AN INSIGHT INTO DIVERSITY OF THE BALKAN PENINSULA BRYOPHYTE FLORA IN THE EUROPEAN BACKGROUND

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RÉSUMÉ. — *Aperçu de la diversité de la flore des bryophytes de la péninsule des Balkans dans le contexte européen.* – Les bryophytes de la péninsule Balkanique sont toujours très pauvrement connues et, au point de vue bryologique, l'Europe du Sud-Est demeure la région la moins prospectée en Europe. Le but de cette étude est d'évaluer l'état des connaissances sur la richesse de la diversité des bryophytes dans la péninsule Balkanique par rapport à l'Europe. Ainsi, la richesse spécifique (diversité alpha), la taille des territoires et leur rapport logarithmique sont pris en considération. Actuellement, la flore bryologique compte, dans le S.-E. de l'Europe, 5 anthocérotées, 267 hépatiques et 897 espèces de mousses. Elle comporte 59,9 % des hépatiques européennes et 69,4 % de la flore des mousses. Les territoires les plus riches en hépatiques sont la Roumanie (197 sp.), suivie par la Bulgarie (170 sp.) et la Slovénie (167 sp.). À l'opposé, les territoires les plus pauvres en hépatiques sont la partie européenne de la Turquie (27 sp.), la FYR de Macédoine (69 sp.) et l'Albanie (91 sp.). De même, la flore des mousses compte la plupart des espèces en Roumanie (747 sp.), suivie par la Slovénie (637 sp.), la Bulgarie (558 sp.) et la Serbie (553 sp.). Cent vingt mousses (12,9 %) et 42 hépatique (16,1 %) sont connues de seulement un des onze territoires régionaux de l'Europe du S.-E. L'image peut être complétée avec les espèces enregistrées dans seulement deux des onze territoires : 149 mousses (16,9 %) et 57 hépatiques (20,95 %). De plus, beaucoup d'espèces décrites de la région dans le passé restent toujours en attente d'une enquête quant à leur statut taxinomique. Dans les dernières années, il y a eu une hausse de l'activité d'enquête sur les bryophytes du S.-E. de l'Europe et les données sur la flore bryologique régionale augmentent constamment. Néanmoins, l'obtention de données récentes sur les bryophytes du S.-E. de l'Europe reste toujours un problème d'actualité. Une enquête intensive des bryophytes du S.-E. de l'Europe est une urgente nécessité, ne serait-ce que pour approcher le niveau de connaissance d'autres régions européennes bien connues.

SUMMARY. — The bryophytes of the Balkan Peninsula are still very poorly known, and the region of South-Eastern Europe is bryologically the less investigated area in Europe. The aim of this study is to evaluate the stage of bryophyte flora knowledge and bryophyte diversity richness in the Balkan Peninsula compared to Europe. Thus, species richness (alpha diversity) and the size of territories, and their logarithmic ratio, are taken into consideration. At the present, bryophyte flora in the region of SE Europe counts 5 hornworts, 267 liverworts and 897 moss species. It comprises 59.9 % of European hepatic and 69.4 % of moss flora. The richest territories in hepatic species are Romania (197 sp.) followed by Bulgaria (170 sp.) and Slovenia (167 sp.). On the other side, the poorest territories in hepatic species are the European part of Turkey (27 sp.), FYR of Macedonia (69 sp.) and Albania (91sp.). Similarly, the moss flora counts most species in Romania (747 sp.) followed by Slovenia (637 sp.), Bulgaria (558 sp.) and Serbia (553 sp.). One hundred and twenty mosses (12.9 %) and 42 (16.1 %) hepatic species are known from only one of eleven regional territories of SE Europe. The picture can be drown with the species recorded in only two of eleven territories: 149 mosses (16.9 %) and 57 hepatics (20.95 %). Besides, many species described from the region in the past still remain open to investigation regarding their taxonomic status. In the last years, there have been high activity in bryophyte investigation in SE Europe, and data on regional bryoflora constantly increase. However, achieving recent data on bryophytes within SE Europe remains still a problem to face. Intensive investigation of bryophytes in SE Europe is urgently needed, just to approach the level of knowledge in other well-known European regions.

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The Bryophytes of the Balkan Peninsula are insufficiently known and the region of South-eastern Europe is one of the most interesting regions of Europe considering its wildlife, due to its paleo-historical, geo-morphological and ecological background (*e.g.* Taberlet *et al.*, 1998; Hewitt, 1999; Schmitt, 2007; Heiser & Schmitt, 2010).

The aim of this study is to evaluate the present state of knowledge of the bryophyte flora in various regions of the Balkan Peninsula, and to compare it with that in other European countries, usually considered as bryologically well known. For the purpose of this study, the state of knowledge in 2008 has been taken as a starting point, since many check-lists date back to this year. Newly described bryophyte species and records made after 2008 were not taken into account in the analyses since they would not significantly change statistical results. In fact, recently there were not many new descriptions in Europe, though several new records were made.

STUDY AREA, MATERIALS AND METHODS

The Balkan Peninsula

The Balkan Peninsula is strictly geographically defined as the area south of the rivers Krka, Sava and Danube, surrounded by the Mediterranean and Black seas. It is situated in SE Europe (Fig. 1). In the political sense it is considered equally with the wider surface of SE Europe, that comprises whole surfaces of the countries: Slovenia, Croatia, Bosnia-Herzegovina, Serbia, Montenegro, Albania, FYR of Macedonia, Greece, Romania, Bulgaria and European part of Turkey (Turkish Thrace = Turkish Trakia).

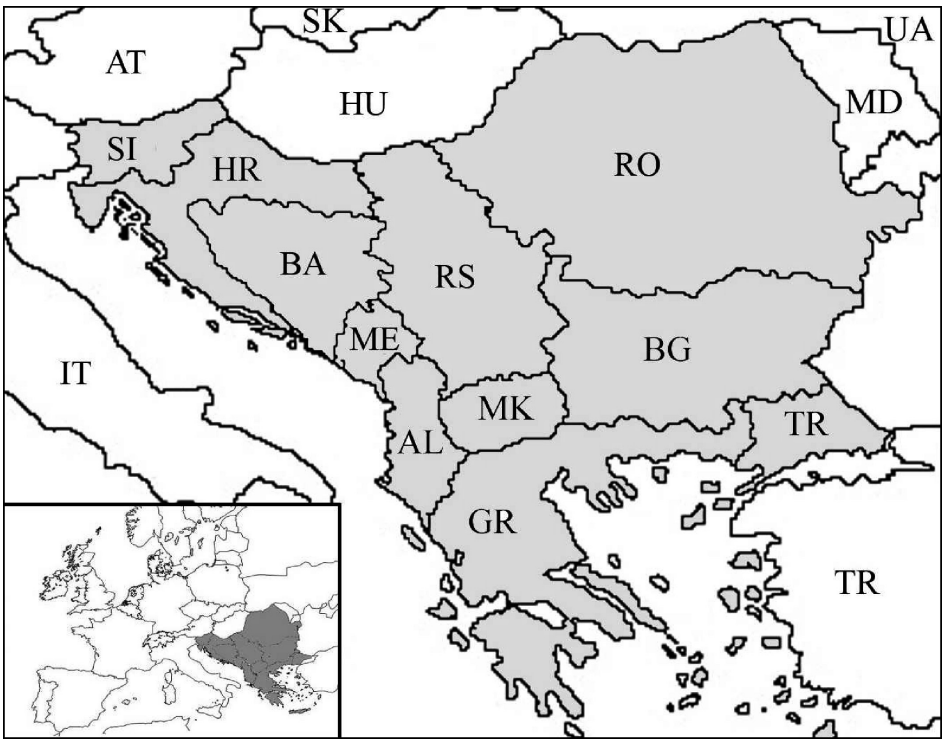

Figure 1. — SE Europe and its position in Europe. Abbreviations: AL = Albania; AT = Austria; BA = Bosnia-Herzegovina; BG = Bulgaria; GR = Greece; HR = Croatia; HU = Hungary; IT = Italy; MD = Moldavia; ME = Montenegro; MK = FYR Macedonia; RO = Romania; RS = Serbia; SI = Slovenia; SK = Slovakia; TR = Turkey (whole country); UA = Ukraine.

The Balkan mainland is hilly and mountainous, while its northern and north-eastern parts transfer into plains. It covers nearly 16 % of European surface (Tab. 1). The east is bordered by the Black and Marmara seas, while south-east is bordered by the Aegean Sea. South and south-west are bordered by Ionian and Adriatic seas. The mainland is scattered and many islands are present. In the north-eastern part it is attaching to the steppic zonobiomes, and in south-eastern it is in contact with Asia Minor and with the Eastern Mediterranean. In the Balkans there are five huge and significant mountain ranges: the Carpathians, the Rhodopean, the Balkan, the Dinaric Alps and the Scardo-Pindean massives. Surface hydrology is unequally but well developed.

TABLE I

The main data about SE Europe

The Balkans s.lat. (SE Europe)	
Surface in km^2	784908
% of the European mainland	15.89
% of agricultural surface	33.78
% of meadows and pastures	23.81
% of forests	26.68

MATERIAL

Alpha diversity and size of the territories are taken into consideration for comparison among different countries. More accurate idea on the bryophyte diversity within the countries of SE Europe can be figured out if logarithmic ratio, of species number and surface of that territory, is calculated (Sabovljević, 2004). The unsolved taxonomical problems recently treated as infraspecific level are not considered for analysis.

The numerical data for the European countries or territories follow Düll (1983, 1984, 1985) ; Werner (1993, 1999, 2003); Abolina (1994); Frisvoll *et al.* (1995); Kubinska & Janovicova (1996); Ingerpuu & Vellak (1998); Mogensen *et al.* (1998); Paton (1999); Saukel & Köckinger (1999); Koperski *et al.* (2000); Sotiaux & Vanderpoorten (2001); Damsholt (2002); Söderström *et al.* (2002); Ganeva & Natcheva (2003); Jóhannsson (2003); Kučera & Váňa (2003); Martinčič (2003); Ochyra *et al.* (2003); Sabovljević (2003, 2006); Sérgio & Carvalho (2003); Erzberger & Papp (2004); Smith (2004); Uyar & Çetin (2004); Aleffi (2005); Cekova (2005); Kürschner & Erdag (2005); Maslovsky (2005); Mogensen & Goldberg (2005); Natcheva & Ganeva (2005); Siebel *et al.* (2005); Colacino & Sabovljević (2006); Cortini-Pedrotti (2006); Dragićević & Veljić (2006); Hallingbäck *et al.* (2006); Sabovljević & Natcheva (2006); Sérgio *et al.* (2006); Siebel & During (2006); Szweykowski (2006); Ros *et al.* (2007) and Sabovljević *et al.* (2008). Distributional types of the Balkan bryophytes are assigned according to Hill *et al.* (2007).

METHODS

To compare species densities in different countries the α-index *sensu* Hobohm (1998a,b; 2000a,b) has been used. This index enables a comparison to be made between species densities in countries (or regions) which are normally of different sizes.

α is expressed by the following formula:

$$\alpha = \log S - (z^* \log A + \log c)$$

with

α = vertical distance to the regression line of the species-area curve in a log-log space; as a measurement of the species density S/A.

S = species number (of a country or region).

A = size of area in km^2 (of a country or region).

z = slope of the log S – log A relationship.

c = intercept of the slope.

This formula is derived from classical Arrhenius' power function used to describe relationship between area size and species number (Arrhenius, 1921):

$$c = S/A^z$$

As impute data for calculating α indices, common logarithms of A and S were used. α indices were calculated using linear regression with log A as independent and log S as dependent variable. Linear regression was computed using SPSS 13.0 package.

RESULTS AND DISCUSSION

The Balkan (SE Europe) bryophyte flora counts up to date 5 hornworts, 267 liverworts and 897 moss species (Sabovljević & Natcheva, 2006; Sabovljević *et al.* 2008). It comprises 59.9 % and 69.4 % of European hepatic and moss flora, respectively. Considering that the phenomena of endemism is accepted in a much wider sense compared to vascular plants, there are likely no "real" bryophyte endemics in the Balkans. In addition, many species described as endemics within the region (*e.g.* Pavletić, 1956) are placed in synonymy with others of a wider distribution, or decreased in taxonomic level into infraspecific taxa (*e.g.* Pavić *et al*., 1998; Košnar & Kučera, 2010). However, 28 mosses and 6 liverwort species are not known from the other southern European mainland countries (Sabovljević, 2004) and exclusively grow only in SE Europe.

The richest territories in hepatic species are Romania (197) followed by Bulgaria (170) and Slovenia (167) (Sabovljevic & Natcheva, 2006). From the other side, the poorest territories in hepatic species are the European part of Turkey (27), FYR of Macedonia (69) and Albania (91). Similarly, the moss flora counts most species in Romania (747) followed by Slovenia (637), Bulgaria (558) and Serbia (553) (Fig. 2).

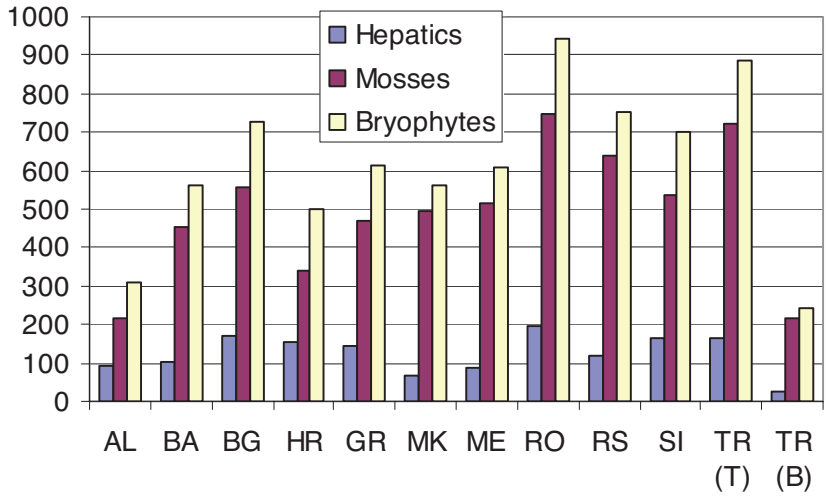

Figure 2. — Species richness (alpha diversity) within SE Europe (abbreviations correspond to Fig. 1; B-part of Turkey in Europe; T-whole country)

It can be assumed that the numbers (which take into consideration only widely accepted species, not doubtful or infraspecific taxa) shown in table II give the state of knowledge for many countries, rather than the real diversity of bryophytes which might occur in these countries.

Many species described from the region in the past still remain open to investigation regarding their taxonomic status (*e.g.* Košnar & Kučera, 2010). *Encalypta serbica* Katić (Katić, 1906) described from Central Serbia at the beginning of the 20th century, but with lost holotype and never seen afterwards in *locus classicus*, still remains to be studied. It is closely related to *E. ciliata* Hedw., but according to description has slightly larger spores and ciliae in calyptra. It is potentially the only endemic bryophyte of Serbia. *Tortula montenegrina* Borth described from Montenegro was lately synonymized with *T. lingulata* Lindb. by Corley *et al.* (1981) without any explanation. Some authors still treat it as subspecies of the latter. However, the question remains, if it is *T. lingulata,* "how was it possible that it was reported only in one locality in SE Europe?" Furthermore, it is a boreal species and even though the habitat is from

TABLE II

Number of bryophyte species per territory unit and hepatic-, moss- and bryophyte diversity indices

Country	Code	Surface (A) km^2	Hepatics (S_1)	Mosses (S_2)	log S_1/logA	log S_2/logA	log S_1+S_2/ logA
Albania	AL	28748	91	216	0.4393	0.5237	0.5578
Andorra	AN	468	118	251	0.7759	0.8986	0.9613
Apennine Pen.	AP	301255	289	863	0.4492	0.5408	0.5588
Austria	AT	82730	259	760	0.4977	0.5858	0.6117
Balkan Peninsula	BK	784908	272	897	0.4130	0.5009	0.5204
Belarus	BY	207600	103	337	0.3785	0.4753	0.4972
Belgium	BE	30528	175	557	0.5001	0.6123	0.6387
Benelux	BX	64453	177	568	0.4674	0.5727	0.5972
Bosnia-Herz.	BA	51129	105	456	0.4292	0.5647	0.5838
Britain & Ireland	BI	315134	296	763	0.4494	0.5242	0.5501
Bulgaria	BG	110669	170	558	0.4422	0.5442	0.5674
Croatia	HR	56538	157	342	0.4621	0.5332	0.5677
Czech Rep.	CZ	78864	215	634	0.4763	0.5722	0.5981
Denmark	DK	43094	138	479	0.4317	0.5784	0.6021
Estonia	EE	45226	118	407	0.4450	0.5605	0.5845
Finland	FI	338145	221	661	0.4240	0.5101	0.5327
France	FR	550100	308	827	0.4335	0.5082	0.5322
Germany	DE	349520	247	804	0.4316	0.5241	0.5451
Greece	GR	132562	144	469	0.4214	0.5215	0.5442
Hungary	HU	93030	143	483	0.4338	0.5402	0.5628
Iberian Peninsula	IB	596843	290	811	0.4263	0.5036	0.5266
Iceland	IS	103000	133	471	0.4237	0.5332	0.5549
Israel	IL	27799	39	220	0.3580	0.5270	0.5430
Latvia	LV	64589	165	485	0.4610	0.5583	0.5848
Lithuania	LT	65200	109	226	0.4232	0.4890	0.5245
Luxembourg	LU	2586	137	455	0.6261	0.7789	0.8124
Macedonia FYR	MK	25713	69	493	0.3904	0.6106	0.6235
Montenegro	ME	13812	88	518	0.4697	0.6556	0.6721
Norway	NO	385155	281	790	0.4383	0.5188	0.5424
Poland	PL	304460	250	700	0.4373	0.5188	0.5430
Portugal	PT	92345	179	487	0.4537	0.5413	0.5686
Romania	RO	237500	197	747	0.4268	0.5345	0.5534
Scandinavian Pen.	SC	777000	296	834	0.4195	0.4959	0.5175
Serbia	RS	88361	118	637	0.4188	0.5669	0.5818
Slovakia	SK	49036	229	674	0.5031	0.6031	0.6301
Slovenia	SI	20251	167	535	0.5161	0.6336	0.6609
Spain	ES	504030	274	794	0.4275	0.5085	0.5311
Sweden	SE	449964	265	807	0.4281	0.5137	0.5342
Switzerland	CH	39770	261	832	0.5254	0.6349	0.6606
The Netherlands	NL	41526	129	442	0.4570	0.5728	0.5969
Turkey (Eur. Part)	TE	23764	27	217	0.3271	0.5339	0.5456
Turkey (whole)	TR	780576	166	721	0.3766	0.4848	0.5001
Ukraine	UA	603628	184	579	0.3918	0.4780	0.4986

a high mountain in Montenegro, it is its southernmost locality. Thus, many doubts remains on this species, although Košnar & Kučera (2010) typified this taxon and synonymized it with *Tortula muralis* subsp. *obtusifolia* (Schwägr.) Culm.

There are more such unresolved bryological problems. Some examples are *Funaria maireana* Copp. from Greece, *Fissidens kosaninii* Latz. from Croatia, *Entodon transsilvanicum* Heuff. and *Funaria transsilvanica* auct. from Romania, or forgotten and non accepted taxa, such as *Amblystegium serbicum* Podp., *Brachythecium kosanini* Podp., *Grimmia montenegrina* Breidler & Szysz., *Orthotrichum baldaccii* Bottinii, *Weissia dalmatica* Latz. and 87 further taxa.

Recently, quite many new taxa were described from the region, but it is not clear whether they should be treated as country or regional endemics and whether the taxonomical rank they have is an adequate one (*e.g. Cinclidotus confertus* Lüth from Greece (Lüth, 2002a) or *Dicranum transsylvanicum* Lüth from Romania (Lüth, 2002b)). Another problem is how to explain this endemism or will these species' ranges be expanded through further bryological investigations? In both cases, molecular approaches would be needed to explain species rank, speciation, relationship, origin or if there are recent wide-spreading events.

One hundred and twenty mosses (12.9 %) and 42 (16.1 %) hepatic species are known from only one of eleven regional territories of SE Europe. Fifty six mosses and 15 hepatics can be found only in Romania, 28 mosses and 8 hepatics in Greece, 10 mosses and 2 hepatics in Slovenia, 6 mosses and 8 hepatics in Bulgaria, 7 mosses and 2 hepatics in Montenegro, 5 mosses and 5 hepatics in Serbia, 2 mosses and 2 hepatics in Croatia, two mosses in each Albania and European Turkey each, and one moss in each FYR Macedonia and Bosnia-Herzegovina. These species are of wider, regional or continental conservation interest. However, the biological, ecological and distributional investigations are urgently needed, to exclude misidentification or under-recording (*e.g.* species from difficult and confused hepatic *Riella* genus.). The picture can be further drown with the species recorded in only two of eleven territories: 149 mosses (16.9 %) and 57 hepatics (20.95 %).

Moreover, the state of bryophyte flora investigations is not the same everywhere within the region of the Balkans. Some areas are relatively well known while others are completely unknown or very poorly known (Sabovljević *et al*., 2001).

Figs. 3, 4, 5 and 6 illustrate the records of hepatic species within the countries of Albania, Croatia, FYR Macedonia and Serbia. They may represent areas which have been badly investigated rather than true differences in diversity. Low species richness reflects more probably areas which were less explored or neglected than real low hepatic diversity.

The bryophyte diversity expressed by diversity index *sensu* Hobohm (Tab. II) shows that Slovenia can be considered as the SE European country richest in hepatics, its hepatic diversity is at the same level as for example those in Switzerland and Slovakia. Montenegro (with 88 known hepatic species in corresponding surface) shows to be the second richest country in hepatic diversity in SE Europe. Its hepatics diversity corresponds to those of Portugal or Benelux.

In SE Europe, Montenegro is the richest in moss diversity as well, closely followed by Slovenia and FYR Macedonia. This last territory is usually treated as not so rich in bryophytes; however, its diversity in mosses is high in ratio to territory size, although it is probably besides Albania and the European part where the lowest bryophyte records were made. An increase of species diversity is expected in both countries with further investigations.

The bryophyte diversity of the Balkan Peninsula expressed by diversity indices and compared with other mainland European countries can be considered as very similar to the other south European mainland (*e.g.* the Apennine and Iberian peninsulas). There are also similarities with the British Isles and Scandinavian Peninsula. Indeed, diversity indices vary but slightly among the five above mentioned regions of Europe (Tab. III).

However, many new bryophyte records have been reported from SE Europe in the last years (*e.g.* Blockeel *et al.,* 2002, 2007, 2009a,b,c; Papp & Sabovljević, 2003; Cvetić & Sabovljević, 2004; Erdag & Kürschner, 2005, Natcheva, 2005; Natcheva & Ganeva, 2007; Papp & Erzberger, 2007, 2009, 2010; Ganeva *et al.* 2008; Papp *et al.,* 2008, 2010; Sabovljević

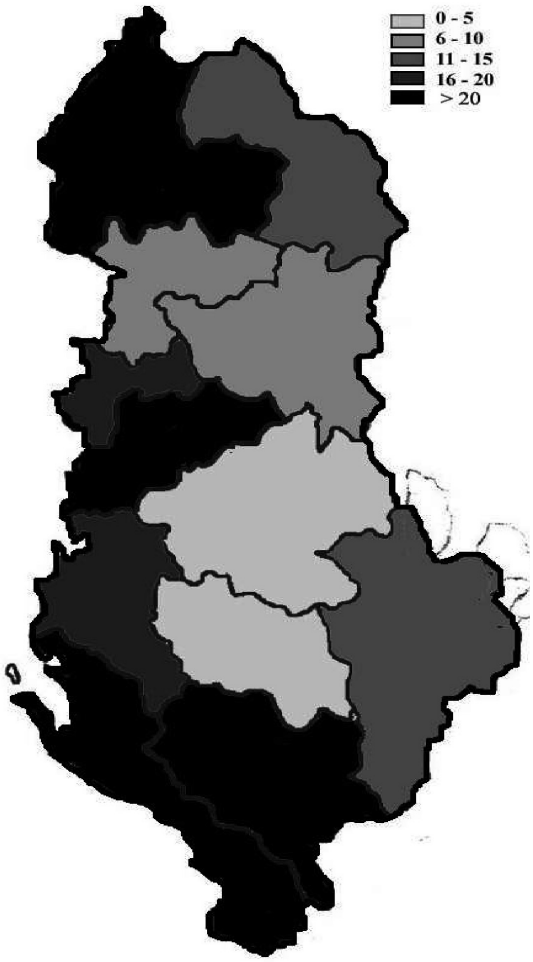

Figure 3. — The presence of hepatic species by counties within Albania.

et al., 2008; Colacino & Marka, 2009; Martinčič, 2009; Cézon *et al*., 2010). Also, new bryophyte records are reported from some usually well known European regions (*e.g.* Hébrard & Pierrot, 1994; Garcia-Zamora *et al*., 1998; Aleffi *et al*., 2003, 2004; Pócs *et al*., 2004; Rams *et al*., 2004; Plašek *et al*., 2009; Orgaz *et al*., 2010); thus, the bryophyte diversity should be taken as the present state of knowledge. The high threats of habitat degradation and extinction in the near future if not stopped, as well as the input of invasive, introduced and alien species in some regions, should be also taken into account when comparing bryophyte diversities.

Considering the indices of bryophyte diversity related to territory area, it can be highlighted that the bryophyte richest countries in Europe are Andorra (0.9613) and Luxembourg (0.8124). Other European countries with high bryophyte diversity are Montenegro (0.6721), Slovenia (0.6609), Switzerland (0.6606), Slovakia (0.6301), FYR Macedonia (0.6235), Austria (0.6117), Denmark (0.6021) and Czech Republic (0.5981). The countries with the lowest bryophyte diversity indices are Belarus and Ukraine. The countries with the poorest hepatic diversity indices are Belarus, Ukraine, Israel and Turkey.

The regression analyses (Fig. 7-9) show that there are similar trends for all three groups tested. Arrhenius species-area model computed as linear regression of $\log_{10}$-transformed values is well supported by r values, which are 0.570 for hepatics, 0.640 for mosses and 0.641

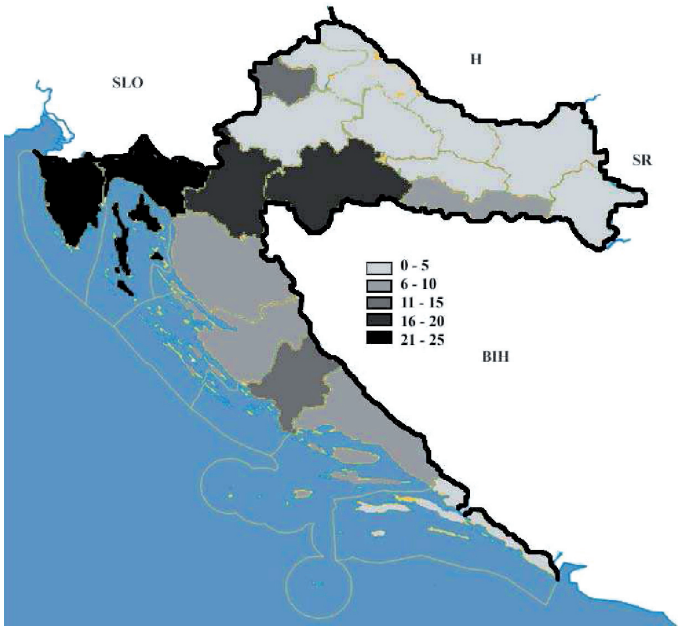

Figure 4. — The presence of hepatic species by counties within Croatia.

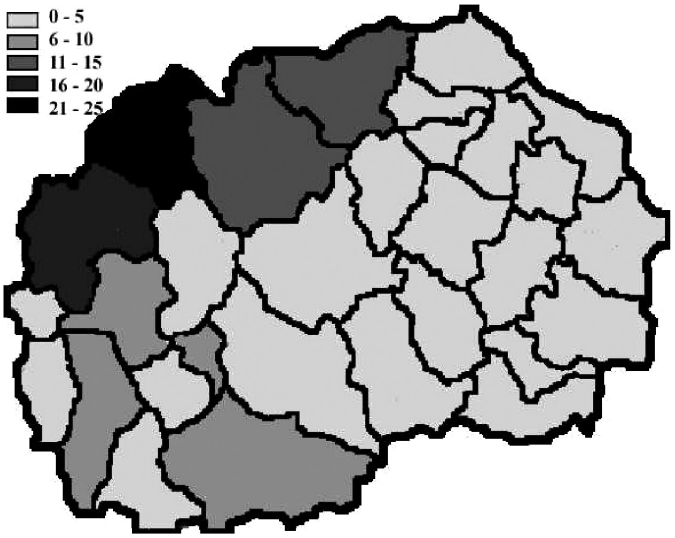

Figure 5. — The presence of hepatic species by counties within Macedonia (FYR).

for bryophyte group. Furthermore, 95 %-confidential lines include the great majority of the dots. The slopes of log(species)-log(area) regression lines, i.e. z-values, are 0.197 for hepatics, 0.170 for mosses and 0.173 for bryophytes. These values are higher than z = 0.15 approximated from the regression models of moss flora richness on the global scale (Mutke & Geffert, 2010). This is rather the consequence of the relatively higher moss diversity of Europe (due to good bryophyte knowledge), and uneven documentation of moss flora on other continents.

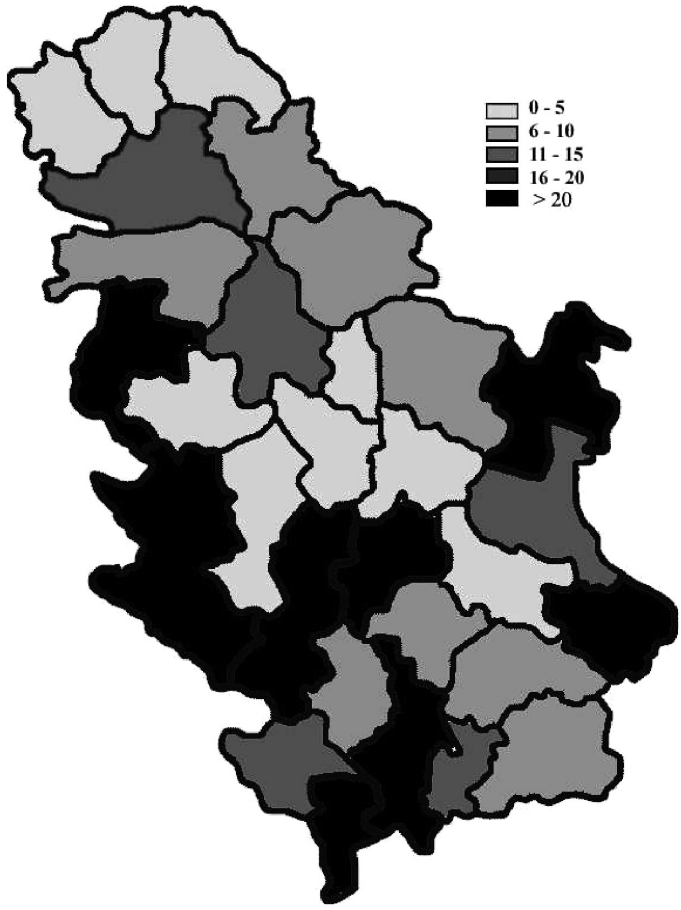

Figure 6. — The presence of hepatics by counties within Serbia.

TABLE III

Comparison on the bryophyte diversity among some bigger regions in Europe

Area	Surface (A) km^2	Hepatics (S1)	Mosses (S2)	Log S1/ Log A	Log S2/ Log A	Log S1+S2/ Log A
Turkey (whole)	780576	166	721	0.3766	0.4848	0.5001
Balkan Peninsula	784908	272	897	0.4130	0.5009	0.5204
Iberian Peninsula	596843	290	811	0.4263	0.5036	0.5266
Apennine Peninsula	301255	289	863	0.4492	0.5408	0.5588
Scandinavian Peninsula	777000	296	834	0.4195	0.4959	0.5175
Britain & Ireland	315134	296	763	0.4494	0.5242	0.5501
Benelux	64453	177	568	0.4674	0.5727	0.5972

Comparison with z-values for vascular flora (*e.g.* 0.13 for Scandinavia, 0.14 for British Isles, 0.15 for Germany, 0.20 for plant communities of Central Europe including mosses and lichens and 0.20 for tropical zone of Africa (Hobohm, 1998a,b) indicates a comparatively rich moss flora in Europe.

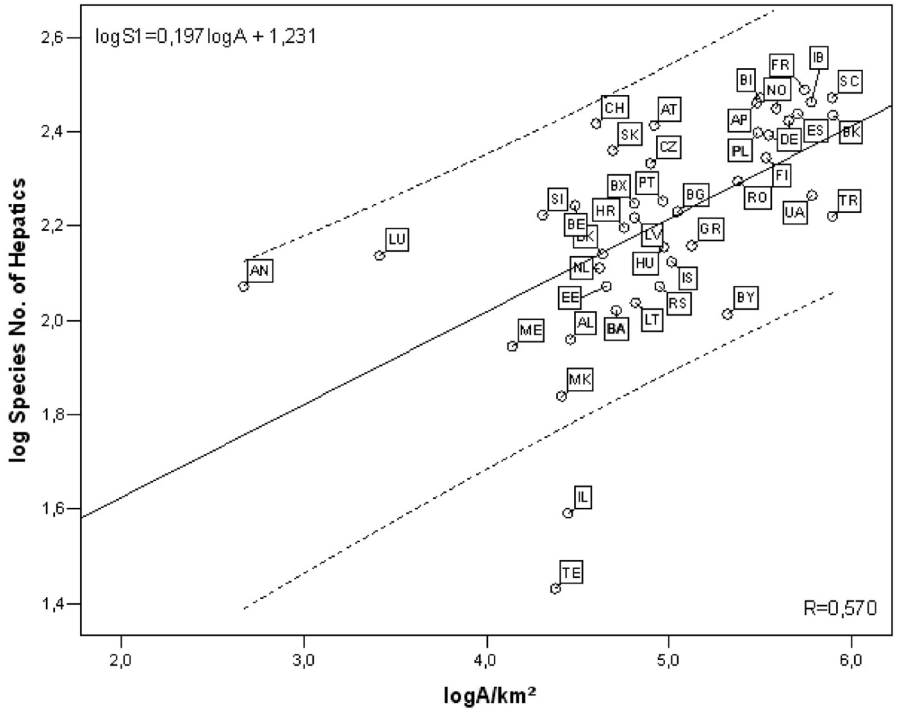

Figure 7. — Species-area line in log-log space for hepatics. Dashed lines represent 95 %-confident interval. For codes, see Tab. II.

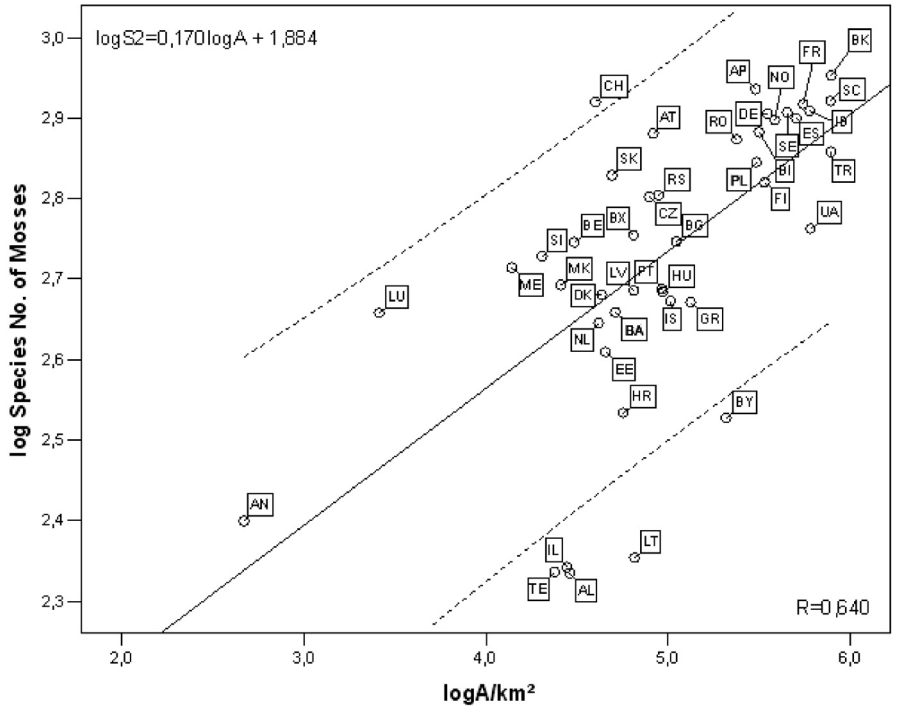

Figure 8. — Species-area line in log-log space for mosses. Dashed lines represent 95 %-confident interval. For codes, see Tab. II.

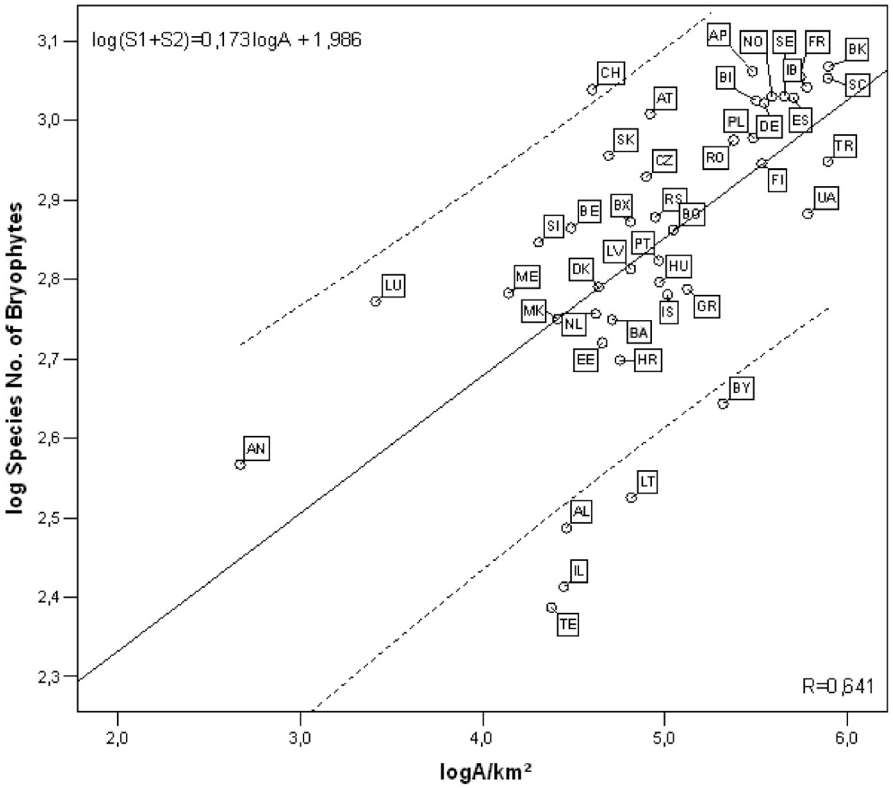

Figure 9. — Species-area line in log-log space for bryophytes. Dashed lines represent 95 %-confident interval. For codes, see Tab. II.

This study estimates bryophyte diversity in SE Europe (i.e. the Balkans) in European background, the region where bryophytes are apparently under-recorded. The comparative approach was conducted with aim to identify a possible influence of uneven sampling intensity on the documented patterns of bryophyte diversity. Some bryophyte diversity basic trends became clear. The lower bryophyte species richness is in arid, semi-arid biomes that arguably reflect real-world biogeographic gradients in species richness. Such a trend is mitigated for some political units that although belonging to arid or semi-arid biomes possess high mountains (vertically distributed various biomes) within their territory. This is the case with Croatia, Montenegro or Albania considering hepatic richness. In the opposite case, if the highlands do not exist, the ecological spectrum is diminished and so the species number (*e.g.* Belarus, Israel, European Turkey and even Lithuania). So, the elevation ranges play important role for species diversity, but this will be the subject of further studies.

Geographical units within the same biogeographical region, with comparable environmental conditions and similar vegetation cover, can be expected to have similar species numbers if the area size is comparable (*e.g.* Kreft *et al.*, 2008). The differences in documented species numbers between some territories are difficult to explain only on the basis of environmental conditions, vegetation, or historical biogeography.

According to this, the Balkan countries where most records of new species are expected are Albania, Macedonia (FYR), Montenegro and Croatia. However, Montenegro is one of the richest area in bryophyte species in the Balkans according to the surface it covers even if it is bryologically under-recorded. Switzerland, Andorra and Luxemburg belong to the bryologically richest areas in Europe according to their surfaces. The numbers of hepatic species are predicted to increase significantly with further investigation in European Turkey, Macedonia,

Montenegro, Albania, Bosnia and Serbia, while moss species numbers should significantly increase in Albania, European Turkey, Croatia, Bosnia-Herzegovina and Greece. Romania and Slovenia remain within similar position in all tested groups. These are the richest countries in bryophyte α diversity within SE Europe.

Phytogeographical aspects of the Balkan bryophyte flora counted by main geoelements showed that temperate species are highly present (43 %), followed by submediterranean (31 %) and boreal (18 %) species. Beside paleo-historical base, the actual relief and climate types presented in the Balkans, as well as the present state of knowledge of the bryophyte flora, are reasons for such a phytogeographical spectrum of the Balkan bryophytes.

The protection and conservation of the bryophytes in SE Europe are present in some countries of the region: *e.g.* Greece, Slovenia, Bulgaria, Romania and Serbia (*e.g.*, Sabovljević *et al*., 2004; Natcheva *et al*., 2006) but are missing in other countries. The reasons for this are rather the absence of local bryologists, a low state of knowledge of bryophyte floras and a governmental low interest into this issue, as well.

CONCLUSION

The bryophyte flora of South-Eastern Europe is not well known; however, even with the present state of knowledge it can be assumed that its bryophyte diversity is high enough. Some countries previously treated as bryologically poor are in fact not so badly known in the view of their diversity indices (*e.g.* FYR Macedonia). The main problem remains the under-recording of the bryophytes. Also many species within the region are known only from very old literature records, and their real state of presence/absence and the level of theirs populations are unknown. These matters open the question of valid bryophyte monitoring, conservation and protection. Regional approaches to further investigations and protection of bryophyte flora are welcome, together with local ones, as well.

Taking into consideration all previous mentions and the fact that the Balkan Peninsula comprises almost all European zono-biomes (in its vertical and horizontal profile), plus the proximity of Asia and Africa, it can be expected that both the number of new species recorded and the data on distribution and population state of already known taxa will increase with further investigations.

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