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CONTRIBUTIONS TO THE BRYOPHYTE FLORA OF THE SKRA-KOUPA WATERFALLS AREA (MT PAIKO, CENTRAL MACEDONIA, NORTH GREECE)

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A field trip to explore a bryologically unknown place in the northern Balkan Peninsula, the environs of the Skra-Koupa waterfalls, part of the North Central (NC) floristical area of Greece, resulted in recording 71 bryophyte taxa (10 liverworts and 61 mosses). One species, *Conocephalum salebrosum*, is found to be new for Greece; in addition, seven species are reported for the first time in this floristical area.

Key words: conservation, liverworts, mosses, new and interesting records, tuff-forming bryophytes

INTRODUCTION

The bryophyte flora of Greece is far from being completed, shown by numerous new publications, which report on new data that contribute to the better knowledge of the bryoflora of the country.

Bryophyte checklists recently published for SE Europe (SABOVLJEVIĆ and NATCHEVA 2006, SABOVLJEVIĆ *et al.* 2008) and the Mediterranean area (ROS *et al.* 2007) included all known data from Greece. Additionally, all publications that mention Greek bryophytes, known up to the end of 2008, are included in an inventory list as part of a thesis on bryophytes of a riparian system in NW Greece (Aliakmonas river, Western Macedonia District) (TSAKIRI 2009). Two more recently published floristical papers reported more than 30 taxa new for the country (BLOCKEEL 2010, ORGAZ ALVAREZ and BLOCKEEL 2010), based on collections in mainland Greece. With all these, it is assumed that the number of the Greek bryophytes accounts *ca* 780 taxa.

The study area

Mt Paiko is located in central North Greece (Central Macedonia District), at the border of Kilkis and Pella Prefectures, very close to the country's northern border and reaches 1,650 m (Poleti peak) (Fig. 1).

The area belongs to the framework of the Natura 2000 project, named Oros Paiko (Natura 2000 code: GR1240003, ca 35,500 ha; Dir. 92/43/EEC) (DAFIS *et al.* 1996). Mt Paiko is connected to the west with the Voras Mts and to the east is surrounded by the Axios river valley.

Geologically, it belongs to the 'Axios Zone' and consists mainly of limestone and ophioliths (MOUNTRAKIS 1985).

The climate is characterised as wet continental with a short and warm summer.

The vegetation of Mt Paiko is transitional between sub-Mediterranean and temperate with a Central European character and is mainly covered by *Fagus* forests, and at lower elevations by variously mixed stands of *Quercus*, *Carpinus* and *Castanea* (ATHANASIADIS and DROSOS 1990).

Hydrologically, the area is relatively rich in flowing waters as many small rivers and streams cross the massif.

Long intensive agricultural use, including grazing, have led to serious forest fragmentation that can be easily seen in these areas. During the last few decades these activities have been significantly reduced which is leading to a gradual and visible forest recovery.

Our collection site is located on the ENE part of the Oros Paiko Natura 2000 site, close to Skra village (northwest of Kilkis city, Kilkis Prefecture) and very close to the northern border of Greece with the Former Yugoslav Republic of Macedonia (FYROM). On the way from Skra to Koupa village, a sudden left turn leads to the Skra-Koupa waterfalls; surveillance/protection of the area belongs to the Goumenissa Forestry Service (Fig. 1). The collection site can be found west of Skra, in vicinity of the highest peaks of the area, namely Skra (1,097 m), Tsouma (1,219 m), Pyrgos (1,494 m) and Kantasi (1,607 m) (listed from north to south).

The area is surrounded by *Quercus* forests on its northeastern and southeastern parts and *Fagus* forests on its southwestern part. Arable land as well as pieces of abandoned arable land occupy large portions of the surrounding area and small natural areas with *Pinus nigra* are also present.

The Megalo Rema stream that crosses the site is dominated by *Platanus orientalis* (YPEHODE 2001).

Along the stream's flow there are tuff formations with intensely calcified bryophytes; these formations are bigger in size at the waterfalls occurring along the stream. Travertine geological deposits are also known in the area (FOSTIROPOULOS 1989, 1991). Intense calcareous precipitation in the stream's water has led to the formation of a small, green-blue, crystal clean lake, with *Chara vulgaris* L. at the bottom. This represents the habitat type "Hard oligo-mesotrophic waters with benthic vegetation of *Chara* formations" (habitat code 3140; Annex I, Dir. 92/43/EEC); this habitat type, although included in the Habitat Directive of the European Council, was not reported for the Oros Paiko site. It is known only from four areas in the country according to the Greek Natura 2000 project (DAFIS *et al.* 1996).

There is no publication on the bryophytes of the Skra area (acc. TSAKIRI (2009) and all subsequent references); thus all data here reported are first listings for the area.

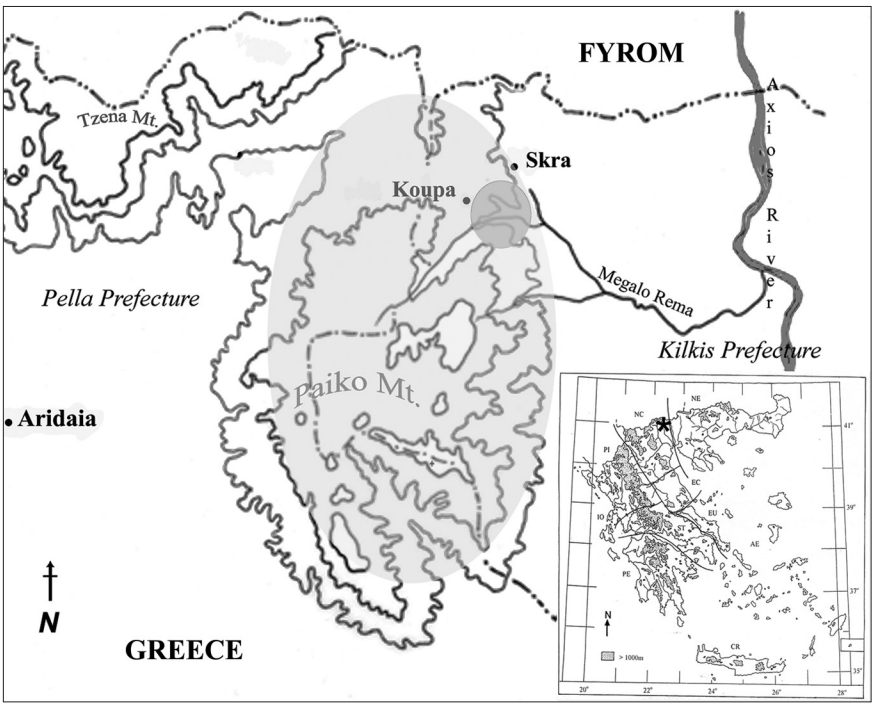

Fig. 1. Location of the studied sites

METHODS

The collecting trip was made in March 2007. Bryophytes were collected around the Skra-Koupa waterfalls from the surrounding mountain sides covered by *Quercus* forest and along the Megalo Rema stream. The investigated area is shown in Figure 1. The specimens have been preserved in the bryological collection of the Hungarian Natural History Museum, Budapest (BP).

Nomenclature of the species names follows GROLLE and LONG (2000) for liverworts and HILL *et al.* (2006) for mosses. New floristical results for the country are given according to the checklists of southeastern Europe (SABOVLJEVIĆ and NATCHEVA 2006, SABOVLJEVIĆ *et al.* 2008) and the Mediterranean area (ROS *et al.* 2007).

Floristical data were analysed according to the available checklists of DÜLL (1995), PRESTON (1981, 1984*a*, *b*), SABOVLJEVIĆ and NATCHEVA (2006), SABOVLJEVIĆ *et al.* (2008), updated with all the new records reported for Greece by BLOCKEEL (2010), ORGAZ ALVAREZ and BLOCKEEL (2010), and TSAKIRI (2009).

For the distribution of bryophyte taxa the floristical regions of Greece are used as given by the Flora Hellenica Project (STRID and TAN 1997) with the differentiations accepted for bryophytes by PRESTON (1981). The abbreviations used for the Greek floristical areas and their definitions are the following: CR (Crete), RH (Rhodos Island), AE: Th (Aegean islands: Thasos), IO (Ionian islands), PE (Peloponnesos), ST (Sterea Hellas), EU (Euboea), PI (Pindos), EC (East Central), NC (North Central, Thessalia), NE: At, Ch, Rd (Northeast: Athos, Chalkidiki, Rhodope Mts).

Site details

North Greece, Central Macedonia, around a waterfall at Skra village, between lat.: 41°03'58" N, long.: 22°23'30" E and lat.: 41°04'05.0" N, long.: 22°23'42.0" E, alt.: 430–460 m a.s.l., 24.03.2007.

RESULTS

Altogether, 71 bryophyte taxa (10 liverworts and 61 mosses) were collected during our fieldwork. The site and all of the collected records belong to the North Central (NC) floristical area of Greece.

One species, *Conocephalum salebrosum* Szweykowski, Buczkowska et Odrzykoski, is considered new for Greece. The recently described taxon (SZWEYKOWSKI *et al.* 2005) was reported in SE Europe from Bosnia-Herzegovina and Romania according to the liverwort checklists (ROS *et al.* 2007, SABOVLJEVIĆ and NATCHEVA 2006, SÖDERSTRÖM *et al.* 2007). Later, the

species was also reported from Bulgaria (NATCHEVA 2008), Serbia (PAPP and ERZBERGER 2009), Albania (PAPP *et al.* 2010) and Montenegro (PAPP and ERZBERGER 2010).

Seven species are reported for the first time in the North Central (NC) floristical area of Greece.

Fissidens viridulus (Sw. ex anon.) Wahlenb. var. *incurvus* (Starke ex Röhl.) Waldh. – previous reports according to DÜLL (1995): CR, RH, AE, IO, PE, ST, PI. This sub-Mediterranean species (DÜLL 1995) is not rare in SE Europe.

Grimmia muehlenbeckii Schimp. is erroneously missing from Greece in SABOVLJEVIĆ *et al.* (2008), although it is mentioned in DÜLL (1995) as *Grimmia trichophylla* var. *tenuis*; this temperate-montane species was reported only once from ST (Phokis; SCHIFFNER and BAUMGARTNER 1919) and had to be verified according to DÜLL (1995). It usually grows on exposed siliceous rocks. The rarity of this kind of substrate in Greece explains that it was reported only once before.

Schistidium pruinosum (Wilson ex Schimp.) G. Roth, is a boreal-montane species; the taxon has just been reported as new for Greece from the PI floristical area (Mt Smolikas; BLOCKEEL 2010) and is endemic to Europe and Asia Minor (BLOM 1996). From SE Europe it is known from Bulgaria and Serbia (SABOVLJEVIĆ *et al.* 2008) and it has been recently reported from Albania (PAPP *et al.* 2010).

Syntrichia papillosa (Wilson) Jur. was reported so far only from PI (BLOCKEEL 1991) and EC (Pinios/Omolio area; DÜLL 1995). This is a frequent epiphytic species in SE Europe.

Syntrichia virescens (De Not.) Ochyra – previous reports according to DÜLL (1995): CR, RH, IO, PI, NE. This is a rather common epiphytic species in SE Europe. Sometimes it also occurs on rocks.

Tortella inflexa (Bruch) Broth. – previous reports according to DÜLL (1995): CR, RH, AE, IO, PI. This subatlantic-sub-Mediterranean species (DÜLL 1995) is not rare in SE Europe.

Tortula atrovirens (Sm.) Lindb. – previous reports according to DÜLL (1995): CR, RH, AE, PE, ST, NE. This sub-Mediterranean species (DÜLL 1995) is widespread in SE Europe.

List of the species

(*) indicates the species considered new for Greece. (+) indicates the species reported for the first time in the North Central (NC) floristical region of Greece.

Hepaticae

*+ ***Conocephalum salebrosum*** Szweykowski, Buczkowska et Odrzykoski – at the stream
Frullania dilatata (L.) Dumort – on the bark of *Quercus*
Leiocolea collaris (Nees) Schljakov – at the stream
Leiocolea turbinata (Raddi) H. Buch – at the stream
Lunularia cruciata (L.) Lindb. – at the stream
Plagiochila porelloides (Torrey ex Nees) Lindenb. – at the stream
Preissia quadrata (Scop.) Nees – at the stream
Radula complanata (L.) Dumort. – at the stream
Reboulia hemisphaerica (L.) Raddi – on soil
Southbya tophacea (Spruce) Spruce – at the stream

Musci

Anomodon viticulosus (Hedw.) Hook. et Taylor – at the stream
Barbula convoluta Hedw. – on soil
Barbula unguiculata Hedw. – at the stream
Bryum alpinum Huds. ex With. – at the stream
Bryum capillare Hedw. – on soil
Bryum pallens Sw. ex anon. – at the stream
Campyliadelphus chrysophyllus (Brid.) R. S. Chopra – at the stream
Ceratodon purpureus (Hedw.) Brid. – on soil
Cirriphyllum crassinervium (Taylor) Loeske et M. Fleisch. – on soil
Cratoneuron filicinum (Hedw.) Spruce – at the stream
Ctenidium molluscum (Hedw.) Mitt. – at the stream
Dialytrichia mucronata (Brid.) Broth. – on soil
Dicranum scoparium Hedw. – on soil
Didymodon insulanus (De Not.) M. O. Hill – at the stream and on soil in the surroundings
Didymodon tophaceus (Brid.) Lisa – at the stream
Didymodon vinealis (Brid.) R. H. Zander – at the stream
Encalypta streptocarpa Hedw. – on soil
Eucladium verticillatum (With.) Bruch et Schimp. – at the stream
Fissidens bryoides Hedw. – on soil
Fissidens taxifolius Hedw. – on soil

+ ***Fissidens viridulus*** (Sw. ex anon.) Wahlenb. var. ***incurvus*** (Starke ex Röhl.) Waldh. – at the stream
Grimmia laevigata (Brid.) Brid. – on siliceous rocks
+ ***Grimmia muehlenbeckii*** Schimp. – on siliceous rocks
Grimmia pulvinata (Hedw.) Sm. – on siliceous rocks
Gymnostomum calcareum Nees et Hornsch. – at the stream
Homalothecium sericeum (Hedw.) Schimp. – at the stream and on the bark of *Quercus*
Hypnum cupressiforme Hedw. – on the bark of *Quercus*
Hypnum cupressiforme Hedw. var. ***lacunosum*** Brid. – on soil
Leucodon sciuroides (Hedw.) Schwägr. – on the bark of *Quercus*
Mnium stellare Hedw. – at the stream
Orthotrichum affine Schrad. ex Brid. – on the bark of *Quercus*
Orthotrichum diaphanum Schrad. ex Brid. – on the bark of *Quercus*
Orthotrichum lyellii Hook. et Taylor – on the bark of *Quercus*
Orthotrichum pallens Bruch ex Brid. – on the bark of *Quercus*
Orthotrichum stramineum Hornsch. ex Brid. – on the bark of *Quercus*
Orthotrichum striatum Hedw. – on the bark of *Quercus*
Oxyrrhynchium hians (Hedw.) Loeske – at the stream and on soil in the surroundings
Oxyrrhynchium schleicheri (R. Hedw.) Röll – at the stream and on soil in the surroundings
Palustriella commutata (Hedw.) Ochyra – at the stream
Philonotis arnellii Husn. – on soil
Plasteurhynchium striatulum (Spruce) M. Fleisch. – at the stream
Platyhypnidium riparioides (Hedw.) Dixon – at the stream
Pleurochaete squarrosa (Brid.) Lindb. – on soil
Pohlia melanodon (Brid.) A. J. Shaw – at the stream
Racomitrium canescens (Hedw.) Brid. – on soil
Rhynchostegiella curviseta (Brid.) Limpr. – at the stream
Rhynchostegiella tenella (Dicks.) Limpr. – at the stream
Rhynchostegium confertum (Dicks.) Schimp. – on soil
Rhynchostegium megapolitanum (Blandow ex F. Weber et D. Mohr) Schimp. – on soil
Rhynchostegium murale (Hedw.) Schimp. – on soil
Schistidium crassipilum H. H. Blom – on siliceous rocks
+ ***Schistidium pruinosum*** (Wilson ex Schimp.) G. Roth – on siliceous rocks
Scleropodium touretii (Brid.) L. F. Koch – on soil
Syntrichia montana Nees – on siliceous rocks
+ ***Syntrichia papillosa*** (Wilson) Jur. – on the bark of *Quercus*
+ ***Syntrichia virescens*** (De Not.) Ochyra – on the bark of *Quercus*
+ ***Tortella inflexa*** (Bruch) Broth. – on soil
+ ***Tortula atrovirens*** (Sm.) Lindb. – on soil
Trichostomum brachydontium Bruch – on soil
Trichostomum crispulum Bruch – at the stream and on soil in the surroundings
Weissia controversa Hedw. – on soil

CONCLUSIONS

About one third of the bryophytes collected in the study area have a sub-Mediterranean–Mediterranean distribution (DÜLL 1983, 1984, 1985). Among them *Leiocolea turbinata*, *Lunularia cruciata*, *Southbya tophacea*, *Bryum alpinum*, *Eucladium verticillatum*, *Rhynchostegiella curviseta*, and *R. tenella* are characteristic members of the bryophyte assemblages along streams. Frequent sub-Mediterranean terricolous species were also found, such as *Didymodon insulanus*, *D. vinealis*, *Oxyrrhynchium schleicheri*, *Pleurochaete squarrosa*, *Rhynchostegium confertum*, *R. megapolitanum*, *Scleropodium touretii, Trichostomum brachydontium.* Some saxicolous sub-Mediterranean species can also be mentioned like *Grimmia laevigata*, *Syntrichia montana* collected from siliceous, and *Gymnostomum calcareum*, *Plasteurhynchium striatulum* from calcareous rocks. Thanks to the continuously humid microclimate along the stream, some boreal, subboreal species can also grow, exemplified by *Leiocolea collaris*, *Preissia quadrata*, *Bryum pallens*, *Campyliadelphus chrysophyllus* and *Mnium stellare*.

Notes on the aspects of nature conservation

Since the area is indeed unique for its natural beauty, *e.g.* waterfalls, crystal clear lake waters, and forests, it has been recently "discovered" by the public. Although this attractive natural gem cannot be closed from the growing numbers of visitors, the area should, and must be, carefully preserved and protected. Goumenissa Forestry Services, which is the responsible body for the protection of the area, has prohibitions for certain activities in the area. Although these are standing, apparently the tuff formations and the still soft calcareous sediments along the stream and at the bank of the lake, are in danger of careless damaging. Along these, also the bryophytes (preferring specific substrates for their growth), including *Didymodon tophaceus*, *Eucladium verticillatum*, *Leiocolea turbinata*, *Southbya tophacea*, are seriously threatened. In light of the experiences even during a brief collecting work completed at the Skra-Koupa waterfall area, a more careful conservational monitoring and a greater level of protection is highly recommended.

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