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Diversity and threat status of the Yugoslav bryoflora

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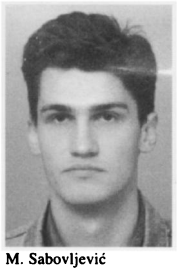
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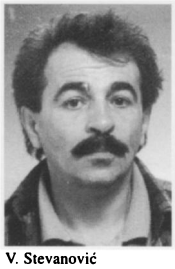
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In the Federal Republic of Yugoslavia, 616 species of bryophytes are recorded. Endemism is low compared with the vascular flora. Only 11 taxa have been treated as local endemics, but all except one are now regarded as synonyms of more widespread taxa. *Encalypta serbica* retains its endemic status, although as a taxonomically doubtful taxon.
Of the Red Listed bryophytes of Europe, 37 moss and 5 liverwort species are present in F. R. Yugoslavia. Five of these are endemic to Europe including Macaronesia.
To date, no measures of bryophyte protection have been taken in F. R. Yugoslavia. However, the major centres of bryophyte diversity are situated in Scientific Reserves, Nature Conservation Reserves and National Parks.

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It is generally accepted that the Balkan Peninsula represents one of the major centres of floristic diversity in the western part of the Palaearctic. In that respect, Yugoslavia (Serbia and Montenegro) is considered to have one of the richest vascular floras in Europe (Stevanović et al. 1995a). However, unlike the vascular flora, studies of the bryophytes in Yugoslavia have been neglected for decades. Despite this, the number of bryophyte species known to occur in Yugoslavia is high.

Although a number of local and foreign bryologists have been concerned with the study of Yugoslavia there is still not much data on the bryoflora. For example, some records published towards the end of the 19th and beginning of the 20th century are still the only available almost one century later. The most complete survey on bryoflora of the former and present Yugoslavia is by Pavletić (1955). Thereafter, only a small number of papers have been published on bryophytes, the most significant of which are Popović (1966), Martinčič (1966, 1968, 1980), Pulević (1969), Pavletić and Pulević (1975, 1980), Grgić (1989) and Gajić et al. (1991).

In Yugoslavia, 616 bryophyte species have been recorded, based on literature data since the middle of the last century and on filed work during the last few years in several National Parks and Nature Reserves. Among them are one species of *Anthocerothopsida*, 32 families, 48 genera and 109 species of *Marchantiopsida*, and 37 families, 159 genera and 506 species of *Bryopsida*. Nomenclature and systematics follow Grolle (1983) for hepatics, and Corley et al. (1981) and Corley and Crundwell (1991) for mosses.

This large number of species is due to the variation in orography, geology, hydrography, climate and other ecological factors, in addition to the complex history of plant life from the Tertiary through the glaciations till today. It is expected that the number of bryophyte species will be increased in Yugoslavia with further research.

In Yugoslavia, the number of endemic mosses and liverworts is much less than for the endemic vascular

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Table 1. Comaparison between taxa that Pavletić (1955) treated as endemic to Yugoslavia and recent classifications.

Pavletić 1955	Recent literature	Reference
Amblystegium serbicum Podp.	*Amblystegium serpens* (Hedw.) B. S. & G.	Düll 1985
Astomum paradoxum Latz.	*Weisia levieri* (Limpr.) Kindb.	Crundwell and Nyholm 1972
Barbula adriatica Baumg.	*Didymodon fallax* (Hedw.) Zander.	Corley et al. 1981
Brachythecium kosanini Podp.	*Brachythecium reflexum* (Starke) B. S. & G.	Corley et al. 1981
Encalypta serbica Katić	?*Encalypta ciliata* Hedw.	Düll 1984
Eucladium angustifolium (Jur.) Glow.	*Eucladium verticillatum* (Brid.) B. S. & G.	Zander 1973
Pottia illyrica Latz.	*Pottia truncata* (Hedw.) B. S. & G.	Düll 1984
Pseudoleskea illyrica Glow.	*Pseudoleskea saviana* (De Not.) Latz.	Corley et al. 1981
Tortula montenegrina Broth.	*Tortula lingulata* Lindb.	Corley et al. 1981
Trichostomum brevifolium Sendt. ex C. Müll.	*Trichostomum crispulum* Bruch.	Corley et al. 1981
Weissia dalmatica Latz.	*Weissia wimmeriana* (Sendt.) B. S. & G.	Düll 1984

plants. Of the vascular flora 9% is endemic whereas only 11 species (1.8%) of the bryophyte species recorded by Pavletić (1955) and Martinčič (1966) are restricted to Yugoslavia. Of these 11 bryophytes, 10 have been placed in synonymy with other species. The only one remaining is, however, a taxonomic problem needing further studies (Table 1). All bryophytes regarded as endemic by Pavletić (1955, 1956) have been classified into threat categories at a local (Yugoslavian) level by Stevanović et al. (1995b; Table 2). Four of the species (*Amblystegium serbicum, Barbula adriatica, Pottia illyrica* and *Trichostomum brevifolium*) have been placed in synonymy with common species. Three of the species, *Pseudoleskea saviana, Weissia levieri* and *Tortula lingulata,* are also Red Listed for Europe as RT (regionally threatened), R (rare) and K (insufficiently known), respectively (ECCB 1995). The taxonomically problematic species, *Encalypta serbica*, should perhaps be placed in category T (taxa apparently threatened but presenting taxonomic problems).

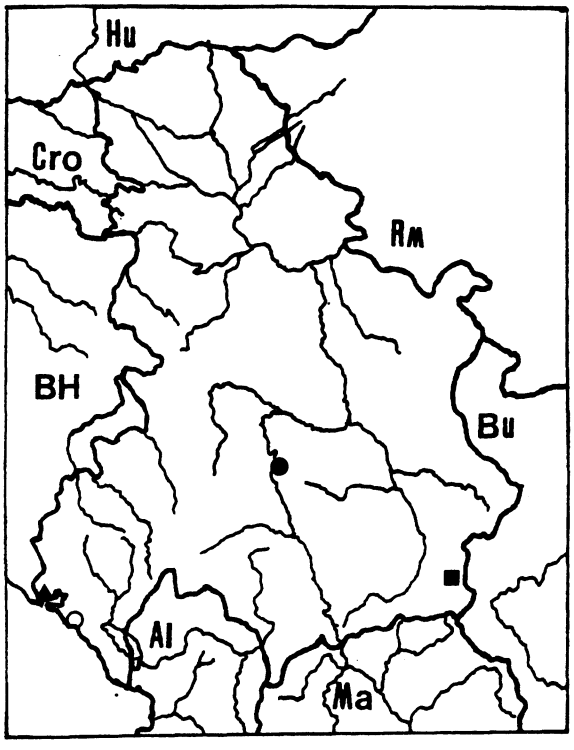

Fig. 1. Distribution in Yugoslavia of some species that Pavletić (1956) considered to be endemic.
(■) *Brachythecium reflexum* (as *B. kosanini*),
(●) *Encalypta serbica,*
(○) *Eucladium verticillatum* (as *E angustifolium*), and
(▲) *Weissia wimmeriana* (as *W. dalmatica*).

Taxa treated as endemic in Yugoslav literature

Amblystegium serbicum Podp. is recorded from the vicinity of Niš by Pavletić (1955, 1956) citing Podpera (1922, 1954). Stevanović et al. (1995b) treat it as rare (R) in Yugoslavia (Table 2). In recent literature it is, however, regarded as a synonym of *A. serpens* (Table 1), which is widespread in Serbia and noted in one locality in Montenegro.

Astomum paradoxum Latz. is a synonym of *Weissia levieri* known from Hercegnovi at the Montenegrian coast. It is treated as rare (R) both at the local (Stevanović et al. 1995b) and European level (ECCB 1995; Tables 2, 3).

Barbula adriatica Baumg. is recorded from one locality in Montenegro. However, the recent synonymy with *Didymodon fallax* makes it widespread species (Table 1).

Table 2. Bryophytes classified as rare or threatened in Yugoslavia . ECCB is threat category in Europe (ECCB 1995) and local is threat category in Yugoslavia (Stevanović et al. 1995b). S/M is occurrence in Serbia (S) or Montenegro (M).

Species	S/M	ECCB[1]	Local[1]	Reference
MARCHANTIOPSIDA				
Aytoniaceae				
Mannia triandra (Scop.) Grolle	M	R		Pavletić 1955
Cephaloziaceae				
Cephalozia lacinulata Spruce	S	V		Gajić et al. 1991
Cephaloziellaceae				
Cephaloziella calyculata (Dur. & Mont.) K. Müll.	M	R		Bischler and Jovet-Ast 1973
Marchantiaceae				
Marchantia paleacea Bertolini	S	K		Pavletić 1955
Porellaceae				
Porella platyphylloidea (Schwein.) Lindb.	S	T		Pavletić 1955
BRYOPSIDA				
Amblystegiaceae				
Amblystegium saxatile Schimp.	S	R		Martinčič 1980
Drepanocladus sendtneri (Schimp.) Warnst.	S	RT		Pavletić 1955
Andreaceae				
Andreaea rothii Web. & Mohr	S	R		Martinčič 1968
Brachytheciaceae				
Brachythecium geheebii Milde	M	R		Pavletić and Pulević 1975
B. reflexum (Starke) B. S. G.	S			Pavletić 1955, 1956, Martinćić 1966, 1968
B. oxycladum (Brid.) Jaeg.	S	R	V	Pavletić 1955, Martinćić 1968
Buxbaumiaceae				
Buxbaumia viridis (Lam.) Moug. & Nestl.	SM	V		Pavletić 1955, ECCB 1995
Dicranaceae				
Campylopus setifolius Wils.	S	R		Popović 1966
Dicranodomtium asperulum (Mitt.) Broth.	S	K		Martinčič 1980
Dicranum viride (Sull. & Lesq.) Lindb.	S	V		Martinćić 1968
Paraleucobryum sauteri (B.S.G.) Loeske	M	R		ECCB 1995
Encalyptaceae				
***E. serbica* Katić	S		R	Katić 1906, Pavletić 1955, 1956, Martinčič 1966, 1968
Ephemeraceae				
Ephemerum recurvifolium (Dicks.) Boulay	M	R		Pavletić 1955
E. sessile (Bruch & Schimp.) C. Müll.	M	R		Pavletić 1955
Fabroniaceae				
Anacamptodon splachnoide (Brid.) Brid.	S	E		Martinčič 1968
Fissidentaceae				
Fissidens algarvicus Solms	M	K		Pavletić 1955
Funariaceae				
Enthostodon hungaricus (Boros) Loeske	S	R		Guelmino 1970
Funaria microstoma Bruch	SM	K		Pavletić 1955, Martinčič 1968
Funarella curviseta (Schwaegr.) Sérgio	SM	RT		Pavletić 1955
Physcomitrium sphaericum (Ludw.) Brid.	S	R		Pavletić 1955Pavletić 1955
Pyramidula tetragona (Brid.) Brid.	S	V		Pavletić 1955
Grimmiaceae				
Grimmia caespiticia (Brid.) Brid.	M	R		ECCB 1995
Hypnaceae				
Hypnum fertile Hedw.	S	RT		Pavletić 1955
Leskeaceae				
Pseudoleskea saviana (De Not.) Latz.	M	RT		Pavletić 1955, 1956, Martinčič 1966, 1968
Neckeraceae				
**Homalia webbiana* (Mont.) Schimp.	S	R		Pavletić 1955
Neckera pennata Hedw.	S	V		Pavletić 1955
Orthotrichaceae				
Orthotrichum patens Bruch ex Schimp.	SM	T		Pavletić 1955, Martinčič 1968
Zygodon forestri (With.) Mitt.	M	V		Pavletić 1955
Pottiaceae				
Anoectangium hornschuchianum (Hook.) Funck	M	V		Pavletić 1955

Cont.

Table 2. *Cont.*

Species	S/M	ECCB[1]	Local[1]	Reference
**Barbula bicolor* (B. S. G.) Lindb.	S	V		Popović 1966
**B. enderesii* Garov.	S	V		Pavletić 1955
Eucladium verticillatum (Brid.) B. S. G.	SM		K	Pavletić 1955, 1956, Glowacki 1907a, 1907b, Podpera 1954
**Hilpertia velenovskyi* (Schiffn.) Zander	S	V		Martinčič 1968
Tortula lingulata Lindb.	M	K	R	Pavletić 1955, 1956, Martinčič 1966, 1968
T. princeps De Not.	M	T		Pavletić and Pulević 1980
T. sinensis C. Müll.	S	R		Martinčič 1980
Weissia levieri (Limpr.) Kindb.	M	R	R	Pavletić 1955, 1956, Martinčič 1966, 1968, Latzel 1931, Podpera 1954
W. triumphans (De Not.) M. O. Hill.	M	K		Martinčič 1968
W. wimmeriana (Sendt.) B. S. G.	M		R	Pavletić 1955, 1956, Martinčič 1966, 1968, Latzel 1931, Podpera 1954
Seligeriaceae				
**Trochobryum carniolicum* Breidl. & Beck.	S	E		Pavletić 1955
Splachnaceae				
Tayloria froelichiana (Hedw.) Mitt.	S	RT		Martinčič 1968

1) E= Endangered, V= Vulnerable, R= Rare, K= Insufficiently known, RT= Regional Threatened, T= Taxa apparently threatened but present taxonomic problems.
*) Endemic to Europe including Macaronesia.
**) Endemic to Yugoslavia.

Brachythecium kosanini Podp. is known from the Vlasina region (Fig. 1) but is now regarded as a synonym of *B. reflexum* (Table 1). It is still the only known locality in Yugoslavia, and Stevanović et al. (1995b) classified it as vulnerable (V) (Table 2).

Encalypta serbica Katić is found in Jošanička banja area in Mt. Kopaonik in Central Serbia (Fig. 1). There are no recent records due to low intensity of bryological investigations for decades. If it is still there, it is protected in the National Park of Kopaonik. Stevanović et al. (1995b) classified it as rare (R) in Yugoslavia (Table 2). This species is the only one of the 11 that Pavletić (1955) treats as endemic, that retains a potential endemic status in Yugoslavia. However the taxonomic status is problematic. Düll (1984, 1985) treats it as a possible synonym of *E. ciliata* with a question mark. Besides taxonomic studies, it also requires distribution studies, since after Katić (1906) there are no records, only citations of Katić by other authors.

Eucladium angustifolium (Jur.) Glow. is known from the Montenegrian coast (Budva, Hercegnovi (Fig. 1). However, the recent synonymy with *E. verticillatum* (Table 1) makes it a widespread species.

Pottia illyrica Latz. is known from the Montenegrian coast (Hercegnovi) and Stevanović et al. (1995b) treat it as rare (R) (Table 2). However, the recent synonymy with *P. truncata* (Table 1) makes it a widespread species.

Pseudoleskea illyrica Glow. is known from the Vlasina region in Serbia and the Orjen area in Montenegro. These are still the only known localities in Yugoslavia for *P. saviana,* a species classified as RT in Europe (ECCB 1995; Tables 2, 3).

Tortula montenegrina Broth. is known from Veliki Maglić Mountain in Montenegro close to the Yugoslav-Albanian border. Treated as rare (R) by Stevanović et al. (1995b), and as insufficiently known (K) by ECCB (1995; Tables 2, 3).

Irichostomum brevifolium Sendtn. ex. Müll. is known from one locality near Niš. It is now regarded as a synonym of *T. crispulum* (Table 1), which is common in many parts of Yugoslavia.

Weissia dalmatica Latz. is known from the Hercegnovi at the Montenegrian coast (Fig. 1) and Stevanović et al. (1995b) treat it as rare (R; Table 2). However, the recent synonymy with *W. wimmeriana* (Table 1) makes it a widespread species.

Threat and conservation of European Red Listed species in Yugoslavia

From the bryophytes Red Listed in Europe (ECCB 1995) 42 species (37 mosses and 5 liverworts) are known from Yugoslavia (Table 3.) Five of these, *Barbula enderesii, B. bicolor, Hilpertia velenovskyi,*

Table 3. Distribution of European Red Listed bryophytes (ECCB 1995) in Yugoslavia. n. e. = no exact locality, n. e. e. = not exact enough for UTM.

Species	Localities in Yugoslavia	UTM
Amblystegium saxatile Schimp.	Serbia: Piribreg (Sara Mt.)	EM 1/7
Anacamtodon splachnoides (Brid.) Brid	Central Serbia	n. e. e.
Andreaea rothii Web. & Mohr	Serbia: SW Kosmet	n. e. e.
Anoectangium hornschuchianum (Hook.) Funck	Montenegro: Komovi	CN 4/28
**Barbula bicolor* (B. S. & G.) Lindb.	Serbia: Ostrozub Mt.	FN 1/90
**Barbula enderesii* Garov.	Serbia: Postenak (Ljubovija)	CP 3/97
Brachythecium geheebii Milde	Montengro: the Piva and the Vrbnica	n. e. e.
Brachythecium oxycladum (Brid.) Jaeg.	Serbia: Topčider (Belg.), Smederevo	DQ 3/56, 4/49
Buxbaumia viridis (Lam.) Moug. & Nestl.	Serbia: Kopaonik Mt., Montenegro: Prokletije Mt.	n. e. e.
Campylopus setifolius Wils.	Serbia: Majdanpečka domena	EQ 4/37
Cephalozia lacinulata Jack ex Spruce	Serbia (n. e.)	n. e. e.
Cephaloziella calyculata (Durieu et Mont) K. Müll.	Montenegro: Kotor Gulf	n. e. e.
Dicranodontium asperulum (Mitt.) Broth.	Serbia: Prevalac (Sara Mt.)	EM 1/70
Dicranum viride (Sull. & Lesq.) Lindb.	Serbia (n. e).	n. e. e.
Drepanocladus sendtneri (Schimp.) Warnst.	Serbia: Vlasina region	FN 2/21
Enthostodon hungaricus (Boros) Loeske	Serbia: Senta cemtery, Padej, Veternik	DR 1/83,73, 2/10
Ephemerum recurvifolium (Dicks.) Boul	Montenegro: Hercegnovi	BN 4/09
Ephemerum sessile (Bruch) C. Müll.	Montenegro: Hercegnovi	BN 4/09
Fissidens algarvicus Solms	Montenegro: Hercegnovi	BN 4/09
Funaria microstoma Bruch ex Schimp.	Serbia: Belgarde, Niš. Montenegro: N	DQ3/55, 56 EN 3/97
Funariella curviseta (Schwegr.) Sérgio	Serbia: Ripanj, Montenegro: Kotor, Hercegnovi	DQ 3/56 CM 1/90 BN 4/09
Grimmia caespiticia (Brid.) Jur.	Montenegro: Prokletije	n. e. e.
**Hilpertia velenovskyi* (Schiffn.) Zender	Serbia: Bačka - Titelski breg	DR 2/04
**Homalia webbiana* (Mont.) Schimp.	Serbia: Rakovica, Drača Bogosavljević	DQ 3/56, -
Hypnum fertile Sendt.	Serbia: Kargujevac	DP 3/79
Mannia triandra (Scop.) Grolle	Montenegro-Alban. border (Klementi)	DN 2/00, 01
Marchantia paleacea Bertolini	Serbia: Vranje - Kazandžol	EN 4/27
Neckera pennata Hedw.	Serbia: Ravanica,	EP 1/74
Orthotrichum patens Bruch ex Brid.	Serbia: Vlasina, Montenegro: N (n. e.)	FN 2/21
Paraleucobryum sauteri (B. S. & G) Loeske	Montenego: Prokletije (n. e.)	n. e. e.
Porella platyphylloidea (Schwein.) Lindb.	Serbia: The Danube sides - Belgrade	DQ 3/65, 66
Pseudoleskea saviana (De Not.) Latz.	Serbia: Vlasina, Montn: Orjen-Crkvice	FN 2/21 CN 1/50
Physcomitrium sphaericum (Ludw.) Brid.	Serbia: Pirot - Kukla	FN 1/72
Pyramidula tetragona (Brid.) Brid.	Serbia: Niš - Gorica	EN 3/97
Tayloria froelichiana (Hedw.) Mitt.	Serbia: west Kosmet (n. e.)	n. e. e.
Tortula lingulata Lindb.	Montenegro: Veliki Maglić	CN 4/09
Tortula princeps De Not.	Montenegro: Velje brod (Podgorica)	CM 3/95
Tortula sinensis (C. Müll.) Broth.	Serbia: Prevalac (Sara Mt.)	EM 1/70
**Trochobryum carniolicum* Breidl. & Beck	Serbia: Leskovac	EN 3/57
Weissia levieri (Limpr.) Kindb.	Montenegro: Hercegnovi	BN 4/09
Weissia triumphans (De Not.) M. O. Hill	Montenegro: Hercegnovi	BN 4/09
Zygodon forestri (With.) Mitt.	Montenegro: Hercegnovi	BN 4/09

Homalia webbiana and Trochobryum carniolicum are endemic to Europe including Macaronesia (Fig. 2). The Belgrade district and the Kotor Gulf are areas of great bryological interest with five and eight European Red Listed species, respectively (Fig. 3). Also, southeast Serbia and the Yugoslavian-Albanian border (particulary the Montenegrian frontier) may also be bryologically interesting. However, there are no recent Yugoslavian records of any of the species Red Listed in Europe and further investigation is needed before their threat status in Yugoslavia can be determined. Certain sites in these areas need to be protected if further investigation shows that the species are still present.

No particular conservation measure has been taken so far to protect bryophytes in Yugoslavia due to lack of knowledge. The bryophyte species inhabiting aquatic ecosystems, particularly travertine barriers and different types of peat bogs, are especially threatened by human impact. Aquatic mosses growing in rapid,

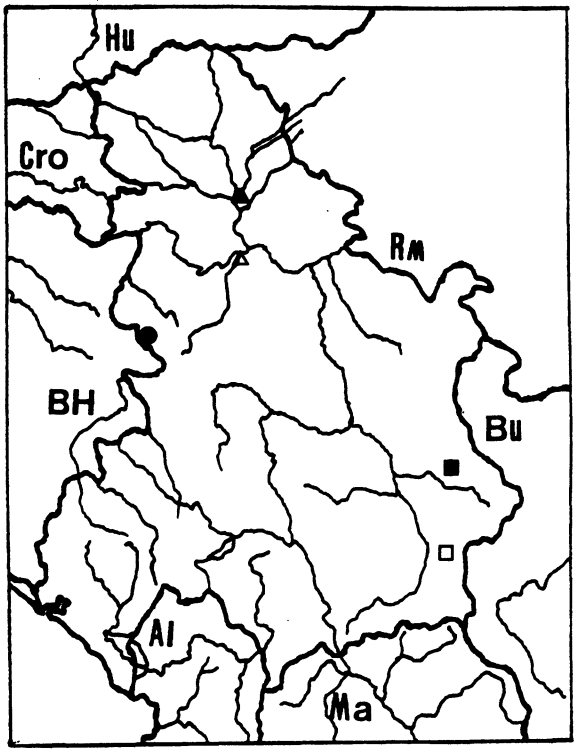

Fig. 2. Distribution in Yugoslavia of bryophytes Red Listed in Europe and endemic to Europe including Macaronesia. (■) *B. bicolor,* (●) *B. enderesii,* (▲) *Hilpertia velenovskyi,* (△) *Homalia webbiana,* (□) *Trochobryum carniolicum.*

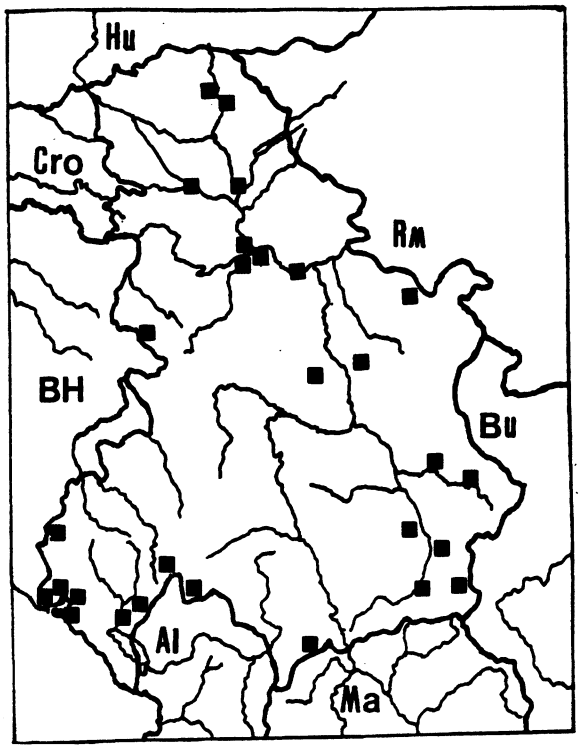

Fig. 3. Distribution in Yugoslavia of bryophytes Red Listed in Europe.

clear and well-aerated waters are also vulnerable and endangered by pollution.

Major human threats to the bryoflora in Yugoslavia can be summarized as: flooding of peat-bogs, gorges and canyons by dam construction; peat exploitation; peat nitrification and mechanical destruction by livestock; drainage and amelioration of marshy areas; destruction of forest ecosystems.

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