

Fungal diversity in the Poloniny National Park with emphasis on indicator species of conservation value of beech forests in Europe

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This paper lists recent finds of macrofungi from the Poloniny National Park in Slovakia. The list contains data on the occurrence of 62 taxa of macrofungi, 35 of which are new to Poloniny, and 15 have not previously been recorded from Slovakia. Additionally, 17 rare species generally considered as threatened in large parts of Europe were found. The study increases the number of fungal indicator species proposed for assessment of the conservation value of European beech forests known from selected nature reserves in Poloniny. The results of this study combined with previously published data shows that Stužica and Rožok National Nature Reserves are the sites with the highest number of these indicator species in Europe.

Key words: wood-inhabiting fungi, indicator species, beech forests, biodiversity, Slovakia, macromycetes

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Príspevok obsahuje súčasné zbery makroskopických húb z Národného parku Poloniny na Slovensku. Zoznam obsahuje dáta o výskyte 62 taxónov húb, z ktorých 36 je nových pre Poloniny a 15 nebolo doposiaľ známych z územia Slovenska. Navyše bolo nájdených 17 vzácných druhov vo všeobecnosti považovaných za ohrozené vo veľkých územiach Európy. Zvýšil sa počet známych druhov húb navrhnutých pre indikáciu prírodnej hodnoty európskych bukových lesov vo vybraných rezerváciách Polonín. Na základe výsledkov tejto štúdie ako aj predtým publikovaných informácií sú Národné prírodné rezervácie Stužica a Rožok považované za lokality s najvyšším známym počtom týchto indikačných druhov v Európe.

INTRODUCTION

The Poloniny National Park (Eastern Carpathians, Slovakia) includes some of the most natural beech forest reserves in Europe. As for naturalness and biodiversity depending on the presence of dead wood these reserves are unique as a reference for large areas of central Europe where most beech forests have been heavily exploited for timber and other products. The amount of dead wood in the forest reserves of Poloniny is most likely close to the natural equilibrium in the European mountain beech forest region (Hahn and Christensen 2004, Christensen et al. 2005). The high conservation value of the forest reserves within the National Park is reflected in the occurrence of a high number of wood-inhabiting fungi which are rare and threatened in large parts of Europe (Christensen et al. 2004).

Long-term mycological research in the Poloniny has documented the occurrence of 1244 fungal taxa (Kuthan et al. 1999). Of these, 1152 taxa are macrofungi. Before our study, a total of 1163 taxa of macrofungi were known from the Poloniny (Adamčík et al. 2003). The area is the best explored concerning the biodiversity of macrofungi in Slovakia.

Thirteen of these indicator species had already been recorded from Stučica National Nature Reserve, making it one of the most valuable European beech forests, nine from Havešová National Nature Reserve and nine from Rožok National Nature Reserve (Kuthan et al. 1999).

The purpose of this study was to document the presence of the wood-inhabiting macrofungal indicator species more completely.

MATERIAL AND METHODS

From 5th to 10th October 2003, we visited four selected sites in Poloniny National Park: Stučica, Rožok, and Havešová National Nature Reserves and Udava Nature Reserve. Poloniny National Park is situated in the NE part of Slovakia and located in the temperate belt of central Europe with a continental climate. Geologically, it is formed by a flysch belt (mostly sandstone or claystone bedrock). The average annual rainfall at an altitude of 500 m above sea level ranges from 800 to 850 mm. Detailed descriptions of the sites are given in Kuthan et al. (1999).

The major part of the fungi was identified during field work. Interesting and problematic species were collected for further study. Names of fungi and author's abbreviations follow in most cases the CABI database (<http://www.indexfungorum.org>). Voucher specimens are deposited in the herbaria C, GENT and SAV. Abbreviations of herbaria are cited in accordance with Index Herbariorum (Holmgren et al. 1990).

Due to the lack of a common European red list of fungi, some rare and/or threatened species were classified as “species of special interest” (SSI) based on data from several national red lists (Benkert et al. 1992, Wojewoda and Ławrynowicz 1992, Arnolds and van Ommering 1996, Stoltze and Pihl 1998, Rimóczi et al. 1999, Gärdenfors 2000).

Three classes of SSI were defined by Ódor et al. (2006):

Class A includes widespread species regarded as very rare and severely threatened (IUCN threat categories “Endangered” to “Critically Endangered”) everywhere in Europe.

Class B includes widespread species regarded as rare all over Europe, and threatened in several countries (IUCN threat categories “Near Threatened” to “Vulnerable”).

Class C encompasses species that are considered to be threatened (IUCN threat categories “Vulnerable” to “Critically Endangered”) in one or several of the covered European countries/regions, but are frequent in others.

Only species in classes A and B are mentioned in the survey of the species.

Abbreviations

* taxon new to Poloniny National Park

** taxon new to Slovakia

I – indicator species of conservation value of beech forests according to Christensen et al. (2004)

SSI(A) – species of special interest, class A

SSI(B) – species of special interest, class B

H–Havešová National Nature Reserve: virgin beech forest (mixed with *Fraxinus excelsior* and *Acer* spp. in upper parts), alt. 440-740 m, area 1.71 km², exposition S, SE and SW, quadrat Q 6999d of central European mapping grid (Niklfeld 1971). The records were made by the authors of the present paper on 7th October 2003.

R–Rožok National Nature Reserve: virgin beech forest, alt. 450-793 m, area 0.6713 km², exposition W, Q 7000b. The records were made by the authors of the present paper on 6th October 2003.

S–Stužica National Nature Reserve: virgin forest, with dominance of *Fagus sylvatica* and *Abies alba*, in upper parts also with *Acer pseudoplatanus*, alt. 650-1200 m, area 7.6 km², slopes and terraces above the Stužická rieka valley (river flowing in E direction), Q 6901a. The records were made by the authors of the present paper on 5th October 2003.

U–Udava Nature Reserve: virgin mixed forest (*Fagus sylvatica* and *Abies alba*), alt. 520-650 m, area 0.52 km², spring area of the Udava river (S direction), Q 6899a. The records were made by the authors of the present paper on 7th October 2003.

Our paper contains only a list of interesting taxa: previously not known from Slovakia or Poloniny, species of special interest, indicator species, rare fungi and species with some taxonomic or nomenclatural remarks. Common species found during our field excursions but already published by Kuthan et al. (1999) are not listed here.



Fig. 1. Geographic position of the studied sites in the Poloniny National Park (Eastern Carpathians, Slovakia). H: Havešová, R: Rožok, S: Stučica, U: Udava. For more information see Material and Methods.

RESULTS

LIST OF INTERESTING TAXA

Agrocybe firma (Peck) Singer, R, rotten wood of stump and fallen log of *Fagus sylvatica* (SAV, GENT col. Walley 3277).

Note: this species grows on litter and rotten wood of *Fagus* and other deciduous trees. In Slovakia it was reported only from Poloniny (Kuthan et al. 1999) and recently also collected in the Vihorlat Mts. (Ripková et al. 2006, in print). Another species of the genus *Agrocybe* growing on rotten wood of *Fagus* in Poloniny is *Agrocybe erebia* (Fr.) Kühner (Kuthan et al. 1999).

Armillaria cf. *gallica* Marxm. & Romagn., H, R, S, U, on decaying wood of *Fagus sylvatica*.

Note: this is the most common *Armillaria* species in Poloniny and is very abundant in the autumn. Kuthan et al. (1999) treated it as *A. cepistipes* f. *pseudobulbosa*. *Armillaria cepistipes* and *A. gallica* are morphologically so similar that they can be identified only with laboratory methods (Jankovský and Scháněl 1997).

* *Biscogniauxia nummularia* (Bull.) Kuntze, S, on decaying wood of *Fagus sylvatica*.

* *Boletus subappendiculatus* Dermek, Lazebn. & J. Veselský, U, terrestrial, under *Abies alba*, *Fagus sylvatica* (GENT col. Walley 3280, SAV).

Note: this species was described from mountainous coniferous forests in northern Slovakia (Dermek 1979). According to our experiences, basidiocarps grow often in clusters, such as in the case of our collection from Poloniny.

I, SSI(B) *Camarops tubulina* (Alb. & Schwein.) Shear, S, R, U, fallen log of *Fagus sylvatica* (GENT col. Walley 3250).

* *Ceriporia excelsa* (S. Lundell) Parmasto, U, on decaying wood of *Fagus sylvatica*.

I, SSI(B) *Ceriporiopsis gilvescens* (Bres.) Domański, H, on decaying wood of *Fagus sylvatica*, R, on at least 3 fallen logs of *Fagus sylvatica* (GENT col. Walley 3263, C col. Heilmann-Clausen 03-043, col. Christensen 03-246), S, U, on decaying wood of *Fagus sylvatica*.

I, SSI(A) *Ceriporiopsis pannocincta* (Romell) Gilb. & Ryvarden, H, on at least 2 logs of *Fagus sylvatica*, R, on more than 8 logs of *Fagus sylvatica*, S, on decaying wood of *Fagus sylvatica*.

** *Ceriporiopsis subvermispora* (Pilát) Ryvarden & Gilb., R, fallen log of *Fagus sylvatica* (C col. Heilmann-Clausen 03-031).

I, SSI(B) *Climacodon septentrionalis* (Fr.) P. Karst., R, on 3 fallen logs of *Fagus sylvatica* (GENT col. Walley 3275, C col. Heilmann-Clausen 03-026, C col. Christensen 03-234).

- * *Clitocybe truncicola* (Peck) Sacc., S, fallen log of *Fagus sylvatica* (SAV).
- * *Conocybe subpubescens* P.D. Orton, S, fallen log of *Fagus sylvatica* (SAV), R, on decaying wood.
- ** *Cortinarius xanthophyllus* (Cooke) Rob. Henry, in forest along road to Rožok National Nature Reserve, terrestrial, under *Fagus sylvatica*, 6 Oct. 2003 (C col. Heilmann-Clausen 03-034).
- Cyphella digitalis* (Alb. & Schwein.) Fr., S, fallen twigs and branch of *Abies alba* (SAV, GENT col. Walley 3247, C col. Christensen 03-231).
- * *Cystolepiota seminuda* (Lasch) Bon, R, litter, *Fagus sylvatica* (SAV).
 Note: Lizoň et al. (1999) referred a collection published in Kuthan et al. (1999) as the only one known from Slovakia. Kuthan et al. (1999) include only collection of *C. sistrata*, which is a species different from *C. seminuda*, but several authors used these names as synonyms. Thus, our collection should be the first published record of *C. seminuda* from Poloniny. Three collections of the species were collected also in the adjacent Vihorlat Mts. (Ripková et al., in print).
- I, SSI(B) *Dentipellis fragilis* (Pers.) Donk, R, on at least 3 logs, S, at least 3 fallen logs of *Fagus sylvatica* (GENT col. Walley 3254), U, on 2 logs of *Fagus sylvatica* (C col. Christensen 03-249).
- ** *Eutypa spinosa* (Pers.) Tul. & C. Tul., H, R, S, U, very common on logs of *Fagus sylvatica*.
- ** *Exidia nucleata* (Schwein.) Burt, S, on decaying wood of *Fagus sylvatica*.
- ** I *Flammulaster limulatus* (Fr.) Watling var. *limulatus*, R, on 2 fallen logs of *Fagus sylvatica* (SAV, C col. Heilmann-Clausen 03-029).
- I, SSI(A) *Flammulaster muricatus* (Fr.) Watling, H, R, fallen log of *Fagus sylvatica* (GENT col. Walley 3285, SAV).
- Gymnopilus penetrans* (Fr.) Murrill, R, fallen log of deciduous tree (SAV).
 Note: we follow the wide concept of the species (Holec 2005b), including *G. hybridus* (Fr.) Singer. Kuthan et al. (1999) distinguished collections from deciduous trees as *G. penetrans* and those from coniferous as *G. sapineus*, but they both represent *G. penetrans*.
- * *Henningsomyces candidus* (Pers.) Kuntze, R, on decaying wood of *Fagus sylvatica* (SAV).
- I, SSI(B) *Hericium coralloides* (Scop.) Pers., H, on at least 3 logs, R, on logs of *Fagus sylvatica*, S on at least 8 logs, U, on fallen and standing dead logs of *Fagus sylvatica*.
 Note: Kuthan (1999) treats this species as *Hericium clathroides* (Pall.) Pers. and a related species growing on *Abies* as *H. coralloides* (Scop.) Gray. The same names are used in most publications from Slovakia and central Europe. However, the basionym *Hydnum coralloides* Scop. was sanctioned by Fries (1821) and Fries' concept corresponds to the taxon growing on beech logs. The correct name for the species growing on *Abies* is *Hericium flagellum* (Scop.) Pers.
- I, SSI(B) *Hericium erinaceus* (Bull.) Pers., R, on decaying log of *Fagus sylvatica*, S, fallen log of *Fagus sylvatica* (C col. Heilmann-Clausen 03-014).

** I *Hohenbuehelia auriscalpium* (Maire) Singer, H, on log of *Fagus sylvatica* (C col. Christensen 03-248), R, on decaying wood of *Fagus sylvatica*.

Note: Kuthan et al. (1999) listed 10 collections of the genus *Hohenbuehelia* on fallen logs of *Fagus* but under the names *H. grisea*, *H. petalooides* and *H. spathulata*. These collections need to be re-examined using modern taxonomical treatments.

* SSI(B) *Hohenbuehelia mastrucata* (Fr.) Singer, S, fallen log of *Fagus sylvatica* (C col. Heilmann-Clausen 03-013).

** *Hymenogaster hessei* Soehner, along road to Udava Nature Reserve, hypogeous, under *Corylus avellana*, 7 Oct. 2003 (GENT col. Walley 3282, 1 small carpophore).

** *Hymenogaster niveus* Vittad., near field station of Poloniny National Park in the village of Nová Sedlica, hypogeous, under *Corylus avellana*, 5. Oct. 2003 (GENT col. Walley 3245).

* *Hypoxylon cohaerens* (Pers.) Fr., H, R, S, U, on decaying wood of *Fagus sylvatica*.

SSI(A) *Ionomidotis irregularis* (Schwein.) E.J. Durand, S, fallen log of *Fagus sylvatica*, associated with *Ossicaulis lignatilis*, leg. V. Kučera (GENT col. Walley 3251, SAV, C col. Christensen 03-232).

Note: *Ionomidotis irregularis* was collected on a fallen log of *Fagus* at Stuzica in the years 1987-1988 (Kuthan et al. 1999). During research in the following years, several mycologists did not succeed in recollecting the species. Recollection after 15 years means not only important information about its occurrence, but it also confirms the ability of the species to inhabit beech logs at Stuzica (our collection was from the other side of the Stuzická rieka river valley in comparison to the previous one).

I, SSI(B) *Ischnoderma resinosum* (Schrad.) P. Karst., H, on more than 5 logs, R, on more than 30 logs of *Fagus sylvatica*, S, on at least 7 fallen logs of *Fagus sylvatica* (GENT col. Walley 3248), U, on at least 3 logs.

* *Lactarius romagnesii* Bon, R, terrestrial, under *Fagus sylvatica* (2 specimens in GENT col. Walley 3272, 3273).

Note: the first published collection of this species in Slovakia is from the adjacent Vihorlat Mts. (Adamčík et al. 2005).

** *Leccinum roseofractum* Watling, R, terrestrial, under *Betula pendula* (SAV).

Lentaria mucida (Pers.) Corner, R, H, on damp rotten log of *Fagus sylvatica* (C col. Christensen 03-238).

** *Lepiota xanthophylla* P.D. Orton, on bank of Žľab stream near the road to Rožok National Nature Reserve, litter, *Corylus avellana*, *Carpinus betulus* and other deciduous trees, 6 Oct. 2003 (C col. Heilmann-Clausen 03-035).

* *Mycena meliigena* (Berk. & Cooke) Sacc., S, on decaying wood of *Fagus sylvatica*.

* *Nectria peziza* (Tode) Fr., S, on decaying wood of *Fagus sylvatica*.

** *Nemania atropurpurea* (Fr.) Pouzar, R, on decaying wood, S, fallen log of *Fagus sylvatica* (SAV, GENT col. Walley 3259), U, on decaying wood.

* *Nemania carbonacea* Pouzar, S, fallen log of *Fagus sylvatica* (GENT col. Walley 3246).

* *Nemania serpens* (Pers.) Gray, S, on decaying wood of *Fagus sylvatica*.

Oligoporus alni (Niemelä & Vampola) Piątek (Syn.: *Postia alni* Niemelä et Vampola), R, on decaying wood of *Fagus sylvatica*.

Note: Kuthan et al. (199) follow the wide concept of *Postia caesia* (Schrad.) P. Karst., but the published records in Poloniny on beech wood evidently belong to *P. alni* (Vampola 1994).

I, SSI(B) *Ossicaulis lignatilis* (Pers.) Redhead & Ginns, H, on decaying logs, R, on at least 4 fallen logs of *Fagus sylvatica* (C col. Christensen 03-237), S, on at least 6 fallen logs of *Fagus sylvatica* (SAV), U, on 2 logs.

Panellus violaceofulvus (Batsch) Singer, S, twigs of *Abies alba* on fallen log (GENT col. Walley 3249, 2 specimens in herb. Heilmann-Clausen 03-11, 03-12).

I, SSI(A) *Phlebia nothofagi* (G. Cunn.) Nakasone (syn. *Mycoacia nothofagi* (G. Cunn.) Ryvarden), H, R, U, fallen log of *Fagus sylvatica* (3 specimens in GENT col. Walley 3264, 3267, 3278, C col. Heilmann-Clausen 03-042).

I, SSI(B) *Pholiota squarrosoides* Peck, H, at least 2 fallen logs of *Fagus sylvatica* (SAV, GENT col. Walley 3287), R, on at least 2 fallen logs of *Fagus sylvatica* (C col. Christensen 03-236).

* *Pluteus luctuosus* Boud., R, on decaying wood of *Fagus sylvatica*.

I, SSI(B) *Pluteus umbrosus* (Pers.) P. Kumm., R, on at least 2 logs of *Fagus sylvatica*, S, U on at least 2 logs.

** *Psathyrella globosivelata* Gröger, U, fallen log of *Fagus sylvatica* (on primordia of *Armillaria*?) (C col. Heilmann-Clausen 03-040).

Pseudoclitocybe cyathiformis (Bull.) Singer, R, rotten fallen log of *Fagus sylvatica* (SAV), S, on decaying wood.

Note: *Pseudoclitocybe beschidica* Singer et Kuthan differs from *P. cyathiformis* by more crowded, paler and more decurrent gills and shorter spores. Kuthan et al. (1999) treat all collections from Poloniny collected on rotten wood of fallen logs of *Fagus sylvatica* as *Pseudoclitocybe beschidica*. Our collection on rotten wood of *Fagus* has spores frequently exceeding 8.5 µm in length, which well fits *P. cyathiformis*, and differs from the original description of *P. beschidica* (7–8.5 × 4.5–5 µm, Singer and Kuthan 1980).

* *Rhodocybe popinalis* (Fr.) Singer, R, litter, *Fagus sylvatica* (SAV).

Note: Baroni (1981) distinguished *Rhodocybe popinalis* from *R. mundula* (Lasch) Singer, for its broader and longer spores, darker colours of its basidiocarps and grassland habitat. Spores, coloration and habitat of our collections from Poloniny well fit the description of *R. mundula*. However, we follow the wide concept of *R. popinalis* by Noordeloos (1983), who does not consider the characters mentioned above to be suitable for delimiting two taxa.

* *Russula albonigra* (Krombh.) Fr., S, terrestrial, under *Fagus sylvatica* (SAV).

Russula aurora Krombh., R, terrestrial, under *Fagus sylvatica* (SAV).

Note: *Russula aurora* and *R. raoultii* are very frequent and typical mycorrhizal fungi of beech forests in Poloniny and the Ondavská vrchovina Mts. (flysh) but are rare in the adjacent Vihorlat Mts. (andesites).

Sparassis nemecii Pilát & Veselý, U, roots of standing trunk of *Abies alba* (SAV, GENT col. Walley 3279, C col. Christensen 03-255).

I, SSI(A) *Spongipellis delectans* (Peck) Murrill, H, log of *Fagus sylvatica* outside reserve, 7 Oct. 2003 (GENT col. Walley 3289).

** SSI(A) *Steccherinum murashkinskyi* (Burt) Maas Geest., R, fallen log of *Fagus sylvatica* (GENT col. Walley 3276, C col. Heilmann-Clausen 03-027).

** *Steccherinum robustius* (J. Erikss. & S. Lundell) J. Erikss., S, fallen log of *Fagus sylvatica* (GENT col. Walley 3252).

* *Tricholoma cingulatum* (Almfelt) Jacobasch, near Havešová National Nature Reserve, terrestrial under *Fagus sylvatica*, 7 Oct. 2003 (C col. Christensen 03-252).

** *Tricholoma orirubens* Quél., near Rožok National Nature Reserve, terrestrial, under *Fagus sylvatica*, 6 Oct. 2003 (C col. Christensen 03-243).

* *Tricholoma populinum* J.E. Lange, on bank of Žľab stream near the road to Rožok National Nature Reserve, terrestrial, under *Populus tremula*, 6 Oct. 2003 (C col. Heilmann-Clausen 03-021).

* *Volvariella caesiointincta* P.D. Orton, H, rotten wood at base of stump of *Fagus sylvatica* (GENT col. Walley 3284).

This contribution contains data on 62 species of macrofungi collected in Poloniny National Park mostly during field excursions from 5th to 10th October 2003. The total number of taxa recorded was 213 (more common species listed in Kuthan et al. (1999) are not included in our paper) and 140 specimens are deposited in herbaria. The major part of the recorded species (152 taxa) is formed by wood-inhabiting fungi. We recorded 133, 114 and 70 taxa in Rožok, Stučica, and Havešová National Nature Reserves, respectively, and 80 in Udava Nature Reserve.

We collected 35 species new to Poloniny, 15 of which had not been published from Slovakia. Including these data, 1199 species of macrofungi are currently known from the area of Poloniny. Most species previously not known from Slovakia are members of taxonomical groups which had not been sufficiently studied in Slovakia before, such as *Nemania atropurpurea*, *N. carbonacea*, *N. serpens*, *Eutypa spinosa* (pyrenomycetes), *Hymenogaster hessei* and *H. niveus* (hypogeous fungi). Our field excursions were successful in the recollections of rare fungi, such as *Ionomidotis irregularis*, *Cyphella digitalis*, *Lentaria mucida*, *Panellus violaceofulvus* and *Spongipellis delectans*.

Fungi collected for the first time in Poloniny include *Biscogniauxia nummularia*, *Boletus subappendiculatus*, *Ceriporia excelsa*, *Clitocybe truncicola*, *Conocybe subpubescens*, *Cystolepiota seminuda*, *Henningsomyces candidus*, *Hohenbuehelia mastrucata*, *Hypoxylon cohaerens*, *Lactarius romagnesii*, *Mycena meliigena*, *Nectria peziza*, *Nemania carbonacea*, *Nemania serpens*, *Pluteus luctuosus*, *Rhodocybe popinalis*, *Russula albonigra*, *Tricholoma cingulatum*, *Tricholoma populinum*, *Volvariella caesiotincta*.

Fungi reported from Slovakia for the first time are *Ceriporiopsis subvermispora*, *Cortinarius xanthophyllus*, *Eutypa spinosa*, *Exidia nucleata*, *Flammulaster limulatus*, *Hohenbuehelia auriscalpium*, *Hymenogaster hessei*, *Hymenogaster niveus*, *Leccinum roseofractum*, *Lepiota xanthophylla*, *Nemania atropurpurea*, *Psathyrella globosivelata*, *Steccherinum murashkinskyi*, *Steccherinum robustius*, *Tricholoma orirubens*.

DISCUSSION

The weather, temperature, humidity and other factors were very suitable for the fructification of fungi during our field research, which is reflected in the number of collected fungi. Even though Poloniny is one of the best studied areas in Europe (Kuthan et al. 1999), our findings within 4 days clearly show that there is still a lot to be discovered. The National Park includes some of the best preserved areas of virgin forest in Central Europe and may constitute one of the most important areas for conservation of saproxylic fungi in Europe. Several authors (Holec 2003, Ainsworth 2004, Christensen et al. 2004) have suggested certain saproxylic fungi to be indicative of naturalness or conservation value of forests in Central Europe. The most comprehensive indicator scheme published to date is that by Christensen et al. (2004), which is based on experience from several European countries. The scheme is focused on species living on beech wood and lists 21 species of fungi indicative of “conservation value of European beech forests”. We consider this scheme highly useful for evaluating the conservation value of the beech-rich stands in Poloniny.

Important are also collections of species which we treat as “species of special interest” (SSI) based on data from national red lists (Ódor et al. 2004, for details see chapter Material and Methods). We collected in total 11 SSI species in category B and 3 in category A, which is a very good score in the European context (cf. Ódor et al. 2004). Also the records of *Ionomidotis irregularis* and *Steccherinum murashkinskyi* are relevant in this context, as both species are extremely rare in Europe and are likely to be indicative of a high continuity of ecological conditions (e.g. decay of dead wood) in Poloniny's forest reserves.

Already before our visit in 2003, the Rožok, Stučica and Havešová reserves appeared to be among the most valuable beech forests in Europe, judged by the indicator species proposed by Christensen et al. (2004). In 2003, we confirmed the occurrence of almost all indicators during our four-day excursion (with the exception of *Inonotus cuticularis*) mentioned from Poloniny in the literature (Kuthan et al. 1999) (Tab. 1). Moreover, we collected 3 new indicator species at Stučica, 7 at Rožok and 4 at Havešová. Out of these indicators *Hohenbuehelia auriscalpium* had not previously been reported from Poloniny, but the species was probably confused with other species of *Hohenbuehelia* in the past (see note on the species). Together with these new records, Stučica and Rožok are sites with the highest known number of indicator species in Europe (Christensen et al. 2004). Only four indicator species proposed by Christensen et al. (2005), viz. *Aurantioporus alborubescens*, *Ganoderma pfeifferi*, *Lentinellus vulpinus* and *Lentinellus ursinus*, have not yet been collected in Poloniny.

Tab. 1. Indicator species of conservation value of beech forests proposed by Christensen et al. (2004) collected in selected reserves in Poloniny National Park; lit – published in Kuthan et al. (1999), new – our recent collections.

| Species | Stučica | | Rožok | | Havešová | | Udava | |
|------------------------------------|---------|-----|-------|-----|----------|-----|-------|-----|
| | lit | new | lit | new | lit | new | lit | new |
| <i>Aurantioporus alborubescens</i> | | | | | | | | |
| <i>Camarops tubulina</i> | | + | | + | | | | + |
| <i>Ceriporiopsis gilvescens</i> | + | + | + | + | + | + | | + |
| <i>Ceriporiopsis pannocincta</i> | + | + | + | + | + | + | | |
| <i>Climacodon septentrionalis</i> | + | | + | + | + | | | |
| <i>Dentipellis fragilis</i> | + | + | + | + | + | + | + | + |
| <i>Flammulaster limulatus</i> | | | | + | | | | |
| <i>Flammulaster muricatus</i> | + | | | + | | + | | |
| <i>Ganoderma pfeifferi</i> | | | | | | | | |
| <i>Hericium coralloides</i> | + | + | | + | | + | + | + |
| <i>Hericium erinaceus</i> | + | + | | + | | | | |
| <i>Hohenbuehelia auriscalpium</i> | | + | | + | | + | | |
| <i>Inonotus cuticularis</i> | + | | + | | + | | | |
| <i>Ischnoderma resinosum</i> | + | + | + | + | + | + | + | + |
| <i>Lentinellus vulpinus</i> | | | | | | | | |
| <i>Lentinellus ursinus</i> | | | | | | | | |
| <i>Phlebia nothofagi</i> | | + | | + | | | | + |
| <i>Ossicaulis lignatilis</i> | + | + | + | + | + | + | + | + |
| <i>Pholiota squarrosoides</i> | + | | + | + | + | + | | |
| <i>Pluteus umbrosus</i> | + | + | + | + | + | + | | + |
| <i>Spongipellis delectans</i> | + | | | | | + | | |
| Total | 13 | 11 | 9 | 15 | 9 | 11 | 4 | 8 |
| Total per site | 16 | | 16 | | 13 | | 8 | |

The indicator system used here was first developed in Denmark (Heilmann-Clausen and Christensen 2000). Since, additional data from forests in other European countries have contributed to an assessment of the indicator value of the suggested species of fungi, leading to the currently used list of 21 species (Christensen et al. 2005). Also our data on the occurrence of the indicators in Poloniny has significantly contributed to this process. However, it is important to consider the indicator scheme to be still in progress, and further evaluation and statistical testing is certainly needed for the system to be trust worthy.

Most of the selected indicator species are widespread in Europe, but several are rare or scattered and precise information about their distribution and ecology is unfortunately scarce in many parts of Europe. The only species not occurring in Slovakia and eastern Europe seems to be *Aurantioporus alborubescens*, which is not known from Slovakia, although extensive studies on the distribution of polypores were published by Kotlaba (1984) and later authors. *Ganoderma pfeifferi*, *Lentinellus vulpinus* and *L. ursinus* are unknown from Poloniny, but they are known from other parts of Slovakia (Lizoň et al. 1999, Ripková et al. in press).

Some of the proposed indicator and SSI species seem to be common and abundant in the beech forests of Poloniny, even though they are rare and scattered in many other parts of Europe, e.g. *Ceriporiopsis gilvescens*, *C. pannocincta*, *Dentipellis fragilis*, *Hericium coralloides*, *Ischnoderma resinosum*, *Ossicaulis lignatilis* and *Pluteus umbrosus*. Some of these are even known to be common in the adjacent Bieszczady Zachodne (Polish part of Poloniny) and the western part of Ukraine close to Poloniny. *Ceriporiopsis gilvescens*, *Hericium coralloides* and *Ischnoderma resinosum* are common in both areas (Domański et al. 1960, 1963, 1967, 1970; Pilát 1940). *Ceriporiopsis pannocincta* and *Dentipellis fragilis* are known to be rather common in Bieszczady Zachodne (Domański et al. 1960, 1963, 1967, 1970) and *Ossicaulis lignatilis* in the western part of Ukraine (Pilát 1940). This shows that the large area of untouched beech forest in the Eastern Carpathians, including reserves in Poland and Ukraine still have viable populations of these fungi and emphasise the importance of the area in an European conservation perspective.

However, some of the species more common in Poloniny and neighbouring areas are known also from less natural places. *Dentipellis fragilis* is scattered all over the Czech Republic, occurring also in managed stands (Dvořák and Hrouda 2005). Similarly, *Ossicaulis lignatilis* and *Ischnoderma resinosum* are relatively common in young beech forests on abandoned logs from previous cutting in Slovakia (Adamčík, pers. obs.), which could indicate that these species do not have a strict natural habitat indication value. A more complicated matter is the presence of some proposed indicator species in synanthropic habitats. In the Czech Republic, Slovakia and Ukraine most collections of *Ganoderma pfeifferi* originate from parks (Kotlaba 1984, Minter and Dudka 1996). It is in this respect

important to note that the proposed list of indicators is not meant to indicate the degree of naturalness in a strict sense, but rather the conservation value of a particular forest stand and a high number of these species indicate at least the valuable habitat of saproxylic fungi. With several thousand years of human interference in natural habitats in most parts of Europe, the concept of strict naturalness is not always the only relevant way to evaluate conservation value of a locality. In North-western Europe many important areas for the conservation of rare saproxylic organisms are formerly grazed forests or royal hunting reserves, which are far from pristine in a Central European sense (e.g. Niklasson and Nilsson 2005). In Denmark and England *Aurantioporus alborubescens*, *Ganoderma pfeifferi* and *Inonotus cuticularis* are particularly frequent in formerly grazed forests hosting a high number of rare and threatened saproxylic fungi (Christensen and Heilmann-Clausen 2003, Ainsworth 2004), and were therefore included as indicators. Our research of indicator species is not yet finished, and future research is likely to show that some of the proposed species are unsuitable as indicators of conservation value in some parts of Europe. For other species, some recent publications have confirmed our results. For example, Holec (2003, 2004, 2005a) mentions *Camarops tubulina*, *Flammulaster limulatus* and *Pholiota squarrosoides* as species occurring especially in near-natural habitats. Tortič (1998) lists *Dentipellis fragilis*, *Hericium coralloides*, *Ischnoderma resinsum* and *Spongipellis delectans* as indicators of old-growth stands of beech and fir in former Yugoslavia. Except for the latter, the same species are also listed as “relict fungi” of primeval forests in the Świętokrzyskie Mountains of Central Poland by Łuszczynski (2003).

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