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REMARKS TO *ABIETION ALBAE* AND ITS SYNTAXA

Peter Kučera*

Comenius University in Bratislava, Botanical garden, workplace Blatnica, 038 15 Blatnica 315, Slovakia

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Abstract

Recent field research in the area of distribution of the alliance *Abietion albae* communities indicate that stands originally included in the alliance are no more beechless. As the alliance *Abietion albae* comprise secondary forest communities primarily from the order *Fagetalia sylvaticae* it should be evaluated as superfluous syntaxon. Detailed nomenclatural notes on syntaxa included in the alliance *Abietion albae* are presented, too.

Key words: *Abies alba* woodlands, beechless woodlands, continentality, *Oxalido-Abietenion*, the Western Carpathians

Introduction

Beechless *Abies alba* stands in the wider region of Tatras have drawn attention of many researchers. The ground of their existence was interpreted in various [although similar] ways: with a stress on climatic influence. Hadač (1962, 1965) was the first who established a syntaxon on the alliance level for part of Slovak and Polish *Abies alba* woodlands; he included in the alliance *Abietion albae* fir stands of the Belianske Tatry Mts., the Popradská Kotlina Basin, the Levočské Vrchy Mts. and the Pieniny Mts. (cf. Hadač 1965). According to Hadač (1965), a characteristic feature of these *Abies* woodlands is their situation at the leeward side of the Tatras with a lower sum of precipitations and a continental climate. These conditions were considered to be the reason of a wide absence of *Fagus sylvatica* or its low presence in the whole region, and the argument for natural occurrence of *Abies alba* woodlands with *Picea abies* (Hadač 1965: 598).

Material and Methods

The names of syntaxa used in this paper are adopted from the relevant literature sources. Nomenclatural adjustments are according to International Code of Phytosociological Nomenclature (Weber et al. 2000; onward as ICPN). Square brackets within author citations of syntaxa are used only to indicate complete authorship of syntaxa names. Plant names follow the checklist of Marhold et al. (1998). Geomorphological units are cited according to Mazúr et Lukniš (1980).

* Corresponding Author: Peter Kučera; peter.kucera@rec.uniba.sk

Results and discussion

Notes on the nomenclature and general content of the *Abietion albae*

The alliance *Abietion albae* was published together with an original diagnosis (ICPN, Art. 2b) by Hadač (1965). Previously, the alliance was published in a syntaxa overview of Tatras (Hadač 1962: 53) as “*Abietion Březina et Hč in Březina 1958*” [thus nomen ineditum (ICPN, Art. 1) as the referred study was only a manuscript: “Březina, Př., Hadač, E., Ježek, V., Vondráček, M.: Rostlinné společenstva doliny Siedmich prameňov. (MS).”]. The name was not published validly there, because no original diagnosis was joined (ICPN, Art. 2b: nomen nudum).

In the vegetation survey of Belianske Tatry Mts. (Hadač et al. 1969: 288), the name *Abietion* – invalidly published by Hadač (1962) – was used again (as *Abietion albae* Březina et Hadač in Hadač 1962), so later identical name arose: *Abietion albae* Březina et Hadač [in Hadač 1962] ex Hadač et al. 1969 [i.e. nom. illeg.: ICPN, Art. 31]. In relation to *Abietion albae* Březina et Hadač [in Hadač 1962] ex Hadač 1965, it could be considered as a homonym, though, both names have the same syntaxonomical content. Lectotype for *Abietion albae* Hadač 1965 could be chosen from either *Glechomo-Abietetum* Hadač 1965 or *Luzulo-Abietetum* Hadač 1965 as the two other associations – *Prenantho-Abietetum* Hadač 1965 and *Calamagrostio-Abietetum* Hadač 1965 – should not be considered as they were validly published (see p. 6-7). *Abietion albae* Hadač et al. 1969 comprised only three associations: *Prenantho-Abietetum albae* Březina et Hadač in Hadač et al. 1969, *Calamagrostio arundinaceae-Abietetum albae* Březina et Hadač in Hadač et al. 1969 and *Abieto-Laricetum* Hadač et al. 1969. However, a lectotype for *Abietion albae* Hadač et al. 1969 have to be chosen from either *Prenantho-Abietetum albae* or *Calamagrostio arundinaceae-Abietetum albae*. In this manner, lectotypes of *Abietion albae* Hadač 1965 and *Abietion albae* Hadač et al. 1969 should not be the same. The association name *Abieto-Laricetum* was not validly published by Hadač et al. (1969) indeed, so it can not serve as potential lectotype for *Abietion albae* Hadač et al. 1969:

Abieto-Laricetum Hadač et al. 1969, nom. inval.; Art. 3b,

original form of the name: “*Abieto-Laricetum* (provis.)” (Hadač et al. 1969: 303).

The name was not validated later by Hadač (1987: 14 “*Abieto-Laricetum carpaticae* Březina et Hadač [in Hadač et al.] ex Hadač 1987”), as the condition of the ICPN, Art. 5 was not fulfilled. Habitats of the *Abieto-Laricetum* should not be completely beechless ones primarily, similarly as in other lower montane forest phytocoenoses of the Dolina Siedmich Prameňov Valley [P. Kučera, 2. 10. 2007, not.]. Large abundance of *Larix decidua* in the most stands of lower montane forests of the Dolina Siedmich Prameňov Valley is to be assigned to anthropic influence. Therefore the association name *Abieto-Laricetum* is not validated here at all.

For nomenclatural purposes only one nomenclatural type is established:

Abietion albae Březina et Hadač [in Hadač 1962] ex Hadač et al. 1969; (Hadač et al. 1969: 288).

Nomenclatural type: *Prenantho-Abietetum albae* Březina et Hadač in Hadač et al. 1969, Hadač et al., 1969: 291, lectotypus hoc loco.

Nomenclatural type for *Abietion albae* Březina et Hadač [in Hadač 1962] ex Hadač 1965 is here not chosen for nomenclatural problems associated with its description.

It was Hadač (1962) who first differentiated a separate syntaxon of *Abies* woodlands with a rank above association; the suballiance *Abieti-Piceenion* Br.-Bl. in Br.-Bl. et al. 1939 was described as a group of “montane” belt coniferous (*Picea abies*) syntaxa (cf. Braun-Blanquet et al. 1939: 4-5, 10, 13-14). Hadač (1965) knew Oberdorfer’s work (Oberdorfer 1962), in which the author differentiated two new suballiances: *Vaccinio-Abietenion* and *Galio-Abietenion*. Hadač wrote that if *Abies alba* woodlands of the region of the Popradská Kotlina Basin and the Levočské Vrchy Mts. would had fallen into group of Oberdorfer’s *Galio-Abietenion*, all of these *Abies* woodlands would have been separated as an independent alliance [*Abietion*] (Hadač 1965: 593).

A critical aspect of the description of the suballiances *Vaccinio-Abietenion* and *Galio-Abietenion* (Oberdorfer 1962) was lack of characteristics of those syntaxa. Except of including of some

associations to both of the suballiances, only very brief description was added: *Vaccinio-Abietenion* – “artenarme Tannen-Fichtenwälder” (Oberdorfer 1962: 37), *Galio-Abietenion* – “artenreiche Fichten-Tannenwälder” (Oberdorfer 1962: 40). The first indication of differentiation of *Vaccinio-Abietenion* and *Galio-Abietenion* can be seen already in an older vegetation survey of Oberdorfer (1957). There, mixed fir forest (“Tannenmischwälder”, Oberdorfer 1957: 507) were divided into: (1) “Assoziationsgruppe artenarmer Tannenmischwälder” (Oberdorfer 1957: 507) and (2) “Assoziationsgruppe artenreicher Tannenmischwälder” (Oberdorfer 1957: 510). Characteristics of associations of both groups of fir forests should help in closer specification of the two suballiances of Oberdorfer (1962). From descriptions of *Abies* syntaxa (Oberdorfer (1957) a lower presence of *Fagus sylvatica* is evident. Differences of mixed fir woodlands against “normal” *Fagus* syntaxa were mostly of climatic (continentality) or edaphic origin (Oberdorfer 1957). Ellenberg (1963) included to the suballiance *Galio-Abietenion* subcontinental *Abies alba* forests, where *Fagus sylvatica* is absent for climatic reasons (Ellenberg 1963: 260). Thus, he followed more or less the same line as Oberdorfer (1957). Müller (1992; the editor of the whole work was E. Oberdorfer himself) also kept up the original intention of Oberdorfer (1957, 1962): “Werden die klimatischen und edaphischen Bedingungen extremer, d. h. buchenungünstiger, so gelangt die Weißtanne zur Vorherrschaft und baut Tannenwälder (verschiedene “Abieteta”) auf, denen die Fichte meist in einem kleineren oder größeren Anteil natürlicherweise beigemengt ist, während die Rotbuche entweder ganz fehlt oder im Unterstand eine unbedeutende Rolle spielt.” (Müller 1992: 233).

Thus, the characteristic feature of the alliance *Abietion albae* as meant by Hadač (1965) – continental climatic conditions on the leeward side of the mountain ranges – is not a differentiating character against the *Galio-Abietenion*.

Original subordinated communities of *Abietion albae*

Hadač (1965) presented the phytocoenotic material of the alliance *Abietion albae* in a constancy table with 6 columns representing 6 types of phytocoenoses: *Piceo-Abietum carpaticum* Kulczyński 1927, *Abies* stand of Domin (1934), *Prenantho-Abietetum*, *Calamagrostio-Abietetum*, *Glechomo-Abietetum* and *Luzulo-Abietetum*.

1. “*Piceo-Abietum carpaticum* Kulczyński 1927”

Hadač (1965: 593) referred to the association “*Piceo-Abietum carpaticum*” of Kulczyński. However, the assigned rank of association was not given correctly by Hadač, for Kulczyński (1928: 120) wrote: “In der vorliegenden Arbeit wurden diese Wälder [*Abies* and *Fagus* woodlands, note by P. Kučera] in vier Assoziationsrassen geteilt, welche zum Teil regionale, zum Teil edaphische Varietäten einer und derselben Assoziation sind.”

Considering the distribution of the *Piceo-Abietum carpaticum* stands, Hadač referred to Kulczyński’s remark that Kulczyński had not seen *Fagus* woods in the Polish Central Pieniny Mts. and thus *Abies alba* woods replace *Fagus sylvatica* woods there (Hadač 1965: 593). However, a careful reading of the study of Kulczyński (1928) shows that such a construction was a misinterpretation of Kulczyński’s words: “Auf dem Gebiete der Zentral- und Westpieninen kommt die Buche nur sehr selten in reinen Beständen vor, dagegen begegnen wir dieser Baumart häufig als Beimischung in den *Abieto-Fagetum*-Beständen.” (Kulczyński 1928: 68). The stands of *Abieto-Fagetum pieninicum* were according to Kulczyński the most wide-spread community on carbonates in the Polish Central and Western Pieniny Mts. The phytocoenotic table of this community (cf. Kulczyński 1928: 128) does not indicate beechless stands, too. Later, stands of the *Abieto-Fagetum pieninicum* were split by Pancer-Kotejowa (1973) into two associations – *Fagetum carpaticum* (*Dentario glandulosae-Fagetum*) and *Carici-Fagetum*. In my opinion, the natural character of total predominance of the *Abies* in some of their stands (especially in *Carici-Fagetum abietetosum*) is disputed. Except of those phytocoenoses, Pancer-Kotejowa described also rare community *Abies alba-Valeriana tripteris*, with fir or spruce-fir canopy. Stands bear marks of anthropic influence as well (cf. Pancer-Kotejowa 1973: 231).

After Kulczyński, the community *Piceo-Abietum carpaticum* occurs only in a peripheral zone of the Pieniny Mts. – on non-carbonate background (Kulczyński 1928: 66). Kulczyński stated that this *Abies alba-Picea abies* community covered large areas in adjacent mountains of the flysch [Western] Carpathians. According to my field notes from the near mountain range of the Spišská Magura Mts. and other Slovak northern flysch mountains, *Fagus sylvatica* grows well in a whole vertical range of lower mountain belt. Occurrence of the stands with predominance of *Picea* (cf. Kulczyński 1928: 126) [and minimal abundance of *Fagus*] in the lower montane belt of the flysch belt region of the Western Carpathians (cf. Lexa et al. 2000) is not of natural origin, except for mires. Hadač (1965) stressed several times different natural conditions which cause the occurrence of beechless *Abies alba* communities of *Abietion albae*, i.e. continentality of the climate at the leeward side of the Tatras. In the contrast to the Podtatranská Kotlina Basin, geographical location of the Pieniny Mts. itself excludes such climatic influence of the Tatras. The stands of *Piceo-Abietum carpaticum* Kulczyński 1928, a community of secondary *Picea* stands, should not be considered as a pillar of existence of *Abietion albae*. This is underlined by the nomenclatural valuation of the *Piceo-Abietum carpaticum* according to the ICPN:

Piceo-Abietum carpaticum Kulczyński 1928, nom. inval.; Art. 3d, Art. 2b (→ Art. 7).

Šomšák (1986: 15) classified *Piceo-Abietum carpaticum* Kulczyński 1928 differently: as a community undoubtedly belonging to the suballiance *Galio-Abietenion*. In an overview of Polish forest syntaxa, Matuszkiewicz (2002) placed *Abies* woodlands into *Vaccinio-Abietenion* Oberdorfer 1962 as well as *Galio-Abietenion* Oberdorfer 1962. The second one should not be considered in relation to *Piceo-Abietum carpaticum* Kulczyński 1928 as it comprises only specific stands of the community *Abies alba-Oxalis acetosella*. Within the suballiance *Vaccinio-Abietenion*, only two associations could be considered: “*Abieti-Piceetum* W. Matuszkiewicz 1967” and “*Galio-Piceetum* J. Matuszkiewicz 1977”. However, stands of *Piceo-Abietum carpaticum* of Kulczyński (1928) are mentioned neither in the frame *Abieti-Piceetum* nor *Galio-Piceetum*. In the overview of forest communities of the Pieniny Mts, Szelağ (1995: 155-157) did not mention stands of the *Piceo-Abietum carpaticum* at all.

2. *Abies* stand of Domin (1934) in the vicinity of the Tatranská Kotlina (Hadač 1965: 594)

A current state of wood stands in the mentioned region show a large expansion of *Fagus sylvatica*. Mostly young, up to (20) 30-year-old *Fagus* individuals grow not only on slopes of the Belianske Tatry Mts. and their bases, but also in large areas of adjacent plains of the Podtatranská Kotlina Basin. Thus, naturally beechless phytocoenoses are not to be considered there at all (cf. Kučera 2008, 2009a).

3., 4. “*Prenantho-Abietum*” and “*Calamagrostio-Abietum*” of the Dolina Siedmich Prameňov Valley (the Belianske Tatry Mts.; Hadač 1965: 594)

These two associations were described by Hadač (1965) for the first time. However, the descriptions included only short data on localities of relevés and constancy table. More detailed descriptions of stands of both syntaxa were given in a later published study of Hadač et al. (1969: 291, 296). There is stated that both communities were better developed in lower elevations in the Dolina Čiernej Vody Valley. Both syntaxa were considered to be communities with natural absence of *Fagus sylvatica* because of climatic reasons (Hadač 1965: 593).

According to my observations (Kučera 2009a) and also Kanka’s data (Kanka 2008; pers. comm.) I hold the opinion that the absence of *Fagus* in the forests of the Dolina Siedmich prameňov Valley (as well as in the whole mountain range of the Belianske Tatry Mts.) is caused by anthropic influence. Original diagnoses of the both syntaxa comprise stands of secondary, not natural phytocoenoses. In this way, neither *Prenantho-Abietum* nor *Calamagrostio arundinaceae-Abietum* could serve as the base for group of a naturally beechless syntaxa (i.e. alliance *Abietion albae*) described by Hadač (1965).

Both associations were not published validly by Hadač (1965). A comparison with published complete relevés of both associations (cf. Hadač et al. 1969: 294, 301) shows that the constancy table (Hadač, 1965: 594-597) is not complete, at least in the case of *Prenantho-Abietum* and *Calamagrostio-Abietum*. In the table by Hadač (1965: 594-597), 9 species of constancy III and II (*Prenantho-Abietum*) and 10 species of constancy II – V (*Calamagrostio-Abietum*) are missing.

Author citations of both syntaxa names are uneasy to set, because the authorship of the syntaxa is not given. Together with localities, only three researchers are cited who made relevés in the field and with a reference to not published manuscript (Hadač 1965: 594).

Prenantho-Abietetum [? Hadač, Březina et Ježek in] Hadač 1965, nom. inval., Art. 2b (→ Art. 7),

Calamagrostio arundinaceae-Abietetum [? Hadač, Březina et Ježek in] Hadač 1965, nom. inval.; Art. 2b (→ Art. 7).

Sufficient original diagnoses and thus valid publication of both names were published later by Hadač et al. (1969: 291, 296):

Prenantho-Abietetum albae Březina et Hadač in Hadač et al. 1969,

Nomenclatural type: Hadač et al., 1969, p. 294, rel. No. 190, lectotypus hoc loco.

Calamagrostio arundinaceae-Abietetum albae Březina et Hadač in Hadač et al. 1969,

Nomenclatural type: Hadač et al., 1969, p. 301, rel. No. 79, lectotypus hoc loco.

Šomšák (1986: 49) established a neotype to the association “*Prenantho-Abietetum* Hadač 1965” from his own relevés could be considered a nomenclatural validation act (cf. ICPN, Art. 2b) assigned to the year 1986 (thus later homonym to *Prenantho-Abietetum* Březina et Hadač in Hadač et al. 1969 arose). As the original relevés of the association *Prenantho-Abietetum* Hadač 1965 were published by Hadač et al. (1969), a nomenclatural type has to be chosen from the material of the Dolina Siedmich Prameňov Valley also for the name of Šomšák as well (ICPN, Recommendation 21A):

Prenantho-Abietetum [? Hadač, Březina et Ježek in] Hadač ex Šomšák 1986, nom. illeg. (Art. 31),

Nomenclatural type: Hadač et al., 1969, p. 294, rel. No. 190, neotypus hoc loco.

5., 6. “*Glechomo-Abietetum*” and *Luzulo-Abietetum* (Hadač 1965: 594) of the Levočské vrchy Mts.

Similarly as by two previous associations, descriptions of *Glechomo-Abietetum* and *Luzulo-Abietetum* comprise only short data on localities of relevés and constancy table. However, on the contrary to previous syntaxa (*Prenantho-Abietetum* and *Calamagrostio-Abietetum*) I do not know another published corresponding works with complete relevés. Thus, the only original information on *Glechomo-Abietetum* and *Luzulo-Abietetum* is available from the work of Hadač (1965). These phytocoenoses were also considered by Hadač (1965: 593) as the communities with a natural absence of *Fagus sylvatica* caused by climatic conditions.

According to recent data from the Popradská Kotlina Basin and the Levočské Vrchy Mts. (cf. Flachbart 2007, Kučera 2008), *Abies* stands of the Levočské Vrchy Mts. are to be regarded as woods with a natural occurrence of *Fagus sylvatica*. In this manner, each of the two mentioned associations comprises secondary coniferous phytocoenoses influenced by anthropic management. Similarly as two previous associations, *Glechomo-Abietetum* and *Luzulo-Abietetum* should not be considered for the ground of existence of beechless syntaxon on the alliance level – *Abietion albae* of Hadač (1965).

In the original place of publication (Hadač 1965), the two association names are followed only with a reference to a unknown manuscript of Hadač and Slavík. Authorship of the syntaxa names is not given (Hadač 1965: 594). On the contrary to *Prenantho-Abietetum* and *Calamagrostio-Abietetum* (see above), completeness of list of taxa could not be evaluated (see above): thus the names are left to be considered as validly published. The nomenclatural evaluation of the names according to the ICPN:

Glechomo-Abietetum [? Hadač et Slavík in] Hadač 1965*,

Luzulo -Abietetum [? Hadač et Slavík in] Hadač 1965**.

*Hadač (1965: 597) used first species name in the phytocoenotic table in the form “*Glechoma hederacea/hirsuta*”. Thus, it is problematic to specify the name of the association (ICPN, Recommendation 10C); see also “*Soldanella carpatica/major*” and “*Primula elatior/carpatica*” in the table of Hadač (1965: 595-596). Šomšák (1986) established a neotype to the association name “*Glechomo hirsutae-Abietetum* Hadač 1965”. As publication of the original relevés of Hadač and Slavík is not known, the neotype should be accepted – on the contrary to above mentioned *Prenantho-Abietetum*. Only if manuscript relevés of Hadač et Slavík was available, the neotype would be chosen from their relevés.

^{**} In the table of Hadač (1965: 594-597), there are mentioned three species of *Luzula* within column No. 6 (*Luzulo-Abietetum*) compiled from 4 relevés: *Luzula pilosa* (constancy 2), *Luzula sylvatica* (1) and *Luzula luzuloides* (5, as *L. nemorosa*). If one would follow the manner of labelling of *Prenatho-Abietetum*, *Calamagrostio [arundinaceae]-Abietetum*, *Glechomo-Abietetum* by Hadač (1965) (all herb species have the highest constancy), the name of this association would be completed to “*Luzulo nemorosae-Abietetum* [? Hadač et Slavík in] Hadač 1965”. In such form, the name were later homonym to *Luzulo luzuloidis-Abietetum* of Oberdorfer (1957: 507); the latter name is syntaxonomic synonym to *Fago-Piceetum* Oberdorfer 1938 and *Luzulo nemorosae-Piceetum* (Schmid et Gaisberg 1936) Br.-Bl. et Sissingh in Br.-Bl. et al. 1939 (Kučera 2009b).

Summarily, the region of the syntaxa of the original diagnosis of the alliance *Abietion albae* (Hadač 1965, Hadač et al. 1969) comprising the Dolina Siedmich Prameňov Valley (the Belianske Tatry Mts) and the Levočské Vrchy Mts. is no more beechless. *Fagus sylvatica* grows and expands widely in the region, as well as in the Popradská kotlina Basin (cf. Flachbart 2007; Kučera 2008, 2009a). Absence of *Fagus* in coniferous stands of that region published in previous studies (Domin 1934, Hadač et al. 1960, Šmarda 1961, Hadač 1965, Šmarda 1966, Zlatník 1975, Plesník 1995) are not caused by specific natural conditions. They were primarily communities of the order *Fagetalia sylvaticae* with *Fagus sylvatica*, *Abies alba*, (*Acer pseudoplatanus*, *A. platanoides*, *Carpinus betulus* and other tree species). The separate alliance *Abietion albae* is a superfluous syntaxon.

Short remarks to syntaxa placed into *Abietion albae* later

In the overview of Slovak syntaxa (Mucina et al. 1985), there were included in the frame of “*Abietion albae* Březina et Hadač in Hadač 1962” altogether 11 associations (Šomšák 1985: 218-219), i.e. 6 syntaxa except those of Hadač (1965) and Hadač et al. (1969).

1. “*Adenostylo alliariae-Abietetum* Kuoch 1954”

Kuoch (1954) included this association into beech woodlands of the “*Fagion silvaticae*”. As Kuoch wrote, the association was a climax forest community occurring between elevation of (1 200) 1 400 – 1 750 m in lower subalpine belt (in the terms of German authors) of peripheral and transitional zone of the Alps. It is an equivalent of the subalpine *Aceri-Fagetum*. Relevés from Slovakia assigned to this community were published by Šomšák (1986) from the region of the Belianske Tatry Mts. and the Spišská Magura Mts. Those woodlands are not comparable with the Swiss ones, at least from the ecological point of view. Moreover, tree-species composition of forests stands of the Spišská Magura Mts. is considerably changed: absence of *Fagus sylvatica* is not a result of natural conditions (cf. Flachbart 2007, P. Kučera, 2006, not.). They are not identical with Kuoch’s (1954) phytocoenoses: the Slovak ones should be listed as: *Adenostylo alliariae-Abietetum* sensu Šomšák 1986 non Kuoch 1954. The neotype chosen for the *Adenostylo alliariae-Abietetum* Kuoch 1954 by Šomšák (1986: 77) have to be assigned only to Šomšák’s pseudonym, for a lectotype for Kuoch’s association is available to set from relevés of Kuoch (1954).

2. “*Arunco-Abietetum* Fajmonová 1984”

Habitat of these woodlands, published by Fajmonová (1984) from the valleys lying northwards of Mt. Veľký bok (the Nízke Tatry Mts.), does not fit into original content of *Abietion albae* of Hadač (1965) (i.e. continental climate character of “beechless” area). Moreover, *Fagus sylvatica* expands in forest stands of that region, at least in the valley of the Svarínka Brook and Čierny Váh River (P. Kučera, 2008, 2009, not.). The original stands of the association *Arunco-Abietetum* will not retain their presupposed beechless character in the future.

3. “*Calamagrostio variae-Abietetum* (Sillinger 1933) Fajmonová 1976 (*Piceetum excelsae normale calcicolum* Sillinger 1933)”

Supposed intention of Fajmonová (1976) was to create nomen novum to Sillinger’s name *Piceetum excelsae normale calcicolum*. However, it was done in the form of a phantom name (nomen fictum):

“*Calamagrostii variae-Abietetum* Sillinger 1933 (corr. auct.) emend. auct. = *Piceetum excelsae normale calcicolum*, *Piceetum excelsae myrtilletosum* p. p.”. More correct form was used by the authoress later (Fajmonová 1979: 67): “*Calamagrostio variae-Abietetum* (Sillinger 1933) nom. nov. = *Piceetum excelsae normale calcicolum*”. Actually, the association should be labelled *Calamagrostio variae-Abietetum* Fajmonová 1976. Including of this syntaxon into the beechless *Abietion albae* of Hadač (1965) was not appropriate as it is not the case of naturally beechless phytocoenoses (Fajmonová 1976: 480, 483). The stands of Fajmonová (1976) fit well beech-fir syntaxa; similarly those of Sillinger (1933).

4. “*Carici albae-Abietetum* Ellenberg et Klötzli 1972”

Slovak stands cannot be included into the association of Ellenberg et Klötzli (1972), which is according to authors an inner Alpien equivalent of *Carici albae-Fagetum* (Ellenberg, Klötzli 1972: 725). Šomšák (1986: 39) used the more appropriate name – *Carici albae-Abietetum* (Březina et Hadač in Hadač et al. 1969) Šomšák 1986 – as the referred plant community originated from the subassociation *Calamagrostio arundinaceae-Abietetum albae caricetosum albae* (Hadač et al. 1969: 296, 301). Remarks on *Calamagrostio arundinaceae-Abietetum albae* Březina et Hadač in Hadač et al. 1969 are given above.

5. “*Circaeo alpini-Abietetum* Šomšák 1982”

Nature of habitat of this unit (Šomšák 1982) differs from the published description of *Abietion albae* of Hadač (1965). As can be seen from original relevés (Šomšák 1982), *Fagus sylvatica* occurred naturally in documented phytocoenoses of *Circaeo alpini-Abietetum*. Recent state of those stands should be examined: stands assigned to this association from the region of Tatry later (cf. Šomšák 1986) are questionable to label as naturally beechless phytocoenoses.

6. “*Mercurialio-Abietetum* Hadač 1965”

A first reference of this name was given by Hadač (1969: 42): “*Mercuriali-Abietetum* Hč 1965; Branisko, E. Slovakia” with only one relevé presented. Later, Šomšák (1986) published other relevés ascribed to this association. Stands of *Mercurialio-Abietetum* Hadač 1969 should be revised, especially with focus on the current natural occurrence of *Fagus sylvatica*.

In the list of *Abietion albae* (Šomšák 1985: 218-219), the association name “*Calamagrostio arundinaceae-Abietetum* Horvat 1950 (*Calamagrostio arundinaceae-Abietetum* Březina et Hadač in Hadač et al. 1969)” was presented. The first used name is a phantom name (nomen fictum), as Horvat (1950) did not use such association name at all: *Calamagrostio arundinaceae-Abietetum* Horvat 1950, nom. fictum, apud Šomšák in Mucina et Maglocký 1985. It is supposed that not validly published name “*Abieto-Piceetum calamagrostidis* Horv. mnskr.” is a basionym for that nomen fictum [*Abieto-Piceetum calamagrostidis* Horvat 1950, nom. nud.; Art. 2b, (Art. 3b)], as the Horvat (1950: 56) used following subordinated subassociation names: “*Abieto-Calamagrostidetum piceetosum*” and “*Abieto-Calamagrostidetum tilietosum*”. Stands of the *Calamagrostio arundinaceae-Abietetum* of the Belianske Tatry Mts. (cf. Hadač et al. 1969) can not be identified with the Croatian ones for ecological and floral reasons (cf. Horvat 1950: 56).

Within the alliance *Abietion albae*, Školek (1995) described a new association *Carici albae-Piceetum* Školek 1995 from the Demänovská Dolina Valley (the Nízke Tatry Mts), a region treated as naturally beechless already by Sillinger (1933). Školek included in the association spruce stands on carbonate background with dominating *Carex alba* in herb layer. However, they are secondary forests primarily with the natural occurrence of *Fagus* (Kučera et al. 2009). Similar is the case of *Piceo-Abietetum albae* Szafer et al. 1923 from the Dolina Chochołowska Valley (the Západné Tatry Mts), what could be seen already from studies of Szafer et al. (1923: 21) and Szafer et al. (1927: 21-22). Classification of the calcicolous *Piceo-Abietetum* Szafer et al. 1923 into the suballiance *Vaccinio-Abietenion* Oberdorfer 1962 (cf. Šomšák 1985) was not correct because of floral and ecological differences.

Abietion albae* vs *Oxalido-Abietenion

A suballiance name *Oxalido-Abietenion* was occasionally used in Slovak literature for some *Abies alba* communities, e.g. by Šomšák (1986), Šomšák et al. (1993), Šomšák (1994), Dražil (2002). The name was published by Passarge (1978: 183) as the suballiance “*Oxalido-Abietion* Brez. et Hadač 62 em. nom. nov.” A basionym for that nomen novum was not included in the place of description, so it has to be “guessed”. The suballiance was placed in the following hierarchy (Passarge 1978: 183; association syntaxa are omitted in the following list):

“*Athyrio-Piceetalia* Hadač 62

Oxalido-Piceion (Kraj. 34) Brez. et Hadač 62 em. Passarge 71

Eu-Oxalido-Piceion (Kraj. 34) Brez. et Hadač 62

Oxalido-Abietion Brez. et Hadač 62 em. nom. nov.”

From the given combination with other syntaxa it could be supposed that:

1. into suballiance *Eu-Oxalido-Piceenion*, Passarge included original content of the alliances *Oxalido-Piceion* (Krajina 1933) Březina et Hadač in Hadač 1962, nom. inval. (ICPN, Art. 2b) and *Chrysanthemo rotundifolii-Piceion* (Krajina 1933) Březina et Hadač in Hadač 1962, nom. inval. (ICPN, Art. 2b),
2. suballiance *Oxalido-Abietenion* of Passarge (1978) originated from the alliance *Abietion albae* of Hadač (1962),
3. alliance *Oxalido-Piceion* sensu Passarge 1979 serves as superordinate syntaxon.

However, Passarge (1978) did not list the study of Hadač (1962) in literature sources. All of the names were not validly published for this reason. Moreover, the mentioned system proposed by Passarge (1978) is confusing and inappropriate.

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Abstrakt

Terénny výskum v oblasti rozšírenia spoločenstiev zväzu *Abietion albae* naznačil, že porasty pôvodne zaradené do tohto zväzu nie sú prirodzene bezbukové spoločenstvá. Zväz *Abietion albae* obsahuje náhradné lesné spoločenstvá pôvodne z radu *Fagetalia sylvaticae* a mal by byť hodnotený ako nadbytočná jednotka. V príspevku sú uvedené aj podrobnejšie nomenklatorické poznámky ku syntaxónom zaradovaným do zväzu *Abietion albae*.

Peter Kučera: Poznámky o zväze *Abietion albae* a jeho syntaxónoch

NEW RECORDS OF MACROMYCETES FOR DEVÍNSKA KOBÝLA MTS.

Ondrej Ďuriška*

Comenius University in Bratislava, Faculty of Natural Sciences, Department of Botany, Révová 39,
811 02 Bratislava, Slovakia

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Abstract

In the Fialková dolina Nature Reserve – one of the preserved territories of the Devínska Kobyla Mts. – 48 species of macromycetes were recorded in years 2007 – 2009. These species had been published neither from this Reserve nor from the whole of Devínska Kobyla massive. An annotated list of the species is presented in this paper.

Key words: fungi, Ascomycota, Basidiomycota, Fialková dolina Nature Reserve, Slovakia

Introduction

The evidence of mycological observations in the Devínska Kobyla Mts. resulted in 428 taxa (species and infraspecific taxa) of macromycetes (Ripková, Ďuriška 2009). Considering the small area of this massive (4900 ha; Feráková 1997), the fungal diversity is rather high, 17.8 % of the 2609 taxa of macromycetes reported from all Slovakia (Adamčík et al. 2003). However, there are still poorly or non-observed places in the Devínska Kobyla Mts. and Fialková dolina Nature Reserve is one of them; only four species were published from there: *Calocybe gambosa* (Fr.) Singer, *Exidia glandulosa* (Bull.) Fr., *Helvella acetabulum* (L.) Quél. and *Hirneola auricula-judae* (Bull.) Berk. (Záhorovská 1997). To fill in such “white-places” a mycological research started in the Fialková dolina Nature Reserve in year 2007 with the aim to find out diversity and ecological demands of macromycetes (Ascomycota and Basidiomycota). About one hundred taxa have been recorded up to this time and 48 of them had been published neither from this Reserve nor from the whole of Devínska Kobyla Mts. As the research has been still running, only these “new” species are presented in this paper. The final results, including detailed characteristics of the Reserve, will be published when the research is finished.

Material and Methods

All specimens are deposited in the herbarium SLO. The abbreviation of herbarium is cited in accordance with the Index Herbariorum (Holmgren et al. 1990). The nomenclature and taxonomic concepts are based on the works quoted for each species. Descriptive terminology follows Vellinga (1988).

Results

The Fialková dolina was designated as Nature Reserve in 1993 and has currently an area of 20.5879 ha (Anonymus 2005). The subjects of its protection are preserved oak-hornbeam forests and

* Corresponding Author: Ondrej Ďuriška; tajfun21@yahoo.com

rare plant species, especially orchids. The Reserve is situated in the Bratislava City – the municipal part of Devín. From south, it is bordered by Devínska cesta road and by limestone quarry. The western border is defined by cottage settlement, eastern by forests and northern by agricultural soil. The elevation ranges from ca 175 to 250 m a. s. l.

During the mycological research of the Fialková dolina Reserve in years 2007 – 2009, 48 species of macromycetes were recorded which had been published neither from this reserve nor from the Devínska Kobyla Mts.

In the following annotated list, each species is supplemented by this information: collection date, substrate, host or associated plants, number of specimens deposited in the herbarium SLO and notes. The notes are focused on possible confusion with similar taxa and ecological characteristics.

Ascomycota

***Ascocoryne cylichnium* (Tul.) Korf**

– 28 Oct 2009, fallen trunk of cf. *Tilia* sp., 1 specimen

– the species could be mistaken for *Ascocoryne sarcoides* (Jacq.) J. W. Groves et Wilson. Both species can be distinguished by the size and shape of spores: while spores of *A. cylichnium* are $22 - 23 \times 5 - 6 \mu\text{m}$, narrowly ellipsoid to fusiform, slightly curved, with 0, 3 or 5 septa when adult, spores of *A. sarcoides* are $10 - 15 \times 4 - 5 \mu\text{m}$, broadly fusiform to ellipsoid, slightly flattened from both sides, with obtuse to rounded ends, at first unseptate, later with 1 – 3 septa (Dissing 2000a).

***Hymenoscyphus fructigenus* (Bull.) Gray**

– 10 Sep 2007, pieces of wood of deciduous tree, 1 specimen

– it can be found on pieces of wood of *Alnus*, *Prunus* and *Quercus*, on fruits of *Carpinus betulus*, *Corylus avellana* and *Fagus sylvatica*. Spores are $12 - 20 \times 3 - 5 \mu\text{m}$, cylindrical, attenuated towards one end, with 0 – 1 septa (Vesterholt 2000).

***Chlorociboria aeruginascens* (Nyl.) Kanouse ex Ramamurthi**

– 24 Sep 2009, fallen trunk of deciduous tree, 1 specimen

– two similar species of the genus *Chlorociboria* are known from Slovakia: *Ch. aeruginosa* (Oeder) Seaver and *Ch. aeruginascens* (Lizoň, Bacigálová 1998). Both species can be distinguished by spore size: while *Ch. aeruginosa* has spores $9 - 14 \times 2 - 4 \mu\text{m}$, *Ch. aeruginascens* $5 - 7 \times 1 - 2 \mu\text{m}$. Because of their tendency to stain green the wood on which they grow, the presence of these fungi can be detected even when the fruitbodies are absent (Dissing 2000b; Evans, Kibby 2004).

***Peziza succosa* Berk.**

– 15 Jun 2007, soil, 1 specimen

– there are a number of similar-looking, brown coloured and soil colonising *Peziza* species that can only be distinguished microscopically. *P. succosa*, however, is easily identified also when bruised or cut, when flesh exudes yellow latex (Hagara et al. 2005).

***Rutstroemia bolaris* (Batsch) Rehm**

– 17 Mar 2009, fallen branch of deciduous tree, 1 specimen

– cup-like when young, the ascocarps of *Rutstroemia bolaris* becoming more flattened with age; they are olive-brown, brown to orange-brown and grow out of the stromatized twigs of deciduous trees, e.g. *Betula*, *Alnus* and *Carpinus*, usually buried in the soil. Spores are narrowly ellipsoid, $15 - 20 \times 5 - 6.5 \mu\text{m}$, with 0 – 3 septa (Schumacher 2000).

***Sarcoscypha jurana* (Boud.) Baral**

– 10 Mar 2007; 11, 12 and 19 Mar 2009, fallen branches and pieces of wood of deciduous trees, 11 specimens

– there are three species of the genus *Sarcoscypha* known in Slovakia: *S. austriaca* (Beck) Boud., *S. coccinea* (Jacq.) Sacc. and *S. jurana* (Lizoň, Bacigálová 1998). Following Baral (2004), I have observed the fresh material, because only fresh and adult to old ascocarps have well-developed taxonomically important characters, such as content of spores and hairs on the outer surface. *S. jurana* is characterized by spores, the poles of which have shape of a saddle and only one large oil drop; hairs are slightly curly (cf. Lizoň 1997; Kotlaba, Pouzar 2007). It seems the species prefers *Tilia* substrate (Kotlaba, Pouzar 2007).

***Scutellinia nigrohirtula* (Svrček) Le Gal**

– 7 Sep 2008, fallen trunk and fallen branch of deciduous trees, 2 specimens
 – the first step to identify *Scutellinia* taxa is to observe marginal and receptacular hairs under microscope, namely their length and base structure. Such hairs of *S. nigrohirtula* are almost identical, up to 420 µm long and with one, occasionally two basal roots (Schumacher 1990). Many other characters are delimiting for *Scutellinia* taxa, e.g. shape, size and ornamentation of spores.

Basidiomycota

***Amanita franchetii* (Boud.) Fayod**

– 10 Oct 2007, soil under *Fagus sylvatica*, 1 specimen
 – following the taxonomical concept of Persson (1992), *Amanita franchetii* is most similar to *A. rubescens* Pers. and namely to its variety *A. rubescens* var. *annulosulphurea* Gillet. To distinguish these taxa, colour of flesh is necessary to observe: while flesh of *A. rubescens* and its variety stains brownish red when cut or bruised, flesh of *A. franchetii* does not change. Hagara et al. (2005) consider the species rare, fructifying mainly with broadleaf trees (*Fagus*, *Quercus*), less with conifers.

Armillaria cf. gallica

– 5 Oct 2007, 4 Oct 2008 and 25 Oct 2009, pieces of wood of *Tilia* sp. and other deciduous trees, 4 specimens
 – because of high macro- and micromorphological similarity of *Armillaria gallica* and *A. cepistipes* Velen., compatibility tests of haploid mycelia (Jankovský, Scháňel 1997) or molecular analyses (Antonín et al. 2009) are required to be sure of species identification.

Ecological data seem to be also useful to distinguish these species: while *A. gallica* is a typical member of lowlands, especially of floodplain forests, *A. cepistipes* is a submontane to montane species. In the middle elevation (approx. 500 m a. s. l.), however, there occur both species (Antonín, Tomšovský 2009; Jankovský 2003).

Recently, Antonín, Tomšovský (2009) published the key to *Armillaria* species in which both species are distinguished also macroscopically, especially based on pileus and stipe cover. However, I have not observed these characters sufficiently and that is why I present the species only as *A. cf. gallica*.

***Coprinellus domesticus* (Bolton) Vilgalys, Hopple et Jacq. Johnson**

– 12 Apr 2007, 15 Jun 2007 and 13 Sep 2007, soil, fallen branch and pieces of wood of deciduous trees, 3 specimens
 – in common with two other species of the genus *Coprinellus*, *C. radians* (Desm.) Vilgalys, Hopple et Jacq. Johnson and *C. xanthotrix* (Romagn.) Vilgalys, Hopple et Jacq. Johnson, it has veil breaking up in small flocks when adult and rust coloured ozonium around the base of stipe. These species can be easily distinguished by size of spores: spores of *C. radians* are 8,5 – 11,5 × 5,5 – 6,5 µm (length overlaps 10 µm), two other species have spores shorter, but with different width: spores of *C. xanthotrix* are 7 – 10 × 4,5 – 6 µm, of *C. domesticus* 6 – 9 × 3,5 – 5 µm (Ripková, Červenka 2005; Vesterholt 2008a).

***Coprinellus impatiens* (Fr.) J. E. Lange**

- 10 Oct 2007 and 10 Oct 2008, soil, pieces of wood and fallen branch of deciduous trees, 4 specimens
- one of the *Coprinus* s. l. species whose lamellae do not liquefy into an ink of spores, but get dry with age (Hagara et al. 2005).

***Coprinellus xanthothrix* (Romagn.) Vilgalys, Hopple et Jacq. Johnson**

- 3 Sep 2009, pieces of wood of deciduous tree, 1 specimen
- for more information see notes on *Coprinellus domesticus*.

***Coprinopsis insignis* (Peck) Redhead, Vilgalys et Moncalvo**

- 10 Sep 2007, soil under *Acer* sp., 1 specimen
- confusion would be possible with *Coprinopsis atramentaria* (Bull.) Redhead, Vilgalys et Moncalvo, veil of which is brown and spores smooth; *C. insignis* has whitish veil and verrucose spores (Vesterholt 2008b).

***Crepidotus casparyi* Velen.**

- 15 Jun 2007, fallen branch of deciduous tree, 1 specimen
- the fungus is more known under the name of *Crepidotus lundellii* (e.g. Senn-Irlet 1995a). However, the study of types has proved the identity of both species. Being the older name, *C. casparyi* has priority (Pouzar 2005).

***Crepidotus crocophyllus* (Berk.) Sacc.**

- 15 Jun 2007, fallen trunk of *Tilia* sp., 1 specimen
- macroscopically, *Crepidotus crocophyllus* is distinctive in having orange tinged lamellae when young and brown squamulose cap; microscopically, the combination of globose spores and a cutis of repent, hyaline hyphae mixed with bundles of ascending, finely incrusted coloured hyphae is characteristic (Ripková et al. 2005).

The species is included in the Red list of fungi of Slovakia in the category VU – vulnerable (Lizoň 2001) and it is also protected by Regulation of the Ministry of Environment of the Slovak Republic No. 93/1999 Coll. on protected plants and animals and on the assessment of the value of protected plants, trees and shrubs and protected animals.

Based on the herbarium material from BRA and SLO, *C. crocophyllus* was hitherto known from the Záhorská nížina Lowland, Podunajská nížina Lowland, Strážovské and Súľovské vrchy Mts., Vihorlatské vrchy Mts. and Bukovské vrchy Mts. (Ripková 2002, Ripková et al. 2005, Kautmanová 2008).

***Crepidotus epibryus* (Fr.) Quél.**

- 10 Oct 2008, herbaceous stem and fallen branches of deciduous trees, 3 specimens
- often overlooked in the field, 2 – 20 mm large basidiocarps of *Crepidotus epibryus* fructify on herbaceous stems, mainly of grasses, on fallen branches and leaves of deciduous trees and on thalli of mosses (Senn-Irlet 1995a). To identify taxa of the genus *Crepidotus*, microscopic observations are necessary. Within this genus, *C. epibryus* is characteristic in having smooth, $6.5 - 9.5 \times 2.5 - 3.5 \mu\text{m}$ spores that are cylindrical in frontal view and lanceolate in side view and often in dyads and tetrads in preparation (cf. Senn-Irlet 1995a).

In the Fialková dolina Nature Reserve, I have collected *C. epibryus* on herbaceous stems and on fallen branches of deciduous trees (not identified more accurately). In the other parts of Slovakia, e.g. in the Muránska planina Mts. and the adjacent area of the Slovenské Rudohorie Mts., this species was collected on fallen leaves of *Fagus sylvatica*, *Acer platanoides* and *Scirpus sylvaticus*, on fallen branches of *Carpinus betulus*, *Alnus glutinosa* and *Fagus sylvatica*, on stems of *Clematis vitalba*, on trunks of *Salix cinerea* and on cones of *Pinus nigra* (Ripková, Blanár 2004); in the Vihorlatské vrchy Mts. on fallen leaves of *Betula pendula*, *Fagus sylvatica*, *Molinia* sp. and *Salix caprea* and on stems of *Rubus* sp. and *Deschampsia* sp. (Ripková et al. 2007).

***Datronia mollis* (Sommerf.) Donk**

- 16 Mar 2007, fallen branch of *Fagus sylvaticus*, 1 specimen
- this fungus is distinctive in having resupinate to semipileate basidiocarps, brown to black upper surface, which is finely tomentose when young, later glabrous; gray-brown hymenophore is labyrinthine-porose to daedaleoid, with pores 0.5 – 1 mm wide and up to 5 mm long; a black line is distinctly visible between the context and the tomentum. It grows especially on *Fagus*, *Salix* and *Alnus* (Breitenbach, Kränzlin 1986).

***Echinoderma perplexa* (Knudsen) Bon**

- 10 Oct 2008, soil, 1 specimen
- the fungus is more known under the name *Lepiota perplexa* Knudsen. Lange (2008a), whose key I have used to identify this species, included it into the genus *Echinoderma* (Bon) Bon.

***Ganoderma lipsiense* (Batsch) G. F. Atk.**

- 13 May 2007, 15 Jun 2007 and 2 Oct 2008, fallen trunks of *Carpinus betulus* and other deciduous trees, 3 specimens
- confusion would be possible with *Ganoderma australe* (Fr.) Pat. Basidiocarps of both species are perennial, laterally attached, the upper surface is dull, dark brown and with a thick, hard crust. They can be distinguished by characters of context and size of spores: context of *G. lipsiense* is brown, often mottled with white spots and streaks and spores are shorter than 8.5 µm; context of *G. australe* is dark reddish brown and homogenous and spores are longer than (Ryvarden, Gilbertson 1993).

It is mentioned that cone-shaped insect galls caused by larvae of *Agathomyia wankowiczi* can be found on poroid underside (Breitenbach, Kränzlin 1986); however, I have not observed such structure on my own collections of *G. lipsiense*.

In the Fialková dolina Nature Reserve, the species fructified on fallen trunks of *Carpinus betulus* and other deciduous trees (not identified more accurately); in the literature, there are more hosts presented: *Abies alba*, *Acer pseudoplatanus*, *Alnus glutinosa*, *Carpinus betulus*, *Cerasus avium*, *Fagus sylvatica*, *Fraxinus excelsior*, *Quercus* sp. div., *Picea abies* and others (Kotlaba 1984).

***Gymnopus brassicolens* (Romagn.) Antonín et al.**

- 5 Oct 2007, 2 and 10 Oct 2008, fallen leaves of deciduous trees, 3 specimens
- there is a strong unpleasant smell of rotten cabbage from the gills and flesh of *Gymnopus brassicolens*. Macroscopically similar, *Marasmiellus foetidus* (Sowerby) Antonín, Halling et Noordel smells also like rotten cabbage and both species can be distinguished microscopically, especially by spore size: while *G. brassicolens* has spores 5 – 7 × 3 – 3.5 µm, *M. foetidus* 8 – 10 × 3.5 – 4.5 µm (cf. Knudsen 1992b).

***Hohenbuehelia petalodes* (Bull.) Schulzer**

- 15 Jun 2007, 10 Sep 2007 and 24 Jun 2008, pieces of wood of cf. *Acer* sp. and other deciduous trees, 4 specimens
- macroscopically, it seems to be a variable species. In the literature, e.g. Elborne (2008), there is presented that characteristic for *Hohenbuehelia petalodes* is growth on soil, wood chips or sawdust, half funnel-shaped to fan-shaped cup and the cup size up to 8.5 cm. However, the basidiocarps of *H. petalodes* from the Fialková dolina Nature Reserve were hardly 4 cm large, the cups were fan-shaped or spoon-shaped and grew on pieces of wood.

***Inonotus cuticularis* (Bull.) P. Karst.**

- 24 Sep 2009, fallen trunk of *Fagus sylvaticus*, 1 specimen
- the species is easily recognised microscopically by the anchorshaped setae in the pileal tomentum (Breitenbach, Kränzlin 1986).

***Lactarius azonites* (Bull.) Fr.**

- 5 Oct 2007, soil under *Quercus* sp., 1 specimen
- the species of the sect. *Plinthogali* with milk white, turning pinkish in contact with the flesh. It is usually found on calcareous soil in park and forests with oak trees (Heilman-Clausen et al. 2000).

***Lactarius glaucescens* Crossl.**

- 24 Jun 2008, soil under *Quercus*, 1 specimen
- from similar *Lactarius piperatus* (L.) Pers., this species can be distinguished by the greenish colour change of milk and flesh and the colour reaction of the milk with KOH; while milk of *L. piperatus* is not reacting, milk of *L. glaucescens* is yellow to orange with KOH. Microscopically, a distinctive difference is in the thickness of suprapellis; while suprapellis in *L. piperatus* is up to 4 µm thick, in *L. glaucescens* 80 – 120 µm thick (Heilman-Clausen et al. 2000).

***Lepiota boudieri* Bres.**

- 19 Sep 2007, soil, 1 specimen
- one of the *Lepiota* species with characteristic projectile-shaped spores (cf. Lange 2008b).

***Macrolepiota mastoidea* (Fr.) Singer**

- 13 Nov 2009, soil under *Fagus sylvaticus*, 1 specimen
- both species without speckled bands on stems, *M. mastoidea* and similar *M. excoriata* (Schaeff.) can be distinguished also by habitats: while *M. mastoidea* grows near frondose trees in clearings, margins of forests and parks, *M. excoriata* prefers open land, especially dry meadows, pastures and dunes (Knudsen 1992a, Lange 2008c).

***Marasmius curreyi* Berk. et Broome**

- 2 Oct 2008 and 10 Oct 2008, fallen leaves of deciduous trees, 2 specimens
- fructifying on fallen leaves of deciduous trees, small fruitbodies of this species (up to 8 mm) were hard to spot in the field. Antonín (1996) reported this species from rest of plant leaves of families *Cyperaceae*, *Juncaceae* and *Poaceae*. An overview of phytogeographical units of Slovakia, the *Marasmius curreyi* has been published from, is included in the work by Ripková et al. (2007): Podunajská nížina Lowland, Biele Karpaty Mts., Malé Karpaty Mts., Štiavnické vrchy Mts., Veľká Fatra Mts. and Vihorlatské vrchy Mts.

***Mycena speirea* (Fr.) Gillet**

- 24 May 2008 and 20 May 2009, fallen trunk and fallen leaves of deciduous trees, 2 specimens
- basidiocarps of *Mycena speirea* are easy to overlook in the field because they are very small and coloured like their woody substrate (Emmett et al. 2008). In the Fialková dolina Nature Reserve, they were up to 1 mm large and with brown and grey tings on cap and stem.

***Ossicaulis lignatilis* (Pers.) Redhead et Ginns**

- 24 Sep 2009, fallen trunk of *Fagus sylvaticus*, 1 specimen
- the species is included in the Red list of fungi of Slovakia in the category LR:nt – Lower Risk:Near Threatened (Lizoň 2001). However, other authors, e.g. Hagara et al. (2005), consider *Ossicaulis lignatilis* a common fungus fructifying on wood of deciduous trees such as *Quercus*, *Fagus*, *Ulmus*, *Populus* and *Aesculus*.

***Oudemansiella mucida* (Schrad.) Höhn.**

- 25 Oct 2009, 13 Nov 2009, fallen trunks of *Fagus sylvaticus* and deciduous tree, 2 specimens
- the striking and photogenic, *Oudemansiella mucida* has a pure white to pale gray, slimy cap resembling glistening porcelain, which is signified by its English name – Porcelain Fungus. A very tough stem has a narrow clear ring (Evans, Kibby 2004). Some authors, e.g. Hagara et al. (2005)

present that *O. mucida* is an uncommon fungus growing on stumps and fallen trunks of *Fagus sylvatica*, but also *Quercus* sp. div. and *Carpinus betulus*. I think, the species has either been overlooked or omitted from the Devínska Kobyla Mts.

***Phellinus contiguus* (Pers.) Pat.**

- 28 Jun 2007, fallen trunk of *Quercus* sp., 1 specimen
- *Phellinus contiguus* is widespread in warmer parts of Europe and have a distribution similar to that of *Quercus*, although it does not grow as far north as this tree (Ryvarden, Gilbertson 1994). Besides *Quercus* trees, the species grows also on *Robinia pseudoacacia*, *Berberis vulgaris*, *Catalpa bignonioides*, *Cornus mas*, *Picea abies* and others (Kotlaba 1984).

***Phellinus pini* (Thore) A. Ames**

- 10 Apr 2008, standing trunk of *Pinus sylvestris*, 1 specimen
- a common parasites of pine trees (*Pinus*) (Papoušek 2004).

***Pholiota tuberculosa* (Schaeff.) P. Kumm**

- 20 May 2009 and 5 Jun 2009, fallen trunks of deciduous trees, 2 specimens
- not common in Slovakia, *Pholiota tuberculosa* produces fruitbodies on decaying fallen trunks and branches of deciduous trees, especially *Fagus sylvatica* and *Tilia* sp. div. (Hagara et al. 2005).

***Piptoporus quercinus* (Schrad.) Pilát**

- 28 June 2007, fallen trunks of *Quercus* sp., 2 specimens
- the fungus is also known under the name *Buglossoporus pulvinus* (Pers.) Donk. There are two saproparasitic species of the genus *Piptoporus* recorded in Slovakia: *P. betulinus* (Bull.) P. Karst. that is a common one producing basidiocarps on birch trees (*Betula*) and *P. quercinus* that is a red-listed species included in the category EN – endangered (Lizoň 2001) and restricted on oak trees (*Quercus*) (Lizoň, Bacigálová 1998; Kotlaba 1984).

***Pluteus dietrichii* Bres.**

- 7 Sep 2008, soil, 1 specimen
- pileipellis cracking into granules and showing underlying white context is characteristic for *Pluteus dietrichii* (Vellinga 1990). However, microscopic observations are needed to be sure of identification.

***Pluteus phlebophorus* (Ditmar) P. Kumm.**

- 15 Jun 2009, fallen trunk of deciduous tree, 1 specimen
- confusion would be possible with *Pluteus nanus* (Pers.) P. Kumm. The most important characters for species differentiation are those of pileipellis: while *P. phlebophorus* has pileipellis distinctly venose from centre to margin and microscopically made up of elements with rounded apex, *P. nanus* has pileipellis glabrous or only in centre venose and microscopically built up of elements with a rather obtuse apex (Vellinga 1990).

***Pluteus plautus* (Weinm.) Gillet**

- 15 Sep 2007 and 10 Oct 2008, fallen trunk, fallen branch and pieces of wood of *Acer* sp. and other deciduous trees, 2 specimens
- I followed the wider taxonomic concept by Vellinga (1990) who merged several names into the synonymy of *Pluteus plautus*, e.g. *P. gracilis*, *P. granulatus* and *P. semibulbosus*. Other authors, e.g. Citérin, Eyssartier (1998), consider these names distinct species.

***Pluteus romellii* (Britzelm.) Sacc.**

- 15 Jun 2007, 7 Sep 2008 and 10 Oct 2008, fallen branch and pieces of wood of deciduous trees, 3 specimens

– with its combination of brown cap and yellow stipe, it is easy to identify this species also in the field (cf. Vellinga 1990).

Pluteus umbrosus (Pers.) P. Kumm.

- 19 Sep 2007, pieces of wood of deciduous tree, 1 specimen
- an easily recognizable *Pluteus* species in the field, *P. umbrosus* has dense brown scales on its paler cap, often forming a distinct net; lamellae with brown edge are also characteristic (cf. Vellinga 1990).

Polyporus alveolarius (DC.) Bondartsev et Singer

- 24 Jun 2008, fallen trunk of deciduous tree, 1 specimen
- this species is distinctive in having 2 – 5 mm long pores and lateral stipe. It fructifies on *Acer* sp. div., *Carpinus betulus*, *Fraxinus* sp. div., *Padus avium*, *Tilia cordata* and other deciduous trees (Kotlaba 1984).

Russula pectinatoides Peck

- 15 Jun 2007, soil, 1 specimen
- it grows under deciduous trees, e.g. *Carpinus betulus*, *Fagus sylvatica* and *Quercus* sp. (Ripková et al. 2007). For taxonomical notes on this species see Adamčík et al. (2006).

Simocybe rubi (Berk.) Singer

- 15 Jun 2007, fallen trunk of deciduous tree, 1 specimen
- with its reduced lateral stipe, *Simocybe rubi* is frequently mistaken for *Crepidotus* taxa (“crepidotoid habitus”) (Ripková 2003). To identify this species, the observations of pileipellis, cystidia and spores are necessary (Senn-Irlet 1995b).

Simocybe sumptuosa (P. D. Orton) Singer

- 4 Jun 2007, fallen branch of deciduous tree, 1 specimen
- macroscopically, *Simocybe sumptuosa* looks like some taxa of the genus *Collybia*, i.e. *Gymnopus* (“collybioid habitus”). Like the species above, a microscope is needed to be sure of species identification (Senn-Irlet 1995b).

Trametes trogii Berk.

- 24 Sep 2009, fallen trunk of cf. *Fagus sylvaticus*, 1 specimen
- confusion would be possible with *Coriolopsis gallica* (Fr.) Ryvarden, trama of which becoming black with KOH; trama of *T. trogii* is without KOH reaction (cf. Breitenbach, Kränzlin 1986). Kotlaba (1984) reported most collections of *T. trogii* from *Populus*, less from *Betula pendula*, *Quercus pubescens*, *Quercus* sp., *Salix alba* and *Salix* sp. Breitenbach, Kränzlin (1986) listed as host tree also *Fagus sylvatica*.

Trichaptum biforme (Fr.) Ryvarden

- 4 Jun 2007 and 24 Sep 2009, fallen branches of *Fagus sylvaticus* and *Quercus* sp., 2 specimens
- one of three species of the genus *Trichaptum* reported from Slovakia (Lizoň, Bacigálová 1998). While *T. biforme* fructifies on deciduous trees, e.g. *Fagus sylvatica*, *Quercus* and *Betula*, two other species, *T. abietinum* (J. Dicks.) Ryvarden and *T. fusco-violaceum* (Ehrenb.) Ryvarden prefer conifers (Hagara et al. 2005).

Tubaria furfuracea (Pers.) Gillet

- 13 May 2007, 13 Sep 2007 and 19 Mar 2009, fallen branches and pieces of wood of cf. *Acer* sp., cf. *Tilia* sp. and other deciduous trees, 4 specimens
- some authors, e.g. Hagara et al. (2005), mention that *Tubaria furfuracea* grows only on soil. In the Fialková dolina Nature Reserve, however, I have collected the species on fallen branches and pieces of wood. According to Jacobsson (1992), woody substrates are also common for this fungus.

Xerocomus communis

- 15 Jun 2007 and 19 Sep 2007, soil under *Carpinus betulus*, 1 specimen
- a very variable species. Both, macro- and microcharacters have to be observed to be sure of identification. Characters of my collection fitted well those described by Knudsen, Taylor (2008): cap was grey brown to brown, at margin brown red and slightly cracking; tubes yellow and slowly turning blue with pressure; stem yellowish; terminal hyphae in pileipellis incrustated; spores subfusiform, $12.2 - 13.5 \times 4.8 - 5.7 \mu\text{m}$.

Xerocomus porosporus (Imler ex G. Moreno et Bon) Contu

- 19 Sep 2007, soil under *Acer* sp. and *Fagus sylvaticus*, 2 specimens
- comparing with similar *Xerocomus* species, *X. porosporus* has a significant proportion of the truncate spores (cf. Knudsen, Taylor 2008).

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Abstrakt

V Prírodnej rezervácii Fialková dolina – jednom z chránených území Devínskej Kobyly – bolo v rokoch 2007 – 2009 zistených 48 druhov makromycétov. Tieto druhy dosiaľ neboli publikované ani z tejto rezervácie, ani z celého masívu Devínskej Kobyly. V práci je uvedený komentovaný zoznam týchto druhov.

Ondrej Ďuriška: Nové nálezy makromycétov pre Devínsku Kobylu

BRYOPHYTE DIVERSITY OF SELECTED SITES OF COMMUNITY IMPORTANCE IN THE BORSKÁ NÍŽINA LOWLAND

Katarína Mišíková^{1*}, Anna Kubinská²

¹Comenius University in Bratislava, Faculty of Natural Sciences, Department of Botany, Révová 39,
811 02 Bratislava, Slovakia

²Botanical Institute of Slovak Academy of Science, Department of Non-vascular plants, Dúbravská cesta 9,
845 23 Bratislava, Slovakia

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Abstract

Bryofloristical research on the Borská nížina Lowland is in an early phase and only selected localities and sites were partially studied. Our contribution shows the results of a basic bryological study from 6 Sites of Community Importance (SCI): Jasenácke, Bahno, Kotlina, Vanišovec, Orlovské vršky and Mešterova lúka. Over all studied sites, a total of 76 bryophyte species were recorded. From the red-listed species, *Riccia fluitans*, *R. rhenana*, *Buxbaumia aphylla*, *Plagiothecium ruthei*, *Sphagnum fimbriatum* and *S. riparium* were found. Species composition of habitats and in particular ecological groups corresponds with the character of particular localities, where predominantly pine and oak forests, alder woods and wetlands occur.

Key words: Slovakia, Sites of Community Importance, bryophytes, ecology

Introduction

Recently, the floristical and chorological data on bryophytes of several areas of Slovakia are missing. This concern mainly the diversity of unattractive sites such as lowlands, downs or human impacted sites. Present state of the bryophyte-diversity knowledge of the Borská nížina Lowland is insufficient, only following recent publications deals with bryophytes from this area: Staníková (1998), Janovicová 2003, Holotová, Šoltés (1997), Šoltés (1997, 2000), Janovicová, Kubinská (2002), Mišíková, Kubinská (2009). Older bryological papers from this area are summarized by Janovicová, Kubinská l. c.

Phytocoenological data are available from localities Orlovské vršky (Hegedúšová, Škodová 2006a), Bahno, Vanišovec (Škodová, Hegedúšová 2006), Mešterova lúka (Hegedúšová, Škodová 2006b), Jasenácke (Viceníková et al. 1999; Malovcová-Staníková 2000). Guttová, Pišút (2007) presented the results of lichen-diversity study of seven Sites of Community Importance (SCI): Vanišovec, Kotlina, Mešterova lúka, Bahno, Zelenka, Orlovské vršky and Jasenácke. Recent mycological data from the Borská nížina Lowland deals with chorology and distribution of some rare and insufficiently known taxa (Adamčík, Ripková 2003; Ripková et al. 2005a; Ripková et al. 2005b; Adamčík et al. 2007), or represents the state of local diversity (Záhorovská, Jančovičová 1997; Adamčík et al. 2003).

In this contribution, preliminary checklist of bryophyte taxa of six SCI localities from the Borská nížina Lowland – Jasenácke, Bahno, Kotlina, Vanišovec, Orlovské vršky, Mešterova lúka is presented and supplemented with the recent literature data. Wetlands, alder swamp woods, acidophilous oak and pine forests are typical for these sites.

* Corresponding Author: Katarína Mišíková; katarina.misikova@fns.uniba.sk

Material and methods

Field research was carried out during years 2005 – 2009. Our own herbarium specimens are deposited in the SLO herbarium (Herbarium of the Department of Botany, Faculty of Natural Sciences, Comenius University); 2 specimens were recorded by other botanists and are deposited in TNP (Herbarium of the Museum of Tatra National Park). The nomenclature of liverworts follows the study by Söderström et al. (2002); nomenclature of bryophytes is based on the work by Hill et al. (2006), except for *Brachythecium velutinum* (Hedw.) Schimp., *Eurhynchium schleicheri* (R. Hedw.) Milde and *Plagiothecium ruthei* Limpr. Threats categories follows Kubinská et al. (2001), habitats nomenclature Stanová, Valachovič (2002). The presence of individual habitats on localities was reviewed with reference to Hegedúšová, Škodová (2006a, 2006b) and Škodová, Hegedúšová l. c. Identification codes and the area of sites are based on the <http://www.sopsr.sk/natura/index1.php?p=4&lang=sk&sec=2> (version 24. 6. 2010).

Sites of research (Fig. 1)

Detail characteristic of studied sites is given by Hegedúšová, Škodová (2006a 2006b), Škodová, Hegedúšová (l. c.), Viceníková et al. (l. c.) and Malovcová – Staníková (l.c.).

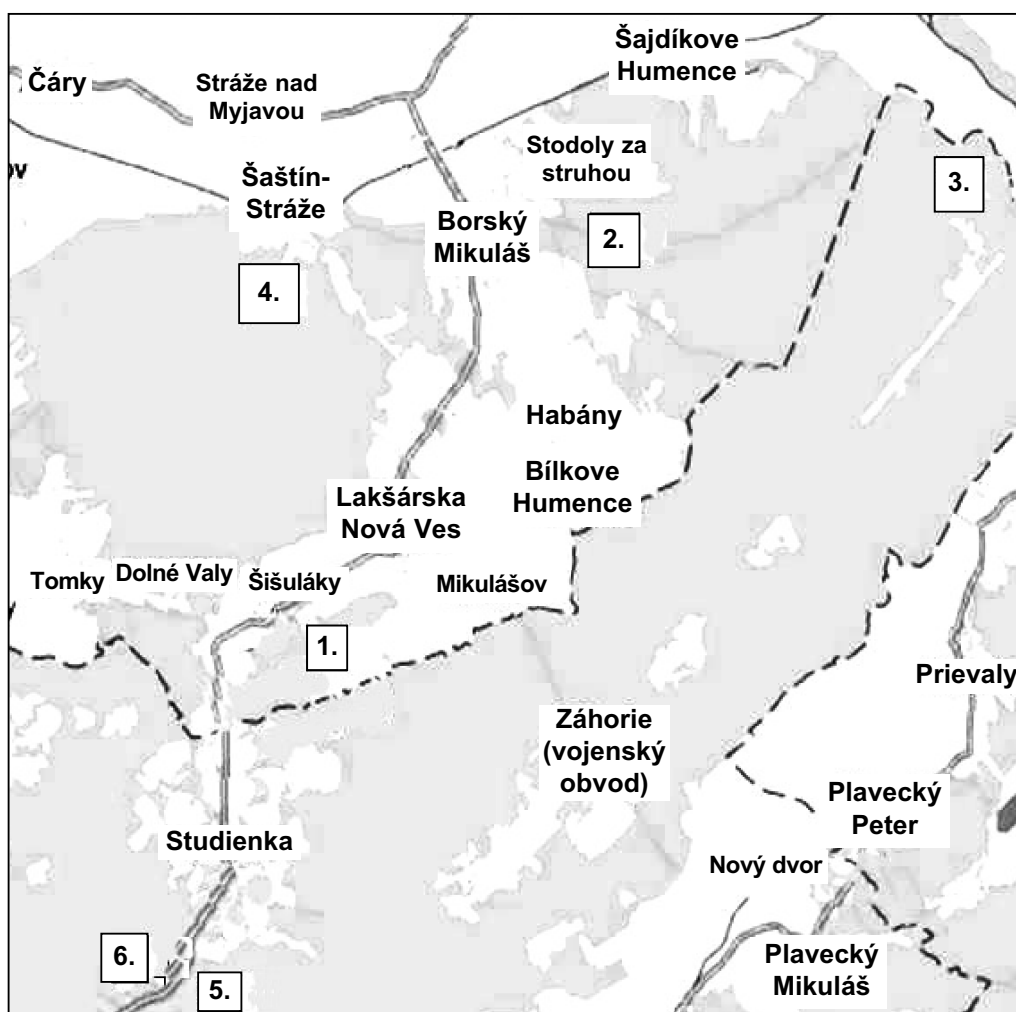


Fig. 1. * Selected Sites of Community Importance (SCI) in the Borská nížina Lowland
*for explanation of numbers see Sites of research above

1. Jasenácke (code: SKUEV 0120), Lakšárska Nová Ves village, ca 210 – 220 m a. s. l., area: 52 ha;
2. Bahno (code: SKUEV 0115), Borský Mikuláš village, ca 220 m a. s. l., area: 153, 67 ha;
3. Kotlina (code: SKUEV 0173), Hlboké village, ca 220 m a. s. l., area: 491, 51 ha;
4. Vanišovec (code: SKUEV 0226), Šaštín village, ca 180 – 220 m a. s. l., area: 668, 42 ha;
5. Orlovské vršky (code: SKUEV 0169), Malacky city, ca 190 m a. s. l., area: 191, 4 ha;
6. Mešterova lúka (code: SKUEV 0170), Malacky city, ca 190 m a. s. l., area: 125, 55 ha.

Results

In total, 76 bryophyte species were recorded, out of them 12 liverwort and 64 moss taxa. Localities differed in number of species – from 23 species (Orlovské vršky) to 49 species (Kotlina) (Tab. 1). From the red-listed species (Kubinská et al. 2001), 6 species were found: *Riccia fluitans* (LR: nt; 1 – N 48°33'16" E 17°09'3"; 6 – N 48°28'44" E 17°03'37"), *R. rhenana* (EN; 1 – N 48°33'16" E 17°09'12"), *Buxbaumia aphylla* (LR:nt; 1 – N 48°33'13" E 17°09'4"), *Plagiothecium ruthei* (VU; 2 – N 48°37'35" E 17°16'28"; 3 – N 48°38'44" E 17°21'15"; 4 – N 48°36'47" E 17°08'52"), *Sphagnum fimbriatum* (VU; data from the literature in the Tab. 2) and *S. riparium* (VU; 2 – N 48°37'31" E 17°16'23") (Tab. 1, Tab. 2). Twelve species occurred on all the 6 studied sites and 5 species on 5 sites (22.4 % from the total number of species). This most frequent group include predominantly forest species, which grow on bare ground or decaying tree trunks, further epigeic mosses growing on dry sandy places; only 2 species (*Amblystegium riparium*, *Sphagnum squarrosum*) are typical for marshes and alder stands. In total 24 species were reported only from 1 locality (31.6 %).

In relation to the habitats, the most numerous is the bryophyte flora of forests. In alder swamp woods (Ls7.4) 44 species were found, in subcontinental Scots pine forests (Ls6.1) 31 species and in acidophilous oak forests (Ls3.6) 21 species (Fig. 2, Tab. 2). Least bryophytes (4) were found in aquatic habitats (Vo2, Vo3) and on herbaceous clearings (X1 – 4 species).

In relation to ecological groups the highest number of species was collected on the shaded, damp or well-drained soil, decaying wood and bases of living trees (Fig. 3, Tab. 2). On the other hand, epilithic bryophytes occur really rarely and only on anthropogenic substrates (concrete walls). On the open water surface, the diversity of bryophytes is naturally low, represented only by the liverwort genus *Riccia*.

Species composition of habitats and in selected ecological groups corresponds with the character of individual sites, where predominantly wetlands, pine forests and alder stand occurs.

Tab. 1. Number of bryophyte species in selected Sites of Community Importance (SCI) in the Borská nížina Lowland with the number of red-listed taxa

Jasenácke	Bahno	Kotlina	Vanišovec	Orlovské vršky	Mešterova lúka
31	41	49	48	23	25
RL*					
4	2	1	1	0	2

*RL – Red List (Kubinská et al. l. c.)

Tab. 2. List of species recorded in selected Sites of Community Importance (SCI) in the Borská nížina Lowland

species	locality*	habitat**	ecol. group***	RL****
<i>Amblystegium riparium</i>	1, 2, 3, 4, 5, 6	Ls7.4 Lk11 Ra3 Ls3.6	B1 B2	
<i>Amblystegium serpens</i>	1, 3	Ls7.4 Ls6.1	B2 C1 D	
<i>Atrichum undulatum</i>	1, 2, 3	Ls6.1 Ls7.4 Ls3.6	B2	
<i>Aulacomnium androgynum</i>	2, 3, 4, 5, 6 (Stano 1995)	Ls7.4 Ls3.6	C1 D	
<i>Aulacomnium palustre</i>	2, 3	Ls7.4 Lk11 Ra3 Ra7	B1 B3	
<i>Brachythecium albicans</i>	4	Ls6.1 X1	B4	

species	locality*	habitat**	ecol. group***	RL****
<i>Brachythecium rutabulum</i>	1, 2, 3, 4, 5, 6	Ls6.1 Ls7.4 Ls3.6	B1 B2 D	
<i>Brachythecium velutinum</i>	1, 3	Ls7.4	B2	
<i>Bryum argenteum</i>	3	Ls6.1	B4	
<i>Bryum moravicum</i>	3	Ls6.1	C1	
<i>Bryum pseudotriquetrum</i>	3, 4	Ls7.4	B1 B3	
<i>Buxbaumia aphylla</i>	1	Ls6.1	B2	LR:nt
<i>Calliergon cordifolium</i>	2, 4	Ls7.4 Lk11	B3	
<i>Calliergonella cuspidata</i>	2, 4, 6	Ls7.4 Lk11 Ra3 Ra7	B1 B3	
<i>Calypogeia azurea</i>	2, 3, 4	Ls7.4 Ra3	B1 B2	
<i>Campylopus introflexus</i>	6 (Hol 1995)	-	-	
<i>Ceratodon purpureus</i>	1, 2, 3, 4, 5, 6	Ls6.1 X1	B4	
<i>Climacium dendroides</i>	1, 2	Ls7.4	B1	
<i>Dicranella heteromalla</i>	1, 2, 3, 4, 5	Ls7.4 Ls6.1 Ls3.6	B2	
<i>Dicranum montanum</i>	1, 2, 3, 4, 5, 6	Ls7.4 Ls6.1 Ls3.6 Lk11 Ra7	C1 D	
<i>Dicranum polysetum</i>	1, 2, 3, 4, 5, 6	Ls6.1 Ls7.4 Ls3.6	B2	
<i>Dicranum scoparium</i>	1, 2, 3, 4, 5, 6, HŠ 2006b	Ls6.1 Ls7.4 Ls3.6	B1 C1 D	
<i>Drepanocladus aduncus</i>	1, 2, 3, 5	Ls7.4 Lk11 Vo2 Ra3	B3	
<i>Eurhynchium angustirete</i>	4	Ls7.4 Ra7 Ra3	B1 B2	
<i>Eurhynchium schleicheri</i>	4	Ra3	B1 B2	
<i>Frullania dilatata</i>	1, 3, 4, 5, 6	Ls6.1 Ls3.6	C2	
<i>Herzogiella seligeri</i>	2, 3, 4, 5	Ls7.4	D	
<i>Hylocomium splendens</i>	3, 4, 5, 6, HŠ 2006a, 2006b; ŠH 2006	Ls6.1 Ls3.6	B1 B2	
<i>Hypnum cupressiforme</i>	1, 2, 3, 4, 5, 6	Ls7.4 Ls6.1 Ls3.6 Lk11 X1	B2 B4 C1 C2 D	
<i>Chiloscyphus pallescens</i>	4	Ls7.4	B1	
<i>Lepidozia reptans</i>	2, 3, 4	Ls7.4 Ra3	B1 D	
<i>Leskea polycarpa</i>	1	Ls7.4	C1 C2	
<i>Leucobryum glaucum</i>	1, 2, 3, 4, 5, 6, HŠ 2006a, ŠH 2006	Ls7.4 Ls6.1 Ls3.6	B1 B2	
<i>Lophocolea bidentata</i>	2, 3, 4	Ls7.4 Ra3	B1 B2	
<i>Lophocolea heterophylla</i>	1, 2, 3, 4, 5, 6	Ls7.4 Ls3.6	D	
<i>Mnium hornum</i>	3	Ls7.4 Ls3.6	B1	
<i>Orthotrichum pumilum</i>	3, 4	Ls6.1	C2	
<i>Orthotrichum speciosum</i>	3	Ls6.1	C2	
<i>Pellia epiphylla</i>	2	Ls7.4	B1	
<i>Plagiomnium cuspidatum</i>	3, 4, 5	Ls6.1 Ls3.6	B1 B2 C1 D	
<i>Plagiomnium rostratum</i>	1, 2, 3, 4, 5, 6	Ls7.4 Ls6.1 Ls3.6	B1 B2	
<i>Plagiomnium undulatum</i>	2, 3, 4, ŠH 2006	Ls7.4 Ls3.6	B1 B2	
<i>Plagiothecium cavifolium</i>	4	Ra7	B1 B2	
<i>Plagiothecium curvifolium</i>	5	Ls3.6	B2	
<i>Plagiothecium nemorale</i>	4	Ls7.4	B1 B2	
<i>Plagiothecium ruthei</i>	2, 3, 4	Ls7.4	B1	VU
<i>Platygyrium repens</i>	1, 3, 4, 5, 6	Ls7.4 Ls6.1 Ls3.6	C1 C2 D	
<i>Pleurozium schreberi</i>	1, 2, 3, 4, 5, 6, HŠ 2006a, 2006b; ŠH 2006	Ls6.1 Ls3.6	B1 B2	
<i>Pohlia nutans</i>	1, 2, 3, 4	Ls7.4 Lk11 Ra7 Lk6.1	B1 B2 C1	
<i>Pohlia wahlenbergii</i>	2	Ls7.4	B1	
<i>Polytrichum commune</i>	2, 4, ŠH 2006	Ls7.4 Ra3 Ra7	B1 B3	
<i>Polytrichum formosum</i>	1, 2, 4, 5, 6	Ls7.4 Ls6.1 Ls3.6	B1 B2	

species	locality*	habitat**	ecol. group***	RL****
<i>Polytrichum juniperinum</i>	1	Ls6.1	B1 B2	
<i>Polytrichum piliferum</i>	1, 2, 3, 4, 5, 6	Ls6.1 X1	B4	
<i>Polytrichum strictum</i>	2, 3	Ra3 Lk11	B1 B3	
<i>Pseudoscleropodium purum</i>	1, 3, 4, 5, 6, HŠ 2006a, 2006b; ŠH 2006	Ls6.1 Ls3.6	B1 B2 B4	
<i>Ptilidium pulcherrimum</i>	4	Ls7.4	C2	
<i>Pylaisia polyantha</i>	6	Ls7.4	C1 C2	
<i>Radula complanata</i>	3, 4	Ls6.1	C2	
<i>Rhizomnium punctatum</i>	1, 2	Ls7.4	B1 B2 D	
<i>Riccardia palmata</i>	2, 3	Ls7.4	D	
<i>Riccia fluitans</i>	1, 6	Vo2	E	LR:nt
<i>Riccia rhenana</i>	1	Vo2	E	EN
<i>Schistidium apocarpum</i> agg.	4	Ls6.1	A	
<i>Sphagnum fimbriatum</i>	1 (Sta 1998) 6(Šo 1997, HŠ 2006b)	-	B1 B3	VU
<i>Sphagnum flexuosum</i>	2, 3, 4	Ls3.6 Ra3	B3	
<i>Sphagnum magellanicum</i>	3	Ra3	B3	
<i>Sphagnum palustre</i>	2, 3, 4	Ls7.4 Ra3	B1	
<i>Sphagnum riparium</i>	2	Vo3 Ra3	B3	VU
<i>Sphagnum squarrosum</i>	1, 2, 3, 4, 6, HŠ 2006	Ls7.4 Lk11 Ra3 Ra7	B1	
<i>Sphagnum subsecundum</i>	2, 3, 4	Ra3	B3	
<i>Sphagnum teres</i>	6	Ra3	B3	
<i>Tetraphis pellucida</i>	1, 2, 3, 4	Ls7.4	D	
<i>Thuidium philiberti</i>	2, 3, 4	Ls7.4	B1 B2	
<i>Tortula muralis</i>	3	Ls6.1	A	
<i>Tortula ruraliformis</i>	3, 4	Ls6.1	B4	

***Locality:** 1 – Jasenácke, 2 – Bahno, 3 – Kotlina, 4 – Vanišovec, 5 – Orlovské vršky, 6 – Mešterova lúka.

Author's abbreviations: HŠ – Hegedúšová, Škodová; Sta – Staníková; Šo – Šoltés; ŠH – Škodová, Hegedúšová; Stano – Stanová 1995 TNP, specimen No. 1/10347; Hol – Holotová 1995 TNP, specimen No. 1/10350.

****Habitat** (Stanová, Valachovič l. c.): Ls7.4 – Alder swamp woods, Ls6.1 – Subcontinental Scot pine forests, Ls3.6 – Old acidophilous oak woods with *Quercus robur* on sandy plains, Lk11 – Common reed beds, X1 – Herbaceous clearings, Vo2 – Natural eutrophic lakes with Magnopotamion or Hydrocharition, Vo3 – Natural dystrophic lakes and ponds, Ra3 – Transition mires and quaking bogs, Ra7 – Transitional tall herb humid meadows.

*****Ecological groups:** A – epilithic species – concrete; B – epigeic species (1 – shady damp soil; 2 – shady, well-drained soil; 3 – unshaded damp places with herb vegetation /marsh, bog/; 4 – insolated dry soil); C – epiphytic species (1 – tree bases and trunks up to 40 cm above ground level; 2 – tree trunks at height between 40 cm and 250 cm above ground level); D – epixylic species; E – open water.

******RL** – Red List (Kubinská et al. l. c.).

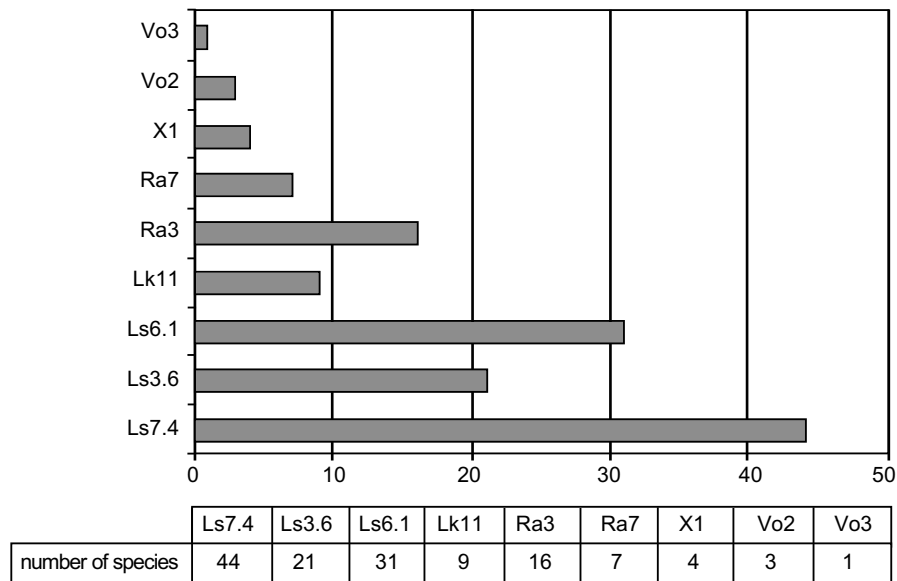


Fig. 2. * Number of bryophyte species in different habitat types
 *for abbreviations see Tab. 2

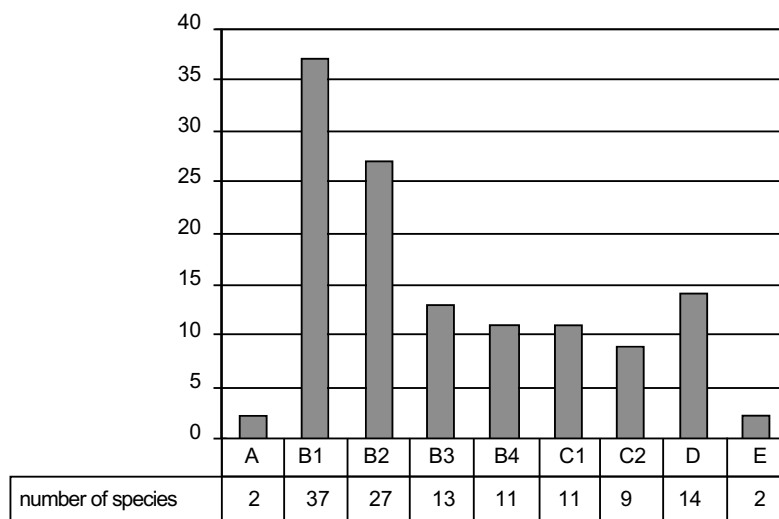


Fig. 3. * Number of bryophyte species in ecological groups
 *for abbreviations see Tab. 2

Acknowledgements

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Abstrakt

Bryofloristický výskum Borskej nížiny je v súčasnosti vysoko aktuálny, nakoľko mnohé jej oblasti neboli doposiaľ bryologicky spracované. V predkladanom príspevku sú prezentované výsledky základného floristického výskumu 6 lokalít Území Európskeho významu (UEV), a to Jasenácke, Bahno, Kotlina, Vanišovec, Orlovské vŕšky a Mešterova lúka, na ktorých bolo zistených 76 druhov machorastov. Z druhov zaradených do červeného zoznamu boli nájdené *Riccia fluitans*, *R. rhenana*, *Buxbaumia aphylla*, *Plagiothecium ruthei*, *Sphagnum fimbriatum* a *S. riparium*. Dominantnými biotopmi na lokalitách sú borovicovo-dubové lesy, jelšiny, mokrade a prechodné rašeliniská, s ktorými korešponduje aj druhové zastúpenie machorastov a ich ekologická charakteristika.

Katarína Mišíková, Anna Kubinská: Diverzita machorastov vybraných Území Európskeho Významu na Borskej nížine

SPECIFIC LOCUS SYSTEMS OF HIGHER PLANTS AS INDICATORS FOR GENOTOXIC DETERIORATION

Karol Mičieta*, Eva Brutovská, Andrea Sámelová

Comenius University in Bratislava, Faculty of Natural Sciences, Department of Botany, Révová 39,
811 02 Bratislava, Slovakia

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Abstract

Specific locus systems provide a simple, relatively easily scored system for the detection of mutations in testing of chemicals and in situ. They are based on a phenotypic change caused by a mutation in a single locus. Numerous test systems have been developed, although some of them use a phenotypic characteristic based on more loci, and therefore are not a true specific locus system, for example the waxy locus of maize and the locus for the colour of *Tradescantia* stamen hair.

Key words: specific locus, mutation assay, genotoxic deterioration

Introduction

Higher plants provide valuable genetic assay systems for screening and monitoring environmental pollutants and chemicals for cytogenetic aberrations and gene mutations (Constantin 1982a, Constantin, Owens 1982, Nilan 1978, Shelby 1980, Nilan, Vig 1976, Mičieta, Murín 1996, Murín, Mičieta 2000). Grant (1994, 1998) has summarized the advantages and limitations of plant bioassays. One of the advantages is that plants are eukaryotes, and therefore their chromosome structure is similar to man, undergoing also mitosis, meiosis and mutations. The methodics are relatively quick and easy, some of the plants, like *Arabidopsis*, have a short generation time. The range of conditions that the assays can be carried out under is wide, and can evaluate genotoxicity of single chemicals to complex mixtures. Also, higher plants can be regenerated from a single haploid or diploid cell, and have a wide range of genetic endpoints: cytological aberrations, gene mutations in whole plants, leaves, embryos, pollen etc. Pollen systems have an analogous position with microbial systems in that scoring of mutation events may be on a per million cell basis. The possibility of in situ monitoring and reliability with their use for number of years with good results in mutagenesis research is another advantage. Genotoxicity results are available for a number of chemicals so that comparisons can be made between different assays. Studies have shown a positive correlation with mammalian cytogenetic assays, and a possible combination with microbial assays to detect promutagens. Higher plant genotoxicity assays have been shown to be highly sensitive (few false negatives) in predicting carcinogenicity of test agents and many hundreds of genetic loci can be monitored.

However, plant assays have also some limitations. One of the limitations is that the life cycle is longer than in many other assay systems like bacteria, yeast and *Drosophila*. There are also large pharmacokinetic differences between plants and mammals, therefore the plant assays are not widely recognized for extrapolation to human beings. Despite that, the results of plant and animal test systems are comparable in many studies (Grant 1978, Clive, Spector 1978, Pavlica et al. 1991). Enneever and

* Corresponding Author: Karol Mičieta; micieta@fns.uniba.sk

Rosenkranz (1986) concluded that plant genotoxicity assays have a higher degree of relevance than might be considered from the pharmacokinetic differences between plants and animals. Constantin (1978) lists the positive biological and operational attributes of plant bioassays: regenerative plasticity, high fecundity, cultural adaptability, range of ploidy, economics of culture and maintenance of specific populations, and versatility.

For *in situ* biomonitoring, the use of higher plants as assay systems has several advantages. Due to unpredictable synergistic and antagonistic effects of environmental agents, it is impossible to predict the biological consequences of the contamination of ecosystems on the basis of the measurement of individual chemicals alone (Mičičeta, Murín 1996, Helma et al. 1998). The plants have the function of natural integration in the dynamic medium (air, water, soil) of the environment. In the same time, they are a stable part of the environment for the entire vegetation period. The plants growing directly in the environment can be used, or standardized model systems can be implemented into it to evaluate the genotoxic deterioration in the real complex of the environment. However, there is a possibility of the native plants populations to be adapted to the conditions of the environment (Mičičeta, Murín 1996).

According to Christianson and Chiscon (1978), most bioassays for mutagenic activity by use of higher plants simply measure the total number of mutations; the portioning of this quantitative measurement into categories – sectors due to deletion, due to point mutation, due to gene conversion, and so on – is difficult. This lack of qualitative characterisation limits the comparisons of different mutagens or their doses. For example, one mutagen or dose might cause mainly deletions while the other might cause primarily point mutations. In another biological system, the relative mutagenicity of those two agents or doses will be the same only if the biological system allows for both types of mutations, and at the same sensitivity as the first assay system. One approach that eliminates the difficulty of the different types of mutations is developing assays specific for a single kind of mutational process. Uhl et al. (2003) depose that mutations occurring at the gene level comprise base substitution mutations, which lead to changes of amino acids (or a termination of the amino acid chain) or frame shift mutations (base insertions and deletions).

A specific locus is equivalent to a gene in the classical Mendelian sense. As such, it is defined as a chromosomal region that controls the development of a phenotypic characteristic, and that is separable by crossing over from adjacent loci governing other specific phenotypic characteristics (Constantin 1978). When the mutations at the gene level occur in a specific locus controlling a certain phenotypic characteristic, it is possible to score the mutants that differ in this characteristic. The principle of allele dominance and recessivity is often used in these systems, with a model organism with known genotype. If the dominant allele in a heterozygote mutates, the resulting phenotype is the one of the recessive homozygote. By scoring of this phenotype the number of mutations in the dominant allele can be estimated, although the mutants in the recessive allele remain undetected. It is also possible to score reverse mutations in a recessive homozygote. In that case, the mutant phenotype is the one of a heterozygote or dominant homozygote, and mutations in both alleles are scored.

Overview of some specific locus systems used for detection of genotoxic deterioration is in the table 1.

Tab. 1. Some of the specific locus systems used in the tests for mutations

Test organism	Test principle	References
<i>Oryza sativa</i>	Induction of chlorophyll mutations in the M ₁ and mutations in the waxy locus of pollen	Kumari et Vaidyanath 1989
<i>Zea mays</i>	Detection of mutations in the waxy locus of pollen (both forward and reverse mutations) The Yg ₂ system with yellowish phenotype of the mutant heterozygote caused by deletion or mutation of the dominant allele	Plewa 1982 Smith et al. 1964 Neuffer, Coe 1974 Conger 1976
<i>Hordeum vulgare</i>	The chlorophyll deficiency system observed in the M ₂ generation (caused by mutations of numerous various loci)	Gustaffson 1940 Constantin 1982b

Test organism	Test principle	References
<i>Arabidopsis thaliana</i>	The thiamine auxotrophy and embryonic mutants	Rédei 1976, 1982 Gichner et al. 1993
<i>Tradescantia</i>	Stamen hair mutation assay on the 4430, 02 clones heterozygous for the flower colour with dominant blue and recessive pink allele	Underbrink et al. 1973 Sparrow, Schairer 1971 Ma et al. 1994
<i>Glycine max</i>	Formation of mosaicism which leads to leaf spots varying in their colour and morphology; detection of somatic crossing over, chromosome deletions, nondisjunction and point mutations	Vig 1982
<i>Nicotiana tabacum</i>		
<i>Avena sativa</i>	The <i>al</i> locus of diploid oats, heterozygous for the albino gene	Nishiyama et al. 1966
<i>Prunus avium</i> , <i>Oenothera organensis</i> and others	The gametophytic type of the self-incompatibility systems based on a multiallelic S locus	Mulcahy, Johnson 1978

The waxy locus

The *waxy* locus in *Zea mays* encodes a granule-bound starch synthase (GBSS I – *waxy* protein) involved in the biosynthesis of amylose in endosperm and pollen grain (Huang et al. 2010). The locus derived its name from the *waxy* appearance of mutant kernels, the phenotype reflecting an alternation of the underlying starch composition (Wax 1922, Sprague et al. 1943, Nelson 1968, Tsai 1974). The starch of wild-type endosperm tissue consists of 15 – 30 % amylose and 70 – 85 % amylopectin, while the endosperm starch in most *waxy* mutants is nearly 100 % amylopectine. The *waxy* locus of *Zea mays* has a higher level of genetic variation than in *Oryza sativa* (Okagaki, Wessler 1988).

The principle of the *waxy* mutation assay is the *waxy* allele (*wx*), which is recessive to the starchy allele (*Wx*) (Collins, Dempston 1909). In the haploid pollen grains, it is possible to detect the alleles by staining with iodine. The grains containing the *Wx* allele are stained dark-blue, while the grains with the *wx* allele are red (Sprague et al. 1943). Both forward and reverse mutations can be detected: forward mutations are scored in heterozygous population, where the mutation of *Wx* causes the expression of recessive phenotype, while reverse mutations can be scored in a recessive homozygote, like the Awax 301 cultivar (Solenská et al. 2007). However, the comparison of the results is difficult because of the different cultivars used for these experiments. (Hopke et al. 1982 used the CM14 cultivar for the testing of reverse mutations.)

More than 50 mutant types of the *wx* locus have been characterized on the molecular level, with the DNA insertions and deletions (indel) playing the most important role (Wessler, Varagona 1985). Most of these mutations are based on the *Ac/Ds* system, described by McClintock (1950). *Ds* (from dissociation) is the locus where the break of the chromosome occurs, if the *Ac* element (activator) is present. Besides the breaks, *Ds* can also change its position in the presence of *Ac*. Both *Ds* and *Ac* are transposable elements. Generally the mutant phenotype of the pollen or kernel can be caused by four causes: (1) the absence of the GBSS I enzyme, (2) decreased synthesis of the enzyme, (3) production of a changed or inactive form of the enzyme, or (4) the mutant protein does not enter the amyloplast, or does not bind the starch granule / binds ineffectively (Huang et al. 2010).

Tradescantia stamen hair mutation bioassay (Trad-SH)

This assay was developed by Dr. Arnold H. Sparrow in Brookhaven National Laboratory, Song Island, New York. The first studies dealt with the effect of nuclear radiation (Sparrow et al. 1972), mutagens in the air and volatile organic compounds (Sparrow, Schairer 1971), and the chemicals in liquid form (Schairer et al. 1982). The great sensitivity of this assay to gaseous mutagens has been

documented; therefore it is very suitable for *in situ* monitoring of air pollution (Schairer, Sautkulis 1982, Schairer et al. 1982).

The assay detects mutations in the mitotic cells of stamen hairs, developing in the young flower buds in the clone 4430 of *Tradescantia* (*T. hirsutiflora* x *T. subacaulis*), or clone 02 (*T. paludosa* x *T. ohaiensis*). These plants are heterozygous for the phenotypic characteristic of the flower colour, with dominant blue and recessive pink. If the dominant allele mutates, a pink cell will appear among the non-mutant blue cells. The stamen hairs of *Tradescantia* contain of a string of single cells, prolonged by mitosis. A string of pink cells between blue cells represents one mutation event, propagated by mitosis. However, if there are two pink cells or strings of pink cells divided by blue cells, they represent two mutation events (Underbrink et al. 1973). The detailed protocol of this assay with the conditions of cultivating the plants and scoring of mutations is available in the study of Ma et al. (1994).

Self-incompatibility systems – S locus

Flowering plants have evolved a variety of mechanisms that insure that accidental self-pollination is not followed by self-fertilization. Such mechanisms are known as self-incompatibility systems, and generally function by preventing either the germination or the tube growth of self-pollen. The function basis of the gametophytic forms of self-incompatibility is the haploid, or gametophytic, genotype that is carried within the individual pollen grains. In the simplest case of self-incompatibility, a single multiallelic locus, S, controls the reaction between pollen and style (Mulcahy, Johnson 1978). A self-incompatibility reaction is triggered when the same “S allele” specificity is expressed in both the pollen and pistil. Thus growth of a pollen tube bearing either one of the two “S allele” specificities carried by the recipient pistil is arrested in the style (Tao, Iezzoni 2010). Determining the numbers of seeds resulting from pollination by a known number of pollen grains provides a good measure of mutation rates at the S locus. This type of gametophytic self-incompatibility can be found in the plants from the family *Rosaceae*, *Solanaceae* and *Plantaginaceae* (McCubbin, Kao 2000, de Nettancourt 2001, Kao, Tsukamoto 2004, Takayama, Isogai 2005, Yamane et al. 2009).

Devreux and de Nettancourt (1974) have appointed two main advantages of this assay. Since pollen is a haploid system, most mutations of the S allele will be expressed, and if mutant pollen is allowed to effect fertilization, the mutant genotype can be recovered and subjected to further study and verification. Mulcahy and Johnson (1978) suggest further advantages: It is not possible to change one “S allele” specificity to another (like S₁ to S₂), because a mutation represents the deactivation of a certain complex of S allele. The deactivation may be limited to pollen, to the style, or exhibited by both (de Nettancourt 1972). Therefore, if a new specificity appears among the mutants, it is a clear indication of contamination. Another advantage is the screening of a great number of pollen (e.g. it is possible to screen over 17.000 pollen grains of *Nicotiana glauca* in one pollination – Pandey 1967). This enables the scoring of rare mutations and relatively accurate estimation of their frequency. Another major advantage of the self-incompatibility system is that the actual screening is accomplished by the stylar tissues themselves. This eliminates the need for great skills on the part of technicians. This system has also a great potential for developing an *in situ* assay, which would mean a significant increase in the capacity of the measurements of the environmental mutagenesis (Mulcahy et Johnson, 1978).

However, this system has also its disadvantages. The studies of Sparrow et al. (1967) appoint a lower sensitivity of this assay compared to *Tradescantia* stamen hair assay, but it is possible that this disadvantage can be overcome by the optimization of the assay. Another problem is represented by the “cryptic self incompatibility”, as exhibited in some plant species, e.g. *Cheiranthus cheiri*. That is, it rigorously excludes self pollen tubes when pollinated with a mixture of self and other pollen. However, it is fully fertile when pollinated with only its own pollen (Bateman 1956). The wide spectrum of environmental stresses, aging or infection can considerably weaken the self-incompatibility system (Pandey 1959). Susceptibility to such influences is apparently a clonal

characteristic (Leffell 1970), and a careful selection of plant material can greatly diminish this possible source of error (de Nettancourt 1972).

According to Richman and Kohn (1996), the S-locus of flowering plants is among the most polymorphic known. The number of alleles provides an estimate of recent effective population size and the sequence relationships among alleles provide another estimate of population size extending millions of years into the past. Relationships between S-alleles and related genes provide a means of dating the age of origin of incompatibility systems and determining which, if any, angiosperm families share incompatibility by homology.

Although the specificity of the gametophytic self-incompatibility can be explained by assuming a single locus with multiple co-dominant S alleles, recent molecular studies revealed that the pistil and pollen S specificities are determined by two different genes, pistil S and pollen S, respectively. As these genes are very tightly linked to each other and behave as if they were a single gene, the term S haplotype has been used to describe the specificity of S locus, while the term “allele” is used to describe the variants of the S locus genes, pistil S and pollen S (Tao, Iezzoni 2010).

Embryonic mutants in *Arabidopsis thaliana*

Arabidopsis thaliana is an autogamous diploid higher plant species, a member of the *Brassicaceae* family. It is about 15 – 30 cm tall and bears siliquae containing 30 – 50 seeds in linear order. The life cycle of the plant is short (5 – 12 weeks) depending upon the growth conditions (light, temperature, and nutrition) and the ecotype (Gichner et al. 1993). The comprehensive analysis of the genome sequence of the plant has been completed recently. The genome sequence and associated analyses provide the foundations for rapid progress in many fields of plant research, such as the exploitation of genetic variation in *Arabidopsis* ecotypes, the assessment of the transcriptome and proteome, and the association of genome. In total, the five chromosomes of *A. thaliana* contain DNA molecules of 115,409,949 basepairs (bp) in length, which encode 25,498 genes (Bevan et al. 2001).

Analysis of development of embryos is the most commonly used method for studying mutagenesis in *Arabidopsis* as proposed by Müller (1963, 1964). In this bioassay, induced mutagenicity is detected in the siliquae of the plants grown from seeds treated with a test chemical by observing color and growth changes in embryos before the seed coat turns brown. Simultaneously, induced sterility is detected through the reduction in the number of embryos in the siliquae.

Embryonic mutants can be distinguished as not fully developed white, yellow, or pale green seeds, with the embryo and seeds smaller than normal. In addition, the embryonic mutants ripen earlier than normal seeds and appear often as small, shrunken seeds. Chlorophyll mutants have embryo and seed size like normal seeds, but differ in colour (white, yellow, pale green). In some cases ‘false embryonic mutants’ can be detected as a consequence of insect or mechanical damage, stress, cultivation conditions, etc. They are found mostly at the site of damaged siliquae or at the top end of the siliquae, whereas true embryonic mutants are distributed mostly randomly all over the siliquae (Gichner et al. 1993). This way, mainly recessive forward mutations are detected, embryos become homozygous for specific alleles according to colour changes.

The thiamine auxotrophy system of *Arabidopsis thaliana* has been described by Rédei (1976). The M₁ seeds are treated with mutagens, and the auxotrophs for thiamine are isolated from M₂ seedlings on the basis of appearance within 10 days after germination. The thiamine auxotrophs germinate with green cotyledons and then fail to develop green leaves. The M₂ mutants are fed with a dilute solution and thiamine twice weekly, so that each suspect mutant can be progeny tested for the verification of the mutation (Constantin 1978).

Discussion

The present concept of testing for mutagenicity involves a tiered-system approach including both prokaryotic and eukaryotic organisms. These organisms are used as surrogates for humans, and any substance which yields positive results is suspect (Constantine 1978). The use of plants as a model organism enables not only the testing of single chemical with a potential mutagenic effect in the laboratory, but also *in situ* testing of all parts of the environment in their reciprocal interactions. The specific locus systems do not show all occurring mutation in the model organism, but enable a relatively simple and accurate scoring of the mutants according to the phenotypical manifestation of the studied locus. The principle of allele dominance and recessivity is used in a model plant cultivar with a known genotype. In that case, a divergence from the expected phenotype is caused by mutation in the specific locus. Both forwards and reverse mutations can be scored, with the difference that the reverse mutations enable the scoring of mutations in both alleles, while in the case of the forward mutations only the dominant allele can be examined. Neither of the possibilities discern double mutants on both alleles.

In the terminology, several assays are listed as specific locus systems, but the scored phenotypical characteristic is in truth influenced by several loci. It is mostly the case of the chlorophyll mutants in several model plants, like *Oryza sativa* (Kumari, Vaidyanath 1989), *Hordeum vulgare* (Gustaffson 1940, Constantin 1982b), *Arabidopsis thaliana* (Gichner et al. 1993), *Glycine max* and *Nicotiana tabaccum* (Vig 1982). Also the S-locus of the self-incompatibility system are actually two loci, responsible for the interaction of pistil and pollen (Tao, Iezzoni 2010). In a true single locus systems, like the *waxy* locus of *Zea mays* (Plewa 1982), the phenotypical change connected with the mutation can be caused by various types of mutations in different positions of the locus and on all levels of the DNA structure. However, there are certain types of mutations characteristic for the given locus that occur more often than the other types, for example the indel mutation of the *waxy* locus (Wessler, Varagona 1985). Therefore, several different assays should be executed in order to discern all possible mutagenic effects of the tested chemical or complex of chemicals.

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Abstrakt

Systémy špecifických lokusov poskytujú jednoduchý, pomerne ľahko hodnotiteľný systém pre detekciu mutácií v testovaní chemických látok a *in situ*. Je založený na zmene fenotypu spôsobenej mutáciou v jednom konkrétnom lokuse. Boli vyvinuté početné testy, hoci niektoré z nich využívajú fenotypickú charakteristiku založenú na viacerých lokusoch, a teda nie sú pravými systémami špecifických lokusov, ako napríklad *waxy* lokus kukurice alebo lokus pre farbu tyčinkových vlásokv *Tradescantia*.

Karol Mičieta, Eva Brutovská, Andrea Sámelová: Špecifické lokusové systémy vyšších rastlín na indikáciu genotoxikkej deteriorizácie

THE IMPACTS OF GLOBAL WARMING ON PLANT BIODIVERSITY

Karol Mičieta*, Andrea Sámelová, Eva Brutovská, Koloman Dienes

*Comenius University in Bratislava, Faculty of Natural Sciences, Department of Botany, Révová 39,
811 02 Bratislava, Slovakia*

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Abstract

Climate is one of the major factors governing the distribution of wild plant species, acting directly through physiological constraints on growth and reproduction or indirectly through ecological factors such as competition for resources. The changes in climate will have consequences for biotic (frequency and consequences of pest and disease outbreaks) and abiotic disturbances (changes in fire occurrence, changes in wind storm frequency and intensity) with strong implications for forest ecosystems. Climatic change not only affects the potential yield levels, but it may also modify the effects of pests and diseases. If climatic change causes a gradual shift of agricultural regions, crops and they associated pests, diseases and weeds will migrate together, though at different rates.

Introduction

The complexity of the atmosphere, hydrosphere, biosphere and geosphere and their interactions via physical, biological and chemical processes constitute the climate system. Solar radiation is the driving force of global climate. A portion of the radiation reaching Earth's surface is scattered or reflected by clouds, aerosols, dust and other particles of the air. Radiation reaching the planet is partly absorbed, causing the Earth to emit thermal radiation, and part of the radiation is reflected back to the atmosphere. Water vapor and radiatively active CO₂, CH₄, N₂O and O₃, among others, partly trap the reflected radiation to warm the surface temperature from a frigid –18 °C to about 15 °C, a natural phenomenon known as the “greenhouse effect”. Human activities have contributed to an increase in the concentration of radiatively active gases and added new greenhouse gases such as halocarbons (like chlorofluorocarbons) and hexafluoride. Together with changes in land cover, this may have contributed to an enhanced greenhouse effect to cause global warming and other climatic changes (Chakraborty et al. 1999).

Changes in the intensity of rainfall will have significant impact on agriculture and the plant pathogens in particular. Changes in physical climate will interact with changes in plant morphology, physiology and chemistry due to increasing CO₂ concentrations to influence diseases. Plant diseases are significant to the production of around 25 crops, which are very important to the assurance of nourishment of the growing world population (Oerke et al. 1994).

Changing phenology of species

A change in phenology including the timing of seed germination, dormancy breaking or bud burst could decrease synchronization between herbivores and their hosts. Thus hosts and prey food available for natural enemies will generally decrease due to lack of synchrony, but in some situations may increase (Lindroth et al. 1993).

* Corresponding Author: Karol Mičieta; micieta@fns.uniba.sk

Phenology is the study of the cycling of biological events during the year and is considered the most responsive aspect of Nature to climate warming. Phytophenology examines plant phenology. Phenological research has a long history, and thus, many longterm phenological data sets exist to be evaluated based upon changes over the past decades. On the basis of phenological records, the effects of climate change on plants can be studied (Sparks, Menzel 2002).

The multitude of recently published studies providing evidence for the ecological impacts of climate change on many different continents strongly suggests that the last 30 years of warmer temperatures have had a substantial influence on both seasonal patterns, and altitudinal and poleward shifts in vegetation (Walther, 2003).

According to Sparks, Menzel (2002) changes have been most profound in those events that occur earlier in the year. They attribute this to the fact that changes in temperature experienced so far have been more pronounced in the winter and early spring period. Therefore, early flowering plant species are most affected by global warming. The same conclusion is drawn by Fitter, Fitter (2002). Furthermore Post, Stenseth (1999) report that woody plants have shown less sensitivity to climatic variability than herbaceous plants (Arft et al. 1999). On the other hand, Mátyás (2005) sees a greater impact in long-term of the climatic change on woody plants, because of the longer time they need for reaching sexual maturity, and therefore lesser chance for adaptation. In England, a set of 385 investigated plants have advanced their flowering date by 4.5 days on average during the past decade (Fitter, Fitter 2002).

Another effect of global warming is plant migration. This can already be observed in natural populations and is expected to happen in agricultural systems. Geographical displacement of some crops might represent an advantage for higher latitude regions, opening the possibility for new crops not previously grown in those locations (Hedhly et al. 2008).

In spite of the general increase in global average temperatures in recent decades, there are some regions that experienced local cooling in the same period (Folland, Karl 2001). In accordance with such spatial variability in climatic trends, there are also regions with no effect or even a later onset of spring phenophases, such as the Balkan (Menzel, 2000); regions in the Ural Mountains (Ahas et al. 2002), in the US-states Virginia and North Carolina (Fitzjarrald et al. 2001), and in China (Schwartz, Chen 2002) particularly the eastern part of southwestern China (Zheng et al. 2002). Fewer phenological data sets are available for the fall season. However, the few data sets that include phenophases in both spring and autumn reveal a trend towards a prolongation at both ends of the season and thus, an extension of the growing season. Whereas in spring the phenological phases in high- and mid-latitudes are considered to depend strongly on temperature conditions during winter and spring, the most important factors causing phase changes in autumn are not as clear (Walther, 2003).

The sexual reproduction

The sexual reproductive phase in plants might be particularly vulnerable to the effects of global warming. Reproductive phase is a good candidate to be affected by climate change: (i) the events of irregular and reduced cropping; (ii) the forecasted change in temperature mainly in the spring, during the flowering season of many plant species; and (iii) the available information on the direct effect of temperature stress on the reproductive phase. But the reproductive phase also provides the plant with an opportunity to adapt to the environmental changes (Hedhly et al. 2008).

The quantity and morphology of pollen, anther dehiscence and pollen wall architecture, as well as the chemical composition and metabolism of pollen have been shown to be affected by high temperatures (Koti, 2005). All these effects could alter male fitness by reducing the available amount of pollen and could also – if the pollen limitation is severe – indirectly limit female fitness by reducing the number of seeds sired. However, given the great amounts of pollen produced in most plant species, small variations in temperature, although inducing an effect, are not expected to produce very dramatic effects in terms of reproductive output (Hedhly et al. 2008).

The immediate effects of global warming are already observable, both in natural populations and agricultural systems. These effects mainly concern: (i) the early onset of sexual reproductive development; (ii) higher or lower reproductive output, depending on the regions and species under study; and (iii) the expansion of crop plants and shifts in geographic distribution of natural populations towards higher latitudes. Early flowering in response to higher temperatures (Menzel, 2006) is actually an advancement of the whole reproductive process that could potentially alter plant–pollinator interaction and subsequent reproductive stages.

It is possible that climate change might cause adaptive evolution of fitness-related traits (Davis, Shaw 2005). Consequently, if climate change can modulate sexual plant reproduction, which strongly contributes to fitness, it is tempting to speculate that the sexual reproductive phase will have an important role in these adaptive processes (Hedhly et al. 2008).

Experiments indicate that higher levels of CO₂ generally increase productivity of plants (Long et al. 2004). However, effects mediated through high temperatures and reduced water availability can counter it.

Apart from having direct effects on plant productivity, climate change can also influence productivity through indirect effects mediated by changes in pests and diseases. Many of the species being affected are pest herbivores, leading to new pests appearing and others disappearing, and altered pressures from existing pest species (Gutierrez et al. 2008; Jepsen et al. 2008).

Impact of increasing levels of CO₂, O₃

Several studies show that many plants now flower and leaf out earlier than they did a few decades ago as a result of changes in climate across much of the world (Parmesan, Yohe 2003; Root et al. 2003; Parmesan, 2007). There is no doubt about the existence of a positive CO₂ effect on final dry matter formation under favourable conditions for plant growth (Lemon, 1983). A typical secondary effect of raising CO₂ is partial stomatal closure (Raschke, 1975; Morison, 1987). The degree of opening can be considered as a compromise in the balance between limitation of water loss and admission of CO₂ (Wong, 1979).

Increasing the concentration of CO₂ activates plant photosynthesis. Hasegawe et al. (2005) reported that, if CO₂ concentration increases an additional 200-ppm over the currently level the yield of rice would increase by about 15 %. Yields of other crops such as wheat and soybeans will increase at the same rate; these yield increases at a higher CO₂ concentration are known as the fertilizer effect. Furthermore, water requirements will decrease because stomas partially close under these conditions (Yoshimoto et al. 2005).

Increasing the concentration of CO₂ leads to positive impacts on crop growth; however, the higher temperatures of global warming can obstruct crop growth. The rise in temperature shortens the growth period due to early flowering and fruit bearing, and decreases the nourishment sent to seed due to increased respiration; hence, seeds may not fully develop. Furthermore, high temperatures during the flowering period cause spikelet sterility (Furuya, Kobayashi 2009).

Current levels of CO₂ limit CO₂ assimilation in C3 crops, and increasing CO₂ concentrations up to about 800 – 1000 ppm stimulate photosynthesis (Amthor, 2001). However, stimulation of photosynthesis does not directly translate in increased biomass, or yield. In determinate crops such as cereals, grain yield not only depends on photosynthesis but also on the length of the active phase of leaf photosynthesis, and the sink capacity of the grains.

According to the review by Kimball et al. (2002), elevated CO₂ stimulates biomass in C3 grasses by an average of 12 %, grain yield in wheat (*Triticum aestivum* L.) and rice (*Oryza sativa* L.) by 10 – 15 %, and tuber yield in potato (*Solanum tuberosum* L.) by 28 %. Yield stimulation in C4 crops is much lower. The effect of elevated CO₂ depends on temperature. Based on the differential temperature sensitivity of the solubility of CO₂ and O₂, it could be expected that increasing temperature would increase the affinity

of ribulose biphosphate carboxylase/oxygenase (rubisco) for CO₂, leading to an increase in the CO₂-stimulation of photosynthesis with temperature (Long, 1991). However, this effect may not result in increased biomass or yield. In individual leaves of soybean (*Glycine max* (L.) Merr.) stimulation of photosynthesis by elevated CO₂ increased as temperature was increased from 25 to 35 °C (i.e. optimal growth rates), whereas both whole plant photosynthesis and total biomass production showed the opposite trend (Ziska, Bunce 1997). The authors argued that if CO₂ and temperature increase concurrently, self-shading could limit the response of CO₂ assimilation. But the situation is more complex because CO₂ also reduces stomatal conductance and, in turn, transpirational cooling which leads to higher canopy temperatures (Fuhrer, 2003). An increase in temperature by 2.5 °C under field conditions strongly reduced (– 42 %) dry matter yield of a perennial rye grass sward at ambient, but not at elevated CO₂ (Nijs et al. 1996). Similarly, wheat yield declined with increasing temperature, but less in the presence of elevated CO₂ (Wheeler et al. 1996).

It has been postulated that a downward adjustment of photosynthesis occurs because of a reduced demand for the utilization of assimilates within plants which have feedback effects on nitrogen away from RUBISCO to other nitrogen pools within plants (Xu et al. 1994). Indeed, Carlson, Bazzaz (1980) reported that increased growth at elevated CO₂ for a number of species only occurred when plants were adequately fertilized.

Relatively few studies have considered the combined effects of elevated CO₂ and elevated temperatures on plants. Ashenden et al. (1995) studied the additive effects of elevated CO₂ and elevated temperature regimes on the growth of a range of species in a solardome study of 6 native plant species. Exposure to elevated CO₂ caused an increase in total plant dry weight but had no effect on leaf area. The stimulation in the dry weights ($P \leq 0,05$) of plants exposed to elevated CO₂ was primarily due to an increase in root biomass ($P \leq 0,01$); stimulation in shoot growth was not quite significant ($P = 0,05$). In contrast, elevated temperature caused a stimulation in leaf area production and in root dry weight but this was not reflection of CO₂ x temperature on the dry weights or leaf areas of plants. Increased growth in response to elevated CO₂ or temperature was the result of initial stimulation in RGR (relative growth rate) which decreased with time, and in the case of elevated temperature was significantly reversed.

Direct negative effects of O₃ on photosynthetic C fixation, leading to productivity losses, are well established (Lehnherr et al. 1997). Increasing O₃ levels at ambient CO₂ causes a decline in the yield of many crops species (Fuhrer et al. 1997; Fuhrer, Booker 2003). This negative effect results from a limitation of photosynthetic C assimilation due to a reduction in the activity and amount of rubisco (Lehnherr et al. 1997; Farage, Long 1992; Pell et al. 1994), associated with accelerated leaf senescence (Grandjean, Fuhrer 1989). O₃ was found to affect the quality of crops; for instance, grain N concentration.

It is also known that the thinning of the protective stratospheric ozone layer, leading to increased levels of ultraviolet (UV-B) radiation at the earth surface, may have implications for the productivity and quality of sensitive crop species and cultivars (Krupa et al. 1998).

Generally increases with increasing O₃ (Pleijel et al. 1999) leading to a better baking quality of the flour (Fuhrer et al. 1990), whereas in potato, increasing O₃ had a negative impact on tuber quality (Vorne et al. 2002). The protective effect of elevated CO₂ under O₃ stress could be explained by a reduction in leaf conductance, which reduces O₃ uptake, or an increase in the activity of anti-oxidant enzymes (Rao et al. 1995).

Plant diseases, pests and weeds in connection to climate change

Except for early attempts to study impacts of elevated CO₂ on diseases and the impact of air pollution on diseases (Sandermann, 1996), plant pathologists have only recently considered the influence of climate

change on plant diseases. A coordinated international effort on the potential impact of climate change on pest, weeds and diseases commenced with the 1996 under the Global Change and Terrestrial Ecosystems core project of the International Geosphere-Biosphere Program (Sutherst et al. 1996).

The occurrence of plant fungal and bacterial pests depends on climate and weather. Temperature, rainfall, humidity, radiation or dew affects the growth and spread of pathogens, as well as the resistance of the host plant (Patterson et al. 1999). It is likely that climate change will have positive, negative or neutral impacts on specific host–pathogen systems (Coakley et al. 1999).

The classic disease triangle recognizes the role of physical environment in plant disease, as a non-virulent pathogen can induce disease on a highly susceptible host if weather conditions are not favorable. Weather influences all stages of host and pathogen life cycles as well as the development of disease. Relationships between weather and disease are routinely used for forecasting and managing epidemics, and disease severity over a number of years can fluctuate according to climatic variation (Scherm, Yang 1995). Undoubtedly the nature of host (e.g. annual vs. perennial, C3 vs. C4) and pathogen (e.g. root-infecting vs. shoot-infecting, biotroph vs. necrotroph) population and climate (e.g. asymmetric temperature shifts will have different effects from changes in both maxima and minima) will determine how the impacts of climate change will be felt. Consequently, climate change will reduce, increase or have no effect on a disease. By affecting plant or pathogen (or both), CO₂, O₃ or UV-B may enhance, inhibit, or not change disease incidence or severity (Manning, Tiedemann 1995). The occurrence of plant pests (weeds, insects or microbial pathogens) is an important constraint with global average yield losses estimated at about 40 % (Oerke et al. 1994), and production costs significantly dependent on the extent of measures necessary for plant protection. Consequently, changes in the occurrence of pests due to changes in the atmospheric conditions are of both ecological and economic importance. In general, any direct or indirect consequence of increasing CO₂ or O₃, or climate change, which differentially affects the growth or fitness of weeds and crops, will alter crop-weed competitive interactions (Patterson, 1995). In the case of aggressive weed species of tropical and subtropical origins, which are currently restricted to Mediterranean environments, future climatic conditions may lead to an expansion of their potential range in to temperate regions. Plants growing under increased CO₂ and temperature extremes as well as decreased precipitation will provide different nutritional resources for invertebrate hosts, indirectly influencing the fitness of predators and parasitoids feeding on these hosts. There is also the potential for climate change to influence overlap between the appearance and abundance of natural enemies as times when crops are under pressure from herbivores (Thomson et al. 2010).

It has been suggested that climate change may have minor impact on diseases compared with the impact of crop management and genetic improvement in rice (Kropff et al. 1993) and in maize (Paruelo, Sala 1994).

Climate crop loss from diseases in a changing climate will be determined by a large number of interacting factors that directly and indirectly influence plant diseases. Among direct effects, altered physiology and morphology of the host under elevated CO₂ would change the interception of light and precipitation, and modify canopy structure and microclimate to influence disease epidemiology (Chakraborty et al. 1999).

Higher CO₂ levels often lead to slightly reduced nitrogen content of plant tissue. In its turn, this may affect the impact of sucking insects and pathogenic fungi. In general, elevated levels of CO₂ reduce the nutritional value of plants, including decreased nitrogen, leading to increased plant consumption rates in some guilds of pests (Bezemer et al. 1998). This might result in an increased level of plant damage because the pests have to consume more plant tissue to acquire similar levels of nutrition; however, responses are variable and few studies have shown significant shifts in the size of insect herbivore populations. These are a tendency not only for herbivores to consume more plant material, but also to grow more slowly (Lindroth et al. 1993), take longer to develop, show reduced fecundity and suffer heavier mortality (Watt et al. 1995).

Goudriaan, Zadoks (1995) suggested that each (foliar) fungal pathogen has its own N optimum in the leaves, and thus changes in the C:N concentration ratio caused by elevated CO₂ may have

differential effects on pathogenic fungi. Coakley et al. (1999) suppose that elevated CO₂ could promote foliar diseases such as rust, powdery mildews, leaf spots, and blights. However, Coakley et al. (1999) also referred to recent studies of host-pathogen interactions showing that elevated CO₂ can increase host resistance or reduce aggressiveness of the pathogen. This may be due to enhanced production of defense-related substances, or structural changes in the host tissues. In contrast, higher temperature may increase the plant's susceptibility due to inactivation of temperature-sensitive resistance. Increased lignification under warmer conditions may have a positive effect on plant resistance to fungal attack.

Most soil-inhabiting fungi tolerate more than 10- or 20-fold increases in atmospheric CO₂ concentration. Some typical soil-borne plant pathogens like species of *Phytophthora*, *Aphanomyces*, *Sclerotium* and different pathotypes of *Fusarium oxysporum* have been found to be well adapted to and even multiply better at high CO₂ and low O₂ levels. Isolates of *Rhizoctonia solani* and *Pythium irregulare* were inhibited by CO₂ concentrations exceeding 5 – 10 %. *Rhizopus stolonifer*, *Cladosporium herbarum*, *Botrytis cinerea*, *Aspergillus niger* and *Alternaria tenuis* were inhibited at CO₂ concentrations exceeding 5 – 10 %. Within current atmospheric ranges of CO₂, Manning, Tiedemann (1995) found inhibition of several species of *Alternaria* and *Peronospora hyoscyani* f. sp. *tabacina*.

More aggressive strains of pathogens with broad host range, such as *Rhizoctonia*, *Sclerotinia*, *Sclerotium*, and other necrotrophic pathogens may migrate from agricultural crops to natural plant communities. Pathogens, in particular non-specialized necrotrophs, may extend their host range to cause new disease problems in migrating crops (Chakraborty et al. 1999).

Evolution of pathogen populations may accelerate from enhanced UV-B radiation and / or increased fecundity in elevated CO₂ (Scherin, van Bruggen 1994).

It could be expected that under climate change conditions milder winters could favor many crop diseases such as powdery mildew, brown leaf rust and strip rust, and warmer summers may provide optimal conditions, for instance, for cercospora leaf spot disease (Patterson et al. 1999). Alternatively, drier and warmer conditions during the summer would reduce the incidence of several crop diseases, including late potato blight, due to reduced plant susceptibility. But at the same time, the diseases could spread to currently cooler regions.

However, as in the case of insect pests, impact models predict that higher winter temperatures may favor pathogen survival. Jahn et al. (1996) predicted that an increase in temperature, could (i) increase leaf rust of wheat and barley (*Puccinia triticina*, formerly *recondita* f. sp. *tritici*) and powdery mildew of sugar beet (*Erysiphe betae*), (ii) decrease infestation levels caused by foot rot and leaf blotch diseases, and (iii) cause no change in powdery mildew on small grains. Ozone effects on plants lead to altered disease susceptibility, but the effect is variable (Fuhrer, 2003).

Climate affects also agricultural pests. The spatial and temporal distribution and proliferation of insects, weeds, and pathogens is determined, to a large extent, by climate, because temperature, light, and water are major factors controlling their growth and development. Climate also affects the pesticides used to control and/or prevent pest outbreaks: the intensity and timing of rainfall influence pesticide persistence and efficiency; temperature and light affect pesticide persistence through chemical alteration. Most analyses show that in a warmer climate, pests may become more active than currently and may expand their geographical range.

It has been suggested that an expansion of soybean cyst nematode and gray leaf blight in maize is probably caused by global warming (Rosenzweig et al. 2000).

Insects flourish in all climates. Their habitats and survival strategies are strongly dependent on local weather patterns, and are particularly sensitive to temperature because they are cold-blooded. Insects respond to higher temperature with increased rates of development and with less time between generations. However, very high temperatures reduce insect longevity. Warmer winters reduce winterkill, and consequently, increase insect populations in subsequent growing seasons. Drought changes the physiology of host species, leading to changes in the insects that feed on them, and can reduce populations of friendly insects (such as predators or parasitoids), spiders and birds, influencing the impact of pest infestations (Rosenzweig, 2001)

Both pest and beneficial insects can be affected by changing environmental conditions, either directly or indirectly via changes in host physiology and chemical composition, or via effects on predators, competitors, and insect pathogens (Patterson, 1995). It is generally expected that with climate warming in mid- to high-latitude regions insect pests become more abundant. Climate warming affects insect life cycles because of the temperature control of the processes involved. Patterson et al. (1999) provided an extensive list of climatic thresholds and responses for the phenological development of pest insects. Exceeding critical thresholds has implications, for instance, for mortality or fecundity, and increased cumulative temperature (in degree-days) potentially increases the number of generations (Porter et al. 1991). The main effect of climate warming in the temperate zone is believed to be a change in winter survival, while at northern latitudes shifts in phenology in terms of growth and reproduction, may be of prime importance (Bale et al. 2002). Drought can lead to changes in the host plants, making them more attractive to insect pests, while excessive precipitation associated with water logging may have direct negative effects on soil dwelling insects (Watt, Leather 1986), or indirect effects through changes in insect pathogens, predators and parasites (Raulston et al. 1992).

Weeds will benefit from the “CO₂ fertilization effect” and from improvements in water use efficiency associated with the partial closure of stomas by increasing CO₂ concentrations. Climate change could have significant effects on weed growth, weed/crop competition, and the geographical distribution of weeds (Patterson et al. 1999). The range expansion of many weeds into higher latitudes may accelerate with global warming (Patterson, 1993; Rahman, Wardle 1990).

Increasing global atmospheric CO₂ may affect insect feeding activity through effects on host plant physiology and chemical composition (Patterson, 1993). The accompanying climate change will affect the distribution and degree of infestation of insect pests through both direct effect on the life cycles of insects and indirectly through climate effects on hosts, predators, competitors and insect pathogens (Patterson et al. 1999).

Porter et al. (1991) listed the following effects of temperature on insects: limiting geographical ranges; over-wintering; population growth rates; number of generations per annum; length of growing season; crop-pest synchronization; interspecific interactions; dispersal and migration; and availability of host plants and refugia. The effects of climate and weather on insect life cycles have been documented for a wide variability of insect pests of agriculture, rangelands and forests (Kingsolver, 1989; Harrington, Stork 1995).

Climatic conditions affect the survival growth and spread of pathogens as well as the resistance of their hosts to infection (Patterson et al. 1999). Warmer temperatures would likely also shift the occurrence of these diseases into presently cooler regions (Treharne, 1989).

Although weeds will be affected directly by increasing atmospheric CO₂ levels, the most significant effects on pests will result from change in temperature, precipitation distribution, and wind patterns. Climate change will alter the geographic range and impact of many crop pests. New pest/crop associations may occur (Patterson et al. 1999).

Adaptation of plants to climatic changes

There are various genetic and non-genetic options on both individual and population levels to respond to changes in environmental conditions. On the level of populations natural selection adjusts the average fitness of the population to changing conditions. The directed genetic change of the population gene pool towards an optimum state is termed genetic adaptation. The basic precondition for fast and effective genetic adaptation lies in the sufficiently large variation, i.e. in genetic diversity. On individual level, phenotypic plasticity provides the ability to survive in a wider range of environments. Although plasticity does not directly lead to genetic changes, it is also determined by the genetic makeup of the individual (Mátyás, 2005).

The possibilities of adaptation to a climatic change depend on the life history of the individual species. The strategy of short living plants seems to be in sexual reproduction and following adaptation

by natural selection. However, this is not always true, as the plants often lose the ability of sexual reproduction on the borders of areal. With the shift of climatic zones, the southern border of the areal will be most influenced by the climatic change, and the borders of the areal will shift northwards.

In woody plants, other mechanisms of adaptation also play their role. The longevity of trees is connected with the ability to adapt on environmental changes. They have survived the changes of geological periods as species, and also fluctuations of the climate as individuals. The time period for adaptation is relatively short in comparison with their lifespan. (For *Pinus longaeva*, the oldest known tree, the entire Holocene means only 3 – 4 generations.)

Genetic imprinting and after-effects is an element of non-genetic adaptation, which seems to play a role in certain forest trees (Skrøppa, Johnsen 1994). There is also a possibility of limited relevance for responding to large-scale change in the environment is migration through seed dispersal. This was the way to follow climatic changes in the European glacials and interglacials – and impeded migration was the reason for the extinction of many temperate tree species in central Europe (Mátyás, 2005).

Loss of growth vigour and increased pest and disease susceptibility will result in decline of competitive ability of the species at the locations close to the lower limits of tolerance. Other species may gradually take over the dominant position. At the upper limit of distribution, temperature increase will result in higher competitive ability and the species will colonise new potential habitats. Temperature increase will trigger an upward/northward shift of species distribution areas and of vegetation zones in terms of elevation. Mátyás (2005) studied the growth reply of *Pinus ponderosa* on the increase of average temperature by simulating the temporal climatic change by spacial conditions – taking samples of plants from a cooler locality, and growing it in a locality with a warmer climate (Fig. 1). The result of the higher temperature is a slight increase of productivity at first, but then it declines, and the trees are more susceptible to wind and snow damage and the loss of resistency against otherwise harmless pests and diseases.

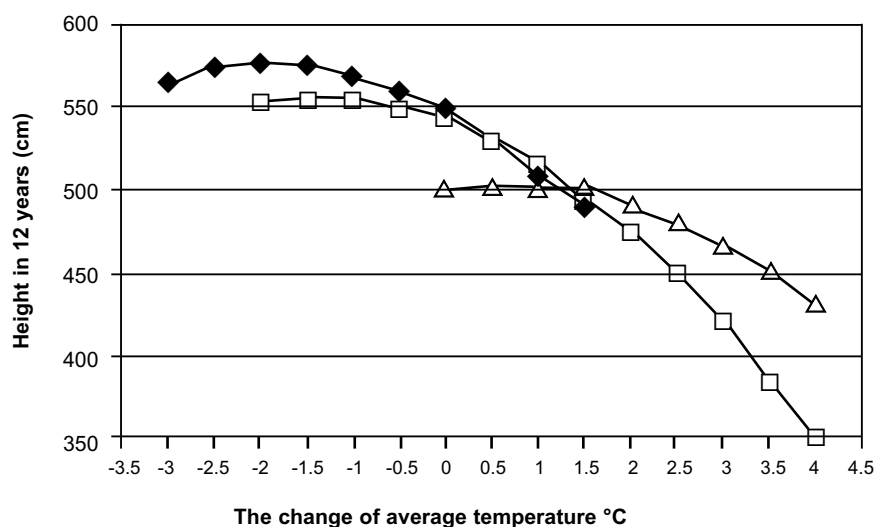


Fig. 1. The growth response of *Pinus ponderosa* on the changing average temperature on tree tested localities in California (Mátyás, 2005)

The migration speed through seed disperse has been determined from palaeobotanical data for *Quercus* and *Fagus* – 100 – 250 m/year, *Betula* and *Pinus* – 200 – 400 m/year. However, the climatic model of Houghton et al. (1996) predicts a yearly isotherm shift 3 km latitudinally, and 11.5 m horizontally. In that case the horizontal migration speed will be not able to keep pace with the climatic change, even if there would be no obstacles. The adaptation of the genofond through the pollen migration can be higher than the migration speed of seeds, but it requires a non-fragmented areal and a population close to natural state, with the natural regeneration mechanisms, which is only rarely fulfilled. Therefore it can come to extinction of the species on the southern and lower altitudinal border

of the areal, while on the northern or upper border the local conditions of the species can get better. However, the increase in the local potential will be slower than the increase in temperature because of the lower migration speed, soil conditions and spacial limitations (Mátyás, 2005).

From the point of view of conservation, the maintenance of the adaptive and evolutionary capacity linked with genetic diversity has to be considered as the precondition for stability of forest ecosystems (Ledig, Kitzmiller 1992; Erikson et al., 1993).

There have been a considerable number of studies on the responses of crop species to elevated CO₂ and the results generally show a 30 % yield increase per doubling of CO₂ concentration (see review by Cure, Acock 1986). The responses of native plant species to elevated CO₂ have received less attention. Many studies have been confined to short-term exposures (days to weeks) and many authors have reported increased whole-plant growth (Poorter, 1993; Baxter et al. 1995). However, in a comparative study of 27 British native species, Hunt et al. (1991) found many which showed no increase in growth and Baxter et al. (1995) reported reduced growth for *Festuca vivipara* L. at elevated CO₂.

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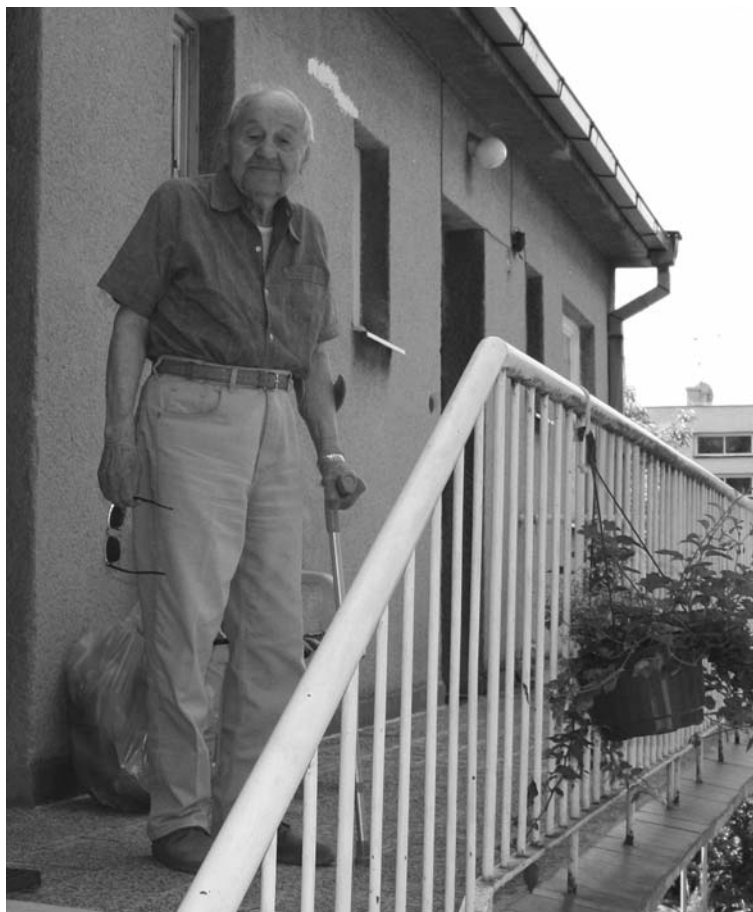
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Abstrakt

Klíma je jedným z hlavných faktorov regulácie šírenia rastlinných druhov, ktorá pôsobí priamo prostredníctvom fyziologických zmien na rast a rozmnožovanie alebo nepriamo prostredníctvom ekologických faktorov, ako je napr. kompetícia o zdroje. Zmeny klímy majú dôsledky pre biotické (frekvencia a dôsledky výskytu škodcov a chorôb) a abiotické negatívne činitele (zmeny vo výskyte požiarov, zmeny vo frekvencii výskytu a intenzite veterných smrští) s výraznými dôsledkami pre najmä pre lesné ekosystémy. Klimatické zmeny neovplyvňujú len potenciálnu úrodu, ale môžu aj modifikovať vplyvy škodcov a chorôb. Ak klimatické zmeny spôsobujú postupný posun poľnohospodárskych regiónov, tak plodiny a s nimi asociované škodce, choroby a buriny budú migrovať s nimi, hoci v rôznej miere.

Karol Mičieta, Andrea Sámelová, Eva Brutovská, Koloman Dienes: Dopady globálneho otepľovania na biodiverzitu rastlín

FOR THE NINETIETH BIRTHDAY OF Doc. RNDr. JOZEF MÁJOVSKÝ



Jozef Májovský, a doyen of Slovak botany, has lived to see his ninetieth birthday on June 10th 2010. He celebrated his jubilee modestly with his co-workers and students. Although much of his life and work has been written about, we are pleased to remember such an expert on Slovak flora, the exceptional scientific talent, and an untiring seeker of truth; a man who has brought a light into the Slovak world of botany. Botany was both his joy, and a gift full of duties.

Born in the city of Prešov, he studied at the Philosophical faculty of Slovak University in Bratislava, a pedagogic combination of natural sciences and geography. When the Faculty of Natural Sciences was founded, he was invited by PhDr. F. Nábělek and took a position at the Botanic institute. After the establishment of departments and after the death of prof. RNDr. J. M. Novacký, the head of the Department of Botany at that time, Jozef Májovský took his place. Simultaneously, he was appointed an associate professor of botany. He was always admirably efficient, motivating many others as a result. He taught, led many graduates and postgraduates, and held numerous head positions. He was a vice-dean for studies on the Faculty of Natural Sciences and vice-rector for development of the Comenius University. It was almost entirely his endeavours as vice-rector for development that caused the beginning of the long-delayed building of the new complex of the Faculty of Natural Sciences. With an infinite energy and resourcefulness, he was able to raise the building of the Department of Botany

on Révová Street from the foundations, insure its motion, and educate the students and postgraduates. The original results of scientific research, publications and manuscripts are a testimony of his creative spirit, perceptiveness and untiring work. All his activities have had deep roots in a sincere love to Slovakia and its flora.

We, who have worked with him, know that without his enthusiasm for botany, our enthusiasm would neither exist, nor be there the extensive documentary collections of the Department of Botany, caryotaxonomic laboratory. The building on Révová street, a place where all of his students now feel at home, would also not exist until now if it were not for his efforts. He was present at the foundation of the Botanical garden in Bratislava, later also of the Biological workplace in Turčianska Štiavnica – today Botanical garden of Comenius University in Blatnica. As director, he participated in the reorganization of botanic gardens in Slovakia to workplaces of scientific research.

Besides the numerous publications, there are also an uncounted number of lectures, expert opinions, reviews, work in scientific councils, committees and unpublished manuscripts that he has written. In uneasy social situation, he kept a sceptic irony, and a heart and mind for botany. His bond with botany was contagious. As a pedagogue he has been always kind, spontaneous, always prepared to advise and collaborate.

Dear Mr. associate professor, we are glad that you are with us, always ready with advice, with a lively interest, new ideas, anticipations and the ability to be always helpful. You have kept a rare quality – the well-wishing for the others and the ability to take pleasure in doing so.

On the occasions of his anniversaries, bibliography and life experiences have been compiled to honour Jozef Májovský till the year 1996 (Peciar 1970, Michalko 1980, Mikoláš, Feráková 1995, Bernátová 2005). The supplement to his publications we present there: Májovský et al. (1996, 1998, 1999, 2000), Bernátová, Májovský (1997, 1999, 2003), Bernátová et al. (1999, 2006), Májovský (2000), Májovský, Bernátová (2001).

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K DEVÄŤDESIATYM NARODENINÁM Doc. RNDr. JOZEFA MÁJOVSKÉHO

Jozef Májovský, nestor slovenskej botaniky, sa 10. júna 2010 dožil deväťdesiat rokov. Svoje jubileum si skromne pripomenul so svojimi spolupracovníkmi a žiakmi. Hoci sa o jeho živote a diele napísalo veľa, je nám ct'ou opäť si zaspomínať vedno s týmto vynikajúcim znalcom flóry Slovenska, výnimočným vedeckým talentom z rodu *neúnavných hladačov*; mužom, ktorý neobyčajným spôsobom osvietil slovenský svet botaniky. Botanika bola jeho radosť i dar plný povinností.

Rodák z Prešova, vyštudoval Filozofickú fakultu Slovenskej Univerzity v Bratislave, pedagogickú kombináciu prírodopis – zemepis. Po zriadení samostatnej Prírodovedeckej fakulty nastúpil na pozvanie PhDr. F. Nábělka do Botanického ústavu Prírodovedeckej fakulty. Zriadením katedier a po smrti vtedajšieho vedúceho Katedry botaniky, prof. RNDr. J. M. Novackého, zaujal jeho miesto. Súčasne bol menovaný docentom botaniky. Bol vždy obdivuhodne výkonný, jeho pracovitosť mala v sebe čosi strhujúce. Vyučoval, viedol množstvo diplomantov, aspirantov, vykonával viaceré riadiace funkcie. Na Prírodovedeckej fakulte bol študijným prodekanom, na Univerzite Komenského aj prorektorom pre výstavbu. Najmä jeho pričinením v pozícii prorektora UK bola začatá dlho odkladaná realizácia výstavby nového komplexu Prírodovedeckej fakulty UK v Bratislave. S nekonečnou energiou a dôvtipom dokázal ako organizátor od základov postaviť budovu Katedry botaniky na Révovej, zabezpečiť jej chod, vychovávať študentov, aspirantov. Objavné výsledky vedeckého výskumu, publikácie i rukopisy sú svedectvom jeho tvorivého ducha, vnímavosti a neúnavnej práce. Všetky aktivity mali hlboké korene v úprimnej láske k Slovensku a jeho rastlinstvu.

My, ktorí sme ho zažili, vieme, že bez jeho zánietenia pre botaniku by nebolo ani nášho zápalu; chýbala by veľká dokumentačná zbierka Katedry botaniky, karyotaxonomické laboratórium, rozsiahla knižnica, či dokonca budova na Révovej, kde sme všetci jeho žiaci mali a doteraz máme domovskú príslušnosť. Stál pri zakladaní Botanickej záhrady v Bratislave, kde pôsobil v rokoch 1956 – 1961 vo funkcii riaditeľa. Významnou mierou sa v tomto období podieľal na reorganizácii botanických záhrad Slovenska na vedecko-výskumné pracoviská. Bol tiež pri zrode Biologického pracoviska v Turčianskej Štiavničke – dnešnej Botanickej záhrady Univerzity Komenského v Blatnici.

Okrem početných publikácií je nevyčísľiteľné jeho množstvo prednášok, odborných posudkov, recenzií, práce vo vedeckých radách, redakčných radách, komisiách a nepublikovaných rukopisov. V neľahkej spoločenskej situácii si zachovával skeptickú iróniu, srdce i hlavu pre botaniku. S botanikou zostal nákazlivo zviazaný. Ako pedagóg bol láskavý, spontánny, vždy pripravený poradiť, spolupracovať.

Milý pán docent, tešíme sa, že ste s nami, stále s radami, stále so živým záujmom, nápadmi, tušeniami, schopnosťou vždy pomôcť. Zachovali ste si vzácnu vlastnosť – žičlivosť iným a schopnosť tešiť sa.

Pri príležitostiach okrúhlych výročí bola spracovaná bibliografia i životné osudy jubilanta do roku 1996 (Peciar 1970, Michalko 1980, Mikoláš, Feráková 1995, Bernátová 2005). Jeho ďalšie publikačné aktivity dopĺňame podľa práce Mikoláš, Feráková (1995) aj na tomto mieste: Májovský et al. (1996, 1998, 1999, 2000), Bernátová, Májovský (1997, 1999, 2003), Bernátová et al. (1999, 2006), Májovský (2000), Májovský, Bernátová (2001).

Dana Bernátová^{1*}, Helena Šípošová², Karol Mičieta³

* Corresponding Author: Dana Bernátová; bernatova@rec.uniba.sk

¹ *Comenius University in Bratislava, Botanical garden, workplace Blatnica, 038 15 Blatnica 315, Slovakia*

² *Institute of Botany, Slovak Academy of Sciences, Department of vascular Plant Taxonomy, Dúbravská cesta 9, 845 23 Bratislava, Slovakia*

³ *Comenius University in Bratislava, Faculty of Natural Sciences, Department of Botany, Révová 39, 811 02 Bratislava, Slovakia*

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