le jardin botanique de L’Université de Cluj, Cluj pp 55-63.

Boşcaiu N (2014). Cl. Secţiilor Ştiinţifice ale Academiei Române 10(1):281-302.

Braun-Blanquet J (1932). Plant Sociology. The Study of Plant Communities, Fifth Impression (1st ed).

Buia A (1959). Plantele rare pentru flora R.P.R., existente în Oltenia, [Rare plants for the flora of R.P.R., present in Oltenia]. Ocorotirea Naturii şi a Mediului Înconjurător 38(1):45-56.

Bureșcu P, Păpușcu CG (2010). Inputs to knowledge of rocks vegetation within Codru-Mora Mountains (NW Romania). Analele Universității din Oradea, Fascicula Biologie 17:62-69.

Bújorean G, Popescu PC (1966). Rezervaţia Naturală Domogled (Bâile Herculane), [Domogled (Bâile Herculane) Natural Reserve]. Ocorotirea Naturii 10:5-29.

Burdjua C (1962). Munțele Ceahlău - Flora și vegetația, [The Ceahlău Mountain - Flora and Vegetation]. Ocorotirea Naturii și a Mediului Înconjurător 38(1):5-29.

Bújorean G, Popescu PC (1968). Carpathian Flora of the Eastern Carpathians. VEB Verlag für Landwirtschaft Leipzig.

Chifu T, Mititelu D, Dăscălescu D (1987). Flora şi vegetaţia judeţului Neamț, [Flora and Vegetation of the Neamț County]. Memoriele Secțiilor Științifice ale Academiei Române 10(1):281-302.

Chifu T, Ştefan N, Asoltani L (2008). Flora și vegetația județului Neamț, [Flora and Vegetation]. In: Chifu T, Manoliu A, Toma C (Eds). Parcul Național Călimani - Studii ecologice și a biodiversității, [The Călimani Natural Park - Ecological and biodiversity research], Editura Alma Mater, Cluj-Napoca pp 15-87.

Chifu T (2014). Cl. Asplenietea trichomanis, In: Chifu T (Ed). Diversitatea fitosociologică a vegetației României, Vol I. Vegetația erbacee natură, [Phytosociological diversity of Romania, Vol I. Vegetation of grassy natural] Editura Academiei României, Bucureşti.
Natural herbaceous vegetation], Editura Institutul European, Iaşi pp 307-364.
Conti F (2003). 
Minuartia graminifolia (Caryophyllaceae), a south-east European species. Botanical Journal of the Linnean Society 143(4):419-432.
Corvin Papiu V (1963). Geologie și drumețe - Trasee în Carpații Românești, [Geology and excursions - Hiking in Romanian Carpathians]. Editura Științifică, București.
Craabe JA, Jermy AC, Lovis JD, Raine R (1993). Asplenium L. In: Tutin TG, Burges NA, Chater AO, Edmonson JR, Heywood VH, Moore DM, ... Webb DA (Eds), Flora Europaea, Vol 1, Cambridge University Press (2nd ed) pp 18-23.
Csürös Ş (1951). Cercetări floristice și de vegetație în Munții Călimani, [Floristic and Vegetation researches in Călimani Mountains]. Studii și Cercetări Științifice. Academia Republicii Populare Române Filiala Cluj 2(1-2):127-143.
Degen A (1901). Die Flora von Herculesbad (Eine Vegetations-Skize), [Flora of Băile Herculane (A vegetation map)]. Budapest, Buchdruckerei-Aktiengesellschaft Pallas.
Dihoru G, Andrei M, Cristurean I (1972). Flora teritoriului dintre Valea Mraconiei și Depresia Dunării. [Flora of the territory between the Mraconiei Valley and the Danube Depression (The Danube's Gorges)]. Acta Horti Botanici Bucurestiensis 1970-1971:479-514.
Dihoru G, Dihoru A (1994). Plante rare, periclitate și endemicice in Flora României - Lista roșie, [Rare, endangered and endemic plants of Romania's Flora - The Red List]. Acta Horti Botanici Bucurestiensis 1993-1994:173-197.
Dihoru G, Negrea G (2009). Cartea roșie a plantelor vasculare din România, [Romanian Red Book of Vascular Plants]. Editura Academiei Române, București.
Doniță N, Popescu A, Pauca-Comănescu M, Mihăilescu S, Biriș A (2005). Habitațele din România, [Habitats from Romania]. Editura Tehnică Silvică, București.
Georgescu CC (1934). Studii phyto-geografice în bazinul inferior al Vâiei Cernei (Bâile Herculane), [Phyto-geographical studies in lower basin of Cerna Valley (Bâile Herculane)]. Analele ICAS I(1):71-133.
Grecescu D (1906). Plantele vasculare ale Ceahlăului până acum cunoscute expuse sub raportul geografico-botanic și sistematic, [The vascular plants of Călimău]. Analele Academiei Române, Memorile Secției Științifice 28(1905-1906):405-489.
Grigoriu AL, Imbrea IM, Alda NR (2005). Vegetation of Cheile Rudăriei (Rudărie Gorge), south-west of Romania, Scientific Conference State-of-the-Art and Problems of Agricultural Science Education, Agricultural Univ Plovdiv, Scientific Works, Vol L (book 6):345-350.
Grințescu G (1923). O excursie botanica pe Muntele Ceuhaul (Carpații Moldovenești), [A botanical trip in the Călimău Mountain (Moldavian Carpathians)]. Natura 6:16-20.
Grințescu G (1952). Asplenium L. In: Săvulescu T (Ed), Flora Republicii Populare Române, [Flora of the Popular Republic of Romania], vol I, Editura Academiei Republicii Populare Române, București pp 125-137.
Gușuleac M (1932). Zur Kenntniss der Felsvegetation des Gebirges der Bicaz-Klamm in den Östkarpaten, [Note about the rocks vegetation from Bicaz Gorges in the Eastern Carpathians]. Bulletinul Facultății de Științe Cernăuți 6(1-2):307-347.
Hayek A (1916). Die Pfianzendecke Österreich-Ungarns, [The vegetation of Austria-Hungary]. Franz Deuticke, Leipzig und Wien.
Hohm M (1998a). Vascular flora of the Kelemen (Calimani) Mts on the side of the Maros (Mures) river drainage area. Studia Botanica Hungarica 27-28(1996-97):75-108.
Hohm M (1998b). A Kelemen-havasok növényzetéről, [The vegetation of Călimani Mountains]. Editura Mentor, Târgu Mureș.
Holderegger R (1994). Zur Flora der Pfannensteine, Kr. Zürich, [The ferns from Pfannenstiel, Kr. Zürich]. Farnblätter 25:3-21.
Horeanu C (1979). Flora rezervației naturale Munticelu-Cheile Șugăului (Județul Neamț), [Flora of Munticelu-Cheile Șugăului natural reserve (Neamț County)]. Anuarul Muzeului de Științe Naturale Piatra Neamț, Ser Botanică-Zoologie 4:75-86.
Horeanu C, Borcea M (1982). Cehălăul - viitor parc național, [Călău - future National Park]. Ocrotirea Naturii și a Mediului Înconjurător 26(1-2):20-33.
Institutul de Cercetări Biologice Iași (ICB Iași) (1994). Anexa nr 7: Lista speciilor de plante din Călimani, în Parcul Național Călimani R.A.- Plan de Management 2008, [Annex no 7: The list of plant species in Călimani National Park, Management Plan-2008]. Retrieved 2015 February 04 from http://www.calimani.ro/documente/Plan%20PNC.zip.
Imbrea I, Nicolin AL, Sorescu C, Corpa C, Buzila L (2014). Rocks habitats in the Rudăriei Gorges Protected Area, Research Journal of Agricultural Science 46(2):97-105.
IUCN (2012). IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN, iv + 32p.
Klinkenberg B (2008). E-flora BC. Electronic Atlas of the Plants of British Columbia [www.eflora.bc.ca] - Lab for Advanced Spatial Analysis, Department of Geography, University of British Columbia, Vancouver. Retrieved 2015 February 02 from http://isb.geog.ubc.ca/biodiversity/eflora/.
Lovis JD, Reichstein T (1968). Über das spontane Entstehung von Asplenium adiantinum Milde aus einem natürlichen Bastard, [About the spontaneous origin of Asplenium adiantinum Milde from a natural bastard]. Naturwissenschaften 55(3):117-120.
Manolii A, Zanoschi V, Coroi A-M, Negrea G, Coroi M, Monah F, Nechita N (2002). Flora Mastriului Cehălău, [Flora of Călăhu Massif], Editura Corson, Iași.
Mardari C (2008). Aspects of the floristic diversity in Neagra Bicazului River Basin (Eastern Carpathians) (I). Journal of Plant Development 15:63-68.
Matacă SŞ (2005). Parcul Natural Porţile de Fier. Floră, vegetație si protecția naturii, [Parc Natural Porțile de Fier. Flora, vegetation and nature protection]. Editura Universității Craiove,
Milde J (1865). Die Höheren Sporenpflanzen Deutschlands und der Schweiz, [The higher spore plants of Germany and Switzerland], Leipzig, Verlag von Arthur Felix.

Mititelu D, Vişalaru G, Chişu T, Ştefan N, Dăscălescu D, Horăceanu C (1986). Flora a Munţilor Câlimani, [Flora of Câlimani Mountains]. Analele Ştiinţifice ale Universităţii “Al. I. Cuza” Iaşi, Ser II, a. Biologie 32:28-30.

Mititelu D, Chişu T, Pascal P (1989). Flora şi vegetaţia judeţului Suceava, [Flora and Vegetation of Suceava County]. Anuarul Muzeului Judeţului Suceava, Fascicula Ştiinţele Naturii 10:93-120.

Morariu I (1965). Vegetaţia şi flora Masivului Răzăiu, [Vegetation and Flora of Răzăiu Massif]. In: Cea de-a V-a Consfătuire de Geobotanică pe țară a S. S. N. G. din R. P. R. - Ghid geobotanic pentru Moldova de Nord (23-30 iulie 1965), Bucureşti pp 65-80.

Nagy Ö (1942). Adatok a Székelyföld, különösen a Gyilkostó és Bicazului környékének növényzete, [Data about Szeklerland, especially flora of the Lacul Roşu]. Scripta Botanica Musei Transsilvanici 1:94-97.

Nechita N (2000). Contribuţii la cunoaşterea vegetaţiei Masivului Hăşmaş (1), [Contributions to knowing of Vegetation of the Hăşmaş Massif (1)]. Studii şi Cercetări, Muzeul de Științe Naturale Piatra Neamţ 9:123-135.

Nechita N (2003). Flora şi vegetaţia comortilelor din Masivul Hăşmaş, Cheile Bicazului şi Lacul Roşu, [Flora and Vegetation from the Hăşmaş Massif, Bicazului Gorges and Lacul Roşu]. Editura Constantin Matasă, Piatra Neamţ.

Nechita N, Bălăreşanu P (2006). Corologia rarităţilor floristice din judeţul Neamţ, [The chorology of floristic rarities from Neamţ County]. Studii şi Cercetări, Muzeul de Științe Naturale Piatra Neamţ 10:121-129.

Nechita N, Mititelu D (1996). Vegetaţia din Munţii Hăşmaş, Cheile Bicazului şi Lacul Roşu, [Vegetation from Hăşmaş Mountains, Bicazului Gorges and Lacul Roşu]. Studii şi Cercetări, Muzeul de Științe Naturale Piatra Neamţ 9:123-135.

Nicolin AL, Imaera IM (2007). Endemic plants in the Minăş Mountains (I), [Contributions to the knowledge of the Vegetation and Flora in Cealău Mountains]. Buletinul de Informaţii al Grădiniţii Botanice şi al Muzeului Botanic de la Universitatea din Cluj 4:79-88.

Nyárády El (1924). Contribuţii la cunoaşterea vegetaţiei şi florii Munțelui Ceahlău, [Contributions to knowing the Vegetation and Flora in Ceahlău Mountains]. Buletinul de Informaţii al Grădiniţii Botanice şi al Muzeului Botanic de la Universitatea din Cluj 37(1):54-58.

Nyárády El (1937). A Gyilkostó (Lacul Roşu) és Békászırosoros (Pasul Bicazului) környékének növényzete, [Vegetation around the Lacul Roşu and Bicaz Gorge]. Sibiu.

Oltean M, Negrea G, Ercuca A, Roman N, Dihoră G, Sanda V, Mihăelescu S (1994). Lista roşie a plantelor superioare din România, [Red List of superior plants in Romania]. In: Oltean M (Coord), Studii, sinteze, documentaţii de științe. 1. Academia Română, Institutul de Biologie, Bucureşti pp 1-52.

Oprea A (2005). Lista critică a plantelor vasculare din România, [Critical checklist of vascular plants of Romania]. Editura Universităţii „Alexandru Ioan Cuza”, Iaşi pp 18.

Oprea A, Sârbu C (2008). Rare plants in Stânişoara Mountains (Eastern Carpathians), Journal of Plant Development 15:47-61.

Oprea A, Sârbu C (2009). Diversitatea floristică a Munţilor Stânişoarei (Carpaţii Orientali), [The floristic diversity in Stânişoara Mountains (Eastern Carpathians)]. Editura Universităţii „Alexandru Ioan Cuza”, Iaşi pp 36.

Oprea A, Sârbu C (2012). The vascular flora of Răzăiu massif (Eastern Carpathians, Romania). Note Memoriile Academiei Române, Memoriile Secţiunii Științifice, Ser 2, 33(1910-1911):293-347.

Papp C (1931). O schiţă a vegetaţiei masivului Ceahlău, [Vegetation map of Ceahlău Massif]. Revista Științifică „V. Adamași” 17(2):68-76.

Pauca A (1936). Contribuţii la studiul florii munţilor Codru şi Muma, [Contributions to the flora of the Codru and Muma Mountains]. Analele Academiei Române, Memoriile Secţiunii Științifice, Ser 3 111:1-71.

Pauca A (1941a). A doua contribuţie la studiul florii munţilor Codru şi Muma, [A second contributions to the flora of the Codru and Muma Mountains]. Analele Academiei Române, Memoriile Secţiunii Științifice, Ser 3 15(1939-1940):109-219.

Pauca A (1941b). Studii fiziocologice în Munţii Codru şi Muma, [Phytoecological study in the Codru and Muma Mountains]. PhD Thesis, Universitatea din Bucureşti.

Peia P (1978). Aspecete de vegetaţie din Cheile Miniişului, [Vegetation aspects from the Minişului Gorges]. Contribuţii Botanice:235-250.

Peia P (1982). Rarităţi din Depresiunea Almăişului şi împrejurimi (judeţul Caraş-Severin), [Rare plants from and the vicinities of the Almăişului Depression (Caraş-Severin County)]. Contribuţii Botanice:159-160.

Pop I, Hodişan I, Ciurăciu Ş (1969). Aspecte de vegetaţie de pe Valea Eșelnita (M-ţii Almăişului, Banat), [Vegetation aspects from the vicinities of Eșelnita Valley (Almăişului Mountains, Banat)]. Contribuţii Botanice:233-243.

Raclaru P (1973). Flora de la Pietrele Doamnei, [Flora of the Lady Stones]. Studii şi Comunicări de Ocrorotea Naturii Suceava 3:121-133.

Raclaru P (1976). Nouvelles contributions à la flore des Monts Rââu, [New contributions to the flora of the Rââu Mountains]. Acta Horti Botanici Bucurestiensis 17(2):68-76.

Reichstein T (1984). Aspleniacae. In: Hegi G, Illustrierte Flora von Mittel-Europa, [Illustrated flora of Central Europe]. Band I, Pteridophyta. Teil 1, Pteridophyta. Teil 1, Parey, Berlin, Hamburg, Germany pp 211-275.
Resmeriță I (1970). Taxonii noi și rari în flora României (Valea Țesna, județul Mehedinți), [New and rare taxaons in Romania’s flora (Țesna Valley, Mehedinți County)], Studii și Cercetări de Biologie, Ser Botanică 22(3):217-222.

Resmeriță I (1971). Flora Văii Țesna, [Flora of Țesna Valley], Comunicări de Botanică, Societatea de Științe Biologice 12:133-149.

Resmeriță I (1972). Vegetația lemnosă din Valea Țesnei, [Woody vegetation from Țesna Valley], Studii și Cercetări de Biologie, Ser Botanică 24(4):277-294.

Resmeriță I, Boșcau N, Coldea G, Lupşa V, Schneider E, Stoicovici L (1968). Contribuții floristice din Dețileul Dunării, [Floristic contributions from Danube’s Gorges] Comunicări de Botanică, Societatea de Științe Biologice 10:177-180.

Roberts B, Proctor J (1992). The ecology of areas with serpentinized rocks, Geobotany 17:1-440.

Sârbu I, Oprea A (2013). Plante vasculare din România: determinator ilustrat de teren, [Vascular Plants from Romania. An illustrated field guide]. Editura Victor B Victor, București pp 36-38.

Schneider H, Russel SJ, Cox CJ, Bakker F, Henderson S, Rumsey F, Barrett J, Gibby M, Vogel JC (2004). Chloroplast phylogeny of asplenioid ferns based on rbcL and trnL-F spacer sequences (Polypodiidae, Aspleniaceae) and its implications for biogeography. Systematic Botany 29(2):260-274.

Schrött L (1968). Vegetația Rezervației Naturale Cheile Nerei, [Vegetation of the Nerei Gorges Natural Reserve]. Ocroritarea Naturii 12(2):193-201.

Schrött L (1969). Contribuții la cunoașterea florei Cheilor Nerei, [Contributions to knowing flora of Nerei Gorges]. Comunicări de Botanică, Societatea de Științe Biologice 9:135-140.

Schrött L (1972). Flora și vegetația rezervației naturale Beușnița-Cheile Nerei (Munții Aninei), [Flora and Vegetation of the Beușnița-Nerei Gorges Natural Reserve (Aninei Mountains)], PhD Thesis Abstract, Universitatea din București.

Schrött L (1996). Considerații asupra florei și vegetației din Cheile Nerei (județul Caraș-Severin), [Considerations about the Flora and Vegetations from Nerei Gorges (Caraș-Severin County)]. Annals of West University of Timișoara-Biology 1:13-26.

Seghedin TG (1985). Flora și vegetația vasculară a Munților Bistriței cuprinși între Văile Bistriței, Neagra Șarului, Neagra și Negrișoara, [Flora and Vegetation of Bistriței Mountains between Bistriței Valley, Neagra Șarului, Neagra and Negrișoara], PhD Thesis, Institutul Agronomic „Ion Ionescu de la Brad” din Șișa.

Seghedin TG (1987). Studiul florei Munților Bistriței, [The study of the Flora of Bistriței Mountains]. Anuarul Muzeului Județului Suceava, Fascicula Științele Naturii 9:35-46.

Simkovics L (1878). Bănsăsi s Hunyadmegyei utazáson 1874-ben, [Trip in the year 1874 in the Banat and Hunedoara counties], Mathematikai és Természettudományi Közlemények 16:479-624.

Sleep NH, Melbom A, Fridriksson T, Coleman RG, Bird DK (2004). H2-rich fluids from serpentinization: Geochimical and biotic implications. Proceedings of the National Academy of Sciences of the United States of America 101(35):12818-12823.

Soó R (1940). A Székelyföld flórájának elmunkálatai. Prodromus Florae Terrae Sclorum (Transsilvaniae orientalis), [Flora of Szeklerland. Prodromus Florae Terrae Sclorum (Eastern Transylvania)]. Magyar Flórumvék 3. Instituti Syst.-Geobotanici Museique Botanici Universitatis Kolozsvár, Cluj-Napoca.

Soó R (1943). A Székelyföld flórája, [Flora of Szeklerland]. Magyar Flórumvék 6. Instituti Syst.-Geobotanici Museique Botanici Universitatis Kolozsvár, Cluj-Napoca.

Ștefan N, Mânzu C, Mardari C (2007). Contributions to the study of saxicolous vegetation from Bicaz Gorges (Eastern Carpathians). Romanian Journal of Biology - Plant Biology 51-52(2007):59-76.

Thiers B (2015). Index Herbariorum: A global directory of public herbaria and associated staff. New York Botanical Garden’s Virtual Herbarium. Retrieved 2015 February 04 from http://sweetgum.nybg.org/ih/.

Universitatea “Babeș-Bolyai” Cluj-Napoca, Facultatea de Biologie și Geografie (2006). Cercetări privind flora și vegetația din parcelele cu pin bănean din Parluc Național Domogled-Valea Cernei (Proiect LIFE NAT 04/RO/00225 ”Pădurile de Pin negru de Banat – parte a rețelei NATURA 2000”), [Research about flora and vegetation of the parcels with Banat black pine from the Domogled-Valea Cernei National Park (Project LIFE NAT 04/RO/00225 – Forests with the Banat black pine – part of the NATURA 2000 network)]. Retrieved 2015 February 04 from http://www.domogled-cerna.ro/live/Studiu%20flora.pdf.

Wagner Jr WH, Moran RC, Werth CH (1993). Asplenium adutorium J. Milde. In: Flora of North America. Retrieved 2015 February 04 from http://www.efloras.org/florataxon.aspx?flora_id=1&taxon_i d=233500190.