School of Doctoral Studies in Biological Sciences
University of South Bohemia in České Budějovice
Falculty of Science

Ecological study of the moss *Hamatocaulis vernicosus*

Summary of Ph.D. Thesis

RNDr. Táňa Štechová

Supervisor: Mgr. Jan Kučera Ph.D.
Department of Botany, Faculty of Science, University of South Bohemia in České Budějovice

České Budějovice 2012

This thesis should be cited as:
Štechová T, 2012. Ecological study of the moss *Hamatocaulis vernicosus*. Ph.D. Thesis Series, No. 9. University of South Bohemia, Faculty of Science, School of Doctoral Studies in Biological Sciences, České Budějovice, Czech Republic, 99pp.

Annotation

The thesis is focused on the endangered wetland moss *Hamatocaulis vernicosus*. The studies included vegetation and chemical characteristics of the species' habitats and long-term reaction to management and other environmental factors, comparison of ecological requirements of *H. vernicosus* and two related species, differences of habitat preferences among some European regions (Bohemian Massif, Western Carpathians, Southern Europe) and among parts of the Czech Republic. Recent and historical distribution of the species was compared, including the quantification of all recent populations.

Financial support

The thesis was supported by Grant Agency of the Czech Academy of Sciences, project no. IAA601410703, the long-term research plans of University of South Bohemia (no. MSM6007665801) and the Agency for Nature Conservation and Landscape Protection of the Czech Republic.

List of papers

Paper I Štechová T. & Kučera J. (2007): The requirements of the rare moss, *Hamatocaulis vernicosus* (Calliergonaceae, Musci), in the Czech Republic in relation to vegetation, water chemistry and management. – Biological Conservation 135: 443–449**.**

Paper II Štechová T., Kučera J. & Šmilauer P. (2012): Factors affecting population size and vitality of *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Musci). – Wetlands Ecology and Management 20: 329–339.

Paper III Štechová T., Hájek M., Hájková P. & Navrátilová J. (2008): Comparison of habitat requirements of the mosses *Hamatocaulis vernicosus*, *Scorpidium cossonii* and *Warnstorfia exannulata* in different parts of temperate Europe. – Preslia 80: 399–410.

Paper IV Štechová T., Holá E., Manukjanová A. & Mikulášková E. (2010): Distribution and habitat requirements of the moss *Hamatocaulis vernicosus* (Mitt.) Hedenäs in the Bohemian Forest. – Silva Gabreta. 16: 1–11.

Paper V Štechová T., Štech M. & Kučera J. (2012): The distribution of *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Bryophyta) in the Czech Republic. Bryonora 49: 5–16.

Introduction

Bryophytes are important components of mire ecosystems. With often a high coverage, the bryophyte layer accounts for a large part of the biomass, not only in bogs dominated by *Sphagnum* spp., but also in rich fens (Sjörs 1950, Clymo 1983, Kooijman 1992, Hájková & Hájek 2003, Hájková & Hájek 2004, Vitt & Wieder 2008). Bryophytes lack the root system and in nearly all mire species there is hardly any internal transport system. Mineral nutrients are taken up directly through the leaves, which are one cell layer thin and usually lack a protecting cuticle (Proctor 1982). The direct contact with the surrounding water, in the absence of roots and rhizomes exploring the soil compartment more substantially, may result in higher sensitivity to changes in the environment compared to vascular plants (Bates & Farmer 1992, Bergamini et al. 2009). Bryophytes play an indicator role of the present state of the habitat, as demonstrated for the rich fens by Juutinen (2011). After a change of environmental conditions, loss of rich fen bryophytes is more rapid than that of the phanerogams (Mälson et al. 2008), hence the changes in bryophyte layer may precede overall changes in the phanerogam vegetation (Bates & Farmer 1992).

Rich fen bryophytes were therefore subject to many studies in last years. In most cases, the studies employed the fen bryophytes as a whole. This can be illustrated in several papers dealing with the species composition of bryophytes in various vegetation types and contrasting site conditions (van Baaren et al. 1987, Hájková & Hájek 2004, Hájková et al. 2004, Hájek et al. 2006). Other studies describe in detail the reaction of bryophytes to various site conditions in terms of chemical composition (Aerts et al. 2001, Bergamini & Peintinger 2002, Bragazza et al. 2003, 2004, Drexler et al. 2003, Paulissen et al. 2005, Kooijman & Paulissen 2006). Attention was paid to the loss of peatland bryophytes' diversity on human-affected sites (Bergamini et al. 2001, Bergamini et al. 2009), and to the possibilities of their protection and restoration of an appropriate management (Barry et al. 2008, Hájková et al. 2009). Nevertheless, the results of the studies dealing with a proper treatment for a particular species are not always applicable to all target species at the locality, as the reaction to management may differ e.g. in case of hummock and pool-inhabiting species in a bog (Moen et al. 2001).

There have been only few studies investigating the ecological requirements of individual bryophyte species – and not only rich fen species. Habitat requirements and competition abilities were studied in the threatened species *Scorpidium scorpioides* (Kooijman 1992, 1993, Kooijman et al. 1994, Kooijman & Bakker 1994, 1995, Kooijman & Westhoff 1995). Another study dealt with the rare peat moss Sphagnum molle (Hekilla & Lindholm 1998). Other studies dealing with the rare peatland species rather have a regional character, describing the situation at individual sites.

This thesis attempts at elucidating the problems of retreat and protection of the most sensitive peatland bryophytes on the model species *Hamatocaulis vernicosus*, which typically represents rare and threatened fen species. It is a widely distributed but rarely common

Holarctic bryophyte, occurring most frequently in the boreal zone (Hedenäs 1989). It belongs to a group of taxa restricted to formerly glaciated and periglacial areas (Janssens 1983), being thus e.g. in Scandinavia locally relatively abundant (Hedenäs 1993, Söderström 1996), however even there the number of localities decreases (Juutinen 2011). In other parts of the Europe, it is a rarer species, classified in most countries as threatened to some extent (e.g. Sérgio et al. 1994, Ludwig et al. 1996; Erzberger & Papp 2004, Kučera & Váňa, 2005). It has been recommended to a special attention within the whole European Union, attaining even the official listing in the Bern Convention (Council Directive 92/43/EEC 1992). The rarity of *H. vernicosus* is probably based on the reported specific habitat requirements (Hedenäs 1999). According to Hedenäs and Hugonnot (Hedenäs 1989, Hedenäs 2003, Hugonnot 2003), *H. vernicosus* occurs at continually wet fens and spring sites, often at peaty lake shores in northern and Western Europe. It prefers mineral-rich sites; pH at the localities in northern Europe ranges between 5.7 – 7.8 and between 5.4 – 7.3 in the Alps (Hedenäs et al. 2003), North American sites have been reported to span pH values between 5 – 8 (Janssens 1983). Conductivity at the Swedish localities was reported between 16 and 396 μS/cm (Hedenäs 2003). Basic chemical characteristics at the sites of occurrence in Central Europe are summarized in **Paper I, III** and **IV**, those from southern Europe were published in Paper III. Everywhere, the species avoids localities with high calcium content (Hedenäs 1989, Hedenäs & Kooijman 1996, Hedenäs et al. 2003), while it prefers higher concentration of iron ions (Hedenäs & Kooijman 1996), which was confirmed at the Central European localities (**Paper II**).

The most common accompanying species of *H. vernicosus* are the mosses *Calliergonella cuspidata, Campylium stellatum, Calliergon giganteum, Sphagnum teres*, and *S. contortum*, and the vascular plants *Carex nigra*, *C. diandra, C. rostrata, Menyanthes trifoliata* a *Potentilla palustris* (**Paper I** and **III**). The frequency of accompanying species can slightly vary in individual regions, similarly to the chemical characteristics of the sites (**Paper III and IV**).

The study of ecological requirements of *H. vernicosus* may be obscured by the fact that the morphologically defined species has been shown to be represented by two genetically different lineages, which might be regarded as cryptic species (Hedenäs & Eldenäs 2007). One of the lineages is widespread in Europe, and was also sampled from several localities in Minnesota (United States). The other lineage occurs only south of the boreal zone in Europe, and was in addition sampled from single localities in Peru and northernmost Asiatic Russian Federation. According to the authors of the study, both cryptic species do not differ in their ecological requirements. This finding was however tested only with respect to the preference for basic chemical composition of water (pH and conductivity), and needs to be studied in more detail.

During the last decades, many fen moss species lost their natural habitat and have become rare (Kooijman 1992, Güsewell et al. 1998, Vasander et al. 2003). The area of unimpaired fens decreased markedly and habitats suitable for surviving of *H. vernicosus* and other sensitive mosses is often only refuge of fen surrounding agriculture land, ruderal

vegetation or shrubland communities. These small refuges are predominantly in the immediate vicinity of springs or wet depressions, often artificially dug trenches or pools (Štechová & Štech 2009, **Paper V**). Therefore, *H. vernicosus* populations underwent a substantial reduction. Of the nearly 150 historically known localities in the Czech Republic, the species nowadays survived at only one-third (**Paper V**). In the changed conditions, only a subtle fraction of the original population often survives. The reasons for the decrease of populations are various. Many localities have been completely destroyed and converted to agricultural or forest production land (Růžička 1987, 1989). Other localities have not been totally destroyed but the site conditions were changed in the way that the species could not survive anymore. A common cause of adverse alteration of site conditions has been the sinking of underground water level. Drainage of the fens may alter the peat chemistry, such as the decrease of pH and leakage of cations (Naucke et al. 1993). Biological attributes change and the dominant species expand (Graf et al. 2010). These processes can be enhanced by cessation of the management (mowing and grazing), resulting in nutrient content increase and promoting secondary succession towards tall forb and shrubland communities (van Belle et al. 2006). In such disturbed habitats, competitive rates between vascular plants and bryophytes and between bryophytes mutually are changed considerably. In habitats with lower pH, calcifuge *Sphagnum* species expand and suppress rich fen bryophytes (Kooijman & Bakker 1994, Grootjans et al. 1996). Reaction of *H. vernicosus* to the lowered pH and higher Sphagnum competition is similar to that of other rich fen mosses – smaller and less vital populations at localities with the high cover of Sphagna (**Paper I, II** and **IV**).

For conservation of *H. vernicosus* and other rare fen bryophytes, re-establishing of the management is necessary at many sites. High cover of the herb layer is a key negative factor influencing the populations of the target species (**Paper II**). Therefore a regular mowing is necessary at localities with the dense vegetation cover. At localities, where the herb layer expansion is blocked by the high level of underground water, no mowing is necessary (**Paper I**). Even there, however, occasional removal of establishing woods is essential (**Paper IV**). At drier sites, hollowing shallow gaps in the proximity of rare bryophytes is beneficial, as this promotes the creation of sufficiently wet open space with low competition pressure, where the sensitive targets species may expand (**Paper I**). However, the traditional management (mowing or grazing) is not always sufficient for the long-term protection of endangered species, and hydrological restoration is often necessary (Mälson et al. 2008, Bergamini et al. 2009).

Aims of the study:

1. Vegetation and chemical characteristics of the *H. vernicosus* localities in the Czech Republic; comparison of sites in the different parts of the Czech Republic (**Papers I, II, IV**).
2. Comparison of the ecological requirement of *H. vernicosus* with the ecological requirement of potential competitors - related species (*Scorpidium cossonii, Warnstorfia exannulata*) (**Paper III**).

3. Comparison of Czech localities with sites in different parts of Europe (Western Carpathian, Southern Europe) (**Paper III**).
4. Reaction of *H. vernicosus* to management at localities (**Papers I, II**).
5. Long-term reaction of *H. vernicosus* to different environmental factors (**Paper II**).
6. Comparison of the recent and historical distribution of *H. vernicosus* in the Czech Republic, quantitative characteristics of all recent populations (**Paper V**).

Conclusions

Hamatocaulis vernicosus grows in the mineral-rich habitats, it has the highest cover at neutral pH (6.7 – 7.2) and conductivity between100 and 250 μS/cm, although most localities had lower values. The vegetation composition at *H. vernicosus* sites is variable according to pH and water table gradient. No noticeable difference between localities in different regions was found within the Czech Republic. However, the optimal conditions of the species are shifted towards more acid conditions (pH about 6) at localities in the southern Europe. No correlation was found between *H. vernicosus* population prosperity and the nutrient concentration; however, the populations are more extensive in iron richer conditions.

The main factor affecting *H. vernicosus* populations is the density of vascular plant cover – the species thrived best in habitats with sparse herbs and abundant "brown mosses". Therefore, at localities with the high vascular plants cover, regular mowing is necessary. The species prefers habitats with the stable high water table. At sites with lower water table, its growth and vitality can be supported by shallow gap cutting.

In the Czech Republic, the species has been recorded at 54 localities, while its occurrence was not verified at 89 historical localities. Population size at recent localities ranges from a few stems to tens of square metres; most of the populations are considered to be adversely affected by various negative factors. Nevertheless, the overall occurrence of *H. vernicosus* in the Czech Republic is not immediately endangered if current conditions at its localities, including the active conservation management, remain unchanged.

Perspectives

A number of questions remains open even after the completion of the above presented papers. First of all, it is necessary to address the questions related to the existence of differentiated phylogenetic lineages within *Hamatocaulis vernicosus*, which were suggested to represent cryptic species by Hedenäs & Eldenäs (2007). Before looking for the differences in ecological preferences of the two cryptic taxa, it might be worth to examine in detail the microspeciation processes within *H. vernicosus* s.l. (and other closely related taxa) in the global perspective, which would help to assess the biological status of the discovered lineages.

Further questions are from a major part connected with the practical protection of a species at the locality. One such aspect is the vegetative reproduction and regeneration from stem fragments and the survival rate of young regenerating plants in various conditions. This topic is being studied in the framework of another dissertation at the Department of Botany.

Detailed knowledge of these issues could substantially help in planning the active conservation measures at localities with small and unstable population of the target species. It particularly applies to the chances of the species to expand into other parts of the locality, estimating the consequences of the direct impact of the mowing technique to the species, or the use of the direct disturbation of the turf for spreading to the neighbouring micro-localities. Another aspect of conservation importance is the competition study between the target species and other bryophytes in various chemical and moisture conditions. The knowledge would facilitate the realization of specific treatments (excavating the gaps, removal of competitive species) at individual localities, where *H. vernicosus* is threatened.

References

Aerts R., Wallén B., Malmer N. & Caluwe H. (2001): Nutritional constraints on Sphagnum-growth and potential decay in northern peatlands. – Journal of Ecology 89: 292–299.

Barry M.J., Andreas B.K. Szalay F.A. (2008): Long-term plant community changes in managed fens in Ohio, USA. – Aquatic Conservation: Marine and Freshwater Ecosystems. 18: 392–407.

Bates J. F. & Farmer A. M. (1992): Bryophytes and lichens in a changing environment. – Clarendon press, Oxford.

Bergamini A., Peintinger M., Fakheran S., Moradi H., Schmid B. & Joshi J. (2009): Loss of habitat specialist despite conservation management in fen remnants 1995-2006. – Perspectives in Plant Ecology Evolution and Systematics 11: 65–79.

Bergamini A., Pauli D., Peintinger M. & Schmid B. (2001): Relationships between productivity, number of shoots and number of species in bryophytes and vascular plants. – Journal of Ecology 89: 920–929.

Bergamini A. & Peintinger M. 2002. Effects of light and nitrogen on morphological plasticity of the moss *Calliergonella cuspidata*. – Oikos 96: 355–363.

Bragazza L., Gerdol R. & Rydin H. (2003): Effects of mineral and nutrient input on mire bio-geochemistry in two geographical regions. – Journal of Ecology 91**:** 417–426

Bragazza L., Tahvanainen T., Kutnar L., Rydin H., Limpens J., Hajek M., et al. Nutritional constraints in ombrotrophic *Sphagnum* plants under increasing atmospheric nitrogen deposition in Europe. – New Phytologist 163: 609**–**16.

Clymo R.S. (1983): Peat. In: Gore A.J.P. (ed.). Ecosystems of the world 4A, mires: swamp, bog, fen and moor, general studies, pp 159–224.

Drexler J.Z. & Bedford B.L. (2003): Pathways of nutrient loading and impacts on diversity in a New York peatland. – Wetlands 22: 263–281.

Erzberger P. & Papp B. (2004): Annotated Checklist of Hungarian Bryophytes. Studia Botanica Hungarica 35: 91–149.

Graf U., Wildi O., Küchler W. & Ecker K. (2010): Five-year changes in Swiss mire vegetation. – Botanica Helvetica 120: 15–27.

Grootjans A.B., VanWirdum G., Kemmers R. & VanDiggelen R. (1996): Ecohydrology in The Netherlands: Principles of an application-driven interdiscipline. – Acta Botanica Neerlandica 45: 491–516.

Güsewell S., Buttler A. & Klötzli F. (1998): Short-term and long-term effects of mowing on the vegetation of two calcareous fens. – Journal of Vegetation Science 9: 861–872.

Hájek M., Horsák M., Hájková P. & Dítě D. (2006): Habitat diversity of central European fens in relation to environmental gradients and an effort to standardise fen terminology in ecological studies. – Perspectives in Plant Ecology Evolution and Systematics 8: 97–114.

Hájková P. & Hájek M. (2003): Species richness and above-ground biomass of poor and calcareous spring fens in the flysch West Carpathians, and their relationships to water and soil chemistry. – Preslia 75: 271–287.

Hájková P. & Hájek M. (2004): Bryophyte and vascular plant responses to base-richness and water level gradients in Western Carpathian Sphagnum-rich mires. – Folia Geobotanice 39: 335–351.

Hájková P., Hájek M. & Kintrová K. (2009): How can we effectively restore species richness and natural composition of a *Molinia*-invaded fen? – Journal of Applied Ecology 46:417–425.

Hájková P., Wolf P. & Hájek M. (2004): Environmental factors and Carpathian spring fen vegetation: the importance of scale and temporal variation. – Annales Botanici Fennici 41: 249–262.

Hedenäs L. (1989): The genera *Scorpidium* and *Hamatocaulis* gen. nov. in northern Europe. – Lindbergia 15: 8–36.

Hedenäs (1993): A generic revision of the *Warnstorfia-Calliergon* group. – Journal of Bryology 17: 447–479.

Hedenäs L. (1999): Altitudinal distribution in relation to latitude; with examples among wetland mosses in the *Amblystegiaceae*. – Bryobrothera 5: 99–115.

Hedenäs L. (2003): The European species of the *Calliergon-Scorpidium-Drepanocladus* complex, including some related or similar species. – Meylania 28: 1–117.

Hedenäs L. & Eldenäs P. (2007): Cryptic speciation, habitat differentiation, and geography in *Hamatocaulis vernicosus* (*Calliergonaceae*, *Bryophyta*). – Plant Systematics and Evolution 268: 131–145.

Hedenäs L. & Kooijman A.M. (1996): Phylogeny and habitat adaptations within a monophyletic group of wetland moss genera (*Amblystegiaceae*). – Plant Systematics and Evolution 199: 33–52.

Hedenäs L, Bisang I. & Schnyder N. (2003): The distribution of bryophytes in Switzerland and Liechtenstein IV. *Hamatocaulis* and *Pseudocalliergon.* – Botanica Helvetica 113:111–123.

Heikkilä R. & Lindholm T. (1988): Distribution and ecology of *Sphagnum molle* in Finland. – Annales Botanici Fennici 25: 11–19.

Hugonnot V. (2003): Rapport sur la présence de *Hamatocaulis vernicosus* (espèce de l'annexe II de la Directive Habitats) dans le Parc National des Pyrénées, zone périphérique. Convention n°. 2003–15S. Association Loisirs Botaniques, Parc National des Pyrénées.

Janssens J.A. (1983): Past and extant distribution of *Drepanocladus* in North America with notes on the differentiation of fossil fragments. – Journal of the Hattori Botanical Laboratory 54: 251–298.

Juutinen R. (2011): The decrease of rich fen bryophytes in springs as a consequence of large-scale environmental loss. A 50-year re-sampling – Lindbergia 34: 2–8.

Kooijman A.M. (1992): The decrease of rich fen bryophytes in the Netherlands. – Biological Conservation 59: 139–143. study. – 34: 2–18.

Kooijman A.M. (1993): Causes of the replacement of *Scorpidium scorpioides* by *Calliergonella cuspidata* in eutrophicated rich fens 1. Field studies. – Lindbergia 18: 78–84.

Kooijman A.M., Beltman B. & Westhoff V. (1994): Extinction and reintroduction of the bryophyte *Scorpidium scorpioides* in a rich-fen spring site in the Netherlands. – Biological Conservation 69: 87–96.

Kooijman A.M. & Bakker C. (1995): Species replacement in the bryophyte layer in mires: the role of water type, nutrient supply and interspecific interactions. Journal of Ecology 83: 1–8.

Kooijman A.M. & Paulissen (2006): Higher acidification rates in fens with phosphorus enrichment. – Applied Vegetation Science 9: 205-212.

Kooijman A.M. & Westhoff V. (1995): Variation in habitat factors and species composition of Scorpidium scorpioides communities in NW-Europe. – Vegetatio 117: 133–150.

Kučera J. & Váňa J. (2005): Seznam a červený seznam mechorostů České republiky. – Příroda 23: 1–104.

Ludwig G., Düll R., Philippi G., Ahrens M., Caspari S., Koperski M., Lütt S., Schulz F. & Schwab G. (1996): Rote Liste der Moose (Anthocerophyta et Bryophyta) Deutschlands. – Schriftenreihe für Vegetationskunde. 28: 189–306.

Mälson K., Backéus I. & Rydin H. (2008): Long-term effects of drainage and initial effects of hydrological restoration on rich fen vegetation. – Applied Vegetation Science 11: 99–106.

Moen A., Nilsen L.S., Øien D.I. & Arnesen, T. (2001): Outlying haymaking lands at Sølendet, central Norway: effects of scything and grazing. – Norsk Geografisk Tidsskrift 53: 93–102.

Naucke W., Heatwaite A.L., Eggelsmann R. & Schuch M. (1993) Mire chemistry. In: Heatwaite A. L. & Göttlich KH (eds.) Mires: Process, Exploitation and Conservation. John Wiley & Sons, Chichester, pp 263–310.

Paulissen M.P.C.P., Besalú L.E., Bruin H., Van der Ven P.J.M. & Bobbink R. (2005): Contrasting effects of ammonium enrichment on fen bryophytes. – Journal of Bryology 27:109–117.

Proctor M.C.F. (1982): Physiological Ecology: Water Relations, Light and Temperature responses, Carbon balance. In: Smith A. J. E. Smith (ed.). *Bryophyte Ecology*, pp. 333–381. Chapman & Hall, London.

Růžička I. (1987): Výsledky záchranného výzkumu ohrožené květeny mizejících rašelinišť a rašelinných luk v okolí Telče. – Vlastivědný sborník Vysočiny, Oddíl Věd Přírodních 8: 153–192.

Růžička I. (1989): Výsledky záchranného výzkumu ohrožené květeny mizejících rašelinišť a rašelinných luk na Jihlavsku. – Vlastivědný sborník Vysočiny, Oddíl Věd Přírodních 9: 135–176.

Sérgio C., Casas C., Brugués M. & Cros R.M. (1994): Lista Vermelha dos Briófitos da Península Ibérica. Instituto da Conservãçao da Natureza; Museu, Laboratório e Jardim Botânico & Universidade de Lisboa. Lisboa.

Sjörs H. (1950): On the relation between vegetation and electrolytes in north Swedish mire waters. Oikos 2: 241–258.

Söderström L. [ed.] (1996): Preliminary distribution maps of bryophytes in Northwestern Europe. Vol.2, Musci (A–I).

Štechová T. & Štech M. (2009): Lokality *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Bryophyta) na Českomoravské vrchovině. – Acta Rerum Naturalium 6: 13–24.

van Baaren M., During H. & Leltz G. (1987): Bryophyte communities in mesotrophic fens in the Netherlands. – Holarctic Ecology 2: 32–40.

van Belle J., Barendregt A., Schot P.P. & Wassen M.J. (2006): The effects of groundwater discharge, mowing and eutrophication on fen vegetation evaluated over half a century. – Applied Vegetation Science 9: 195–204.

Vasander H., Tuittila E.S., Lode E., Lundin L., Ilomets M., Sallantaus T., Heikkilä R., Pitkänen M.L. & Laine J. (2003): Status and restoration of peatlands in Northern Europe. – Wetlands Ecology and Management 11: 51–63.

Vitt D.H. & Wieder K. (2008): The structure and function of bryophyte-dominated peatlands. In: Goffinet B., Shaw A.J. (eds.) Bryophyte Biology, Cambridge University Press, Cambridge, pp 357–391.

Paper I

Biological Conservation 135: 443-449, 2007

Vegetation, water chemistry and management at the localities of *Hamatocaulis vernicosus* (Mitt.) Hedenäs (*Calliergonaceae*, Musci) in the Czech Republic

Táňa Štechová[1], Jan Kučera[1]

[1]Department of Botany, Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, CZ–370 05 České Budějovice, Czech Republic

Abstract

Hamatocaulis vernicosus has been revised in detail for its habitat preferences, ecology and population dynamic at all recent localities in the Czech Republic. The sites were surveyed for belowground water level, pH and conductivity of water, and the phytosociological relationships were analysed upon the evaluation of vegetation relevés. Seven localities in different parts of the Czech Republic were selected for a more detailed analysis of water chemistry – NH_4^+, NO_3^-, Ca^{2+} and Fe^{3+} and three localities were selected for manipulative experiments that included mowing and gap cutting during two years.

Hamatocaulis vernicosus had the highest cover at neutral pH (6.7 – 7.2) and conductivity between100 and 250 μS/cm, although most localities had lower values. No correlation was found between the cover of *Hamatocaulis* and the concentrations of NH_4^+ (range 0.15 – 0.30 mg/l), NO_3^- (0.1 – 0.4 mg/l), Ca^{2+} (3 – 10 mg/l), or Fe^{3+} (0.2 – 1.7 mg/l).

Populations of *Hamatocaulis vernicosus* were positively influenced by mowing only at a site with a high cover of vascular plants, and gap cutting was only beneficent at sites with lower water table. The growth and vitality of *Hamatocaulis* can thus be supported by suitable management especially in drier habitats.

Paper II

Wetlands Ecology and Management 20: 329-339, 2012
The original publication is available at www.springer.com
http://www.springerlink.com/content/c3710w86663q5639/

Factors affecting population size and vitality of *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Musci)

Táňa Štechová[1], Jan Kučera[1], Petr Šmilauer[2]
[1]Department of Botany, Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, CZ–370 05 České Budějovice, Czech Republic
[2]Department of Ecosystem Biology, Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, CZ–370 05 České Budějovice, Czech Republic

Abstract
Hamatocaulis vernicosus, a rare moss species, was monitored in 33 fens in the Czech Republic for five to six years. Population size, vitality and trends of population development were recorded. Water chemistry, water level fluctuation, vegetation type and cover, as well as mowing regime were assessed and the effect of these potential predictors on the species populations was examined. Populations of *H. vernicosus* were affected mainly by the density of vascular plants – the species thrived best in habitats with sparse herb and abundant "brown moss" cover. Other important factors included water table fluctuation and water concentration of iron. Populations were more vital and prospered better in sites with a stable water table and more iron-rich conditions. Dependence of population parameters on other measured characteristics of water chemistry was not detected.

Paper III

Preslia 80: 399-410, 2008

Comparison of habitat requirements of the mosses *Hamatocaulis vernicosus*, *Scorpidium cossonii* and *Warnstorfia exannulata* in different parts of temperate Europe

Táňa Štechová[1], Michal Hájek[2,3], Petra Hájková[2,3] & Jana Navrátilová[2,3]

[1]Department of Botany, Faculty of Science, University of South Bohemia, Branišovská 31, CZ–370 05 České Budějovice, Czech Republic, e-mail: tana.stechova@prf.jcu.cz

[2]Department of Botany and Zoology, Masaryk University, Kotlářská 2, CZ-611 37 Brno, Czech Republic, e-mail: hajek@sci.muni.cz, buriana@sci.muni.cz, janaernestova@seznam.cz

[3]Institute of Botany, Academy of Sciences of the Czech Republic, Poříčí 3b, CZ-60300 Brno, Czech Republic

Abstract

Habitat affinities of the red-listed and EU Habitat Directive moss species *Hamatocaulis vernicosus* and the more widely distributed allied species *Scorpidium cossonii* and *Warnstorfia exannulata* were analysed. Ecological preferences of these fen mosses, with respect to water pH, water conductivity, Ellenberg's moisture and nutrient indicator values, were compared in three different European locations (Bohemian Massif, the West Carpathians and Bulgaria) using logistic regressions fitted by means of Huisman-Olff-Fresco models. Inter-specific co-occurrences of the species were also investigated. *Warnstorfia exannulata* preferred slightly acid conditions, about pH 5.6 at all the locations studied. Ecological behaviour of *S. cossonii* was very similar at all the locations, where it occupied base-rich habitats (pH > 7). The pH optimum of *H. vernicosus*, occupying habitats in the middle part of the base richness gradient, varied between locations from 6.0 in Bulgaria to 6.7–7.0 in the West Carpathians and Bohemian Massif. Niche diversification followed the gradient in Ellenberg nutrient indicator values and was similar at all the locations. In the Bohemian Massif and Bulgaria, the occurrence of *W. exannulata* was further associated with a relatively high moisture indicated by the Ellenberg indicator value. The results obtained from the Huisman-Olff-Fresco models accord with the results of inter-specific co-occurrences. Moreover, the latter method revealed a link between *H. vernicosus* and the occurrence of disjunctly occurring boreal sedges, suggesting the relic nature of *H. vernicosus* habitats at these locations.

Paper IV

Silva Gabreta 16: 1-11, 2010

Distribution and habitat requirements of the moss *Hamatocaulis vernicosus* (Mitt.) Hedenäs in the Bohemian Forest

Táňa Štechová[1], Eva Holá[1, 3], Alžběta Manukjanová[1] & Eva Mikulášková[2]

[1] Department of Botany, Faculty of Science, University of South Bohemia, Branišovská 31, CZ–37005 České Budějovice, Czech Republic

[2] Department of Botany and Zoology, Faculty of Sciences, Masaryk University, Kotlářská 2, CZ–61137 Brno, Czech Republic

[3] Agency of nature conservation and landscape protection of the Czech Republic, Nuselská 39,CZ–14000 Praha, Czech Republic

Abstract

The species *Hamatocaulis vernicosus* is a fen moss, which is endangered and protected in Europe. Recent-ly we have known 9 localities of this species in the Bohemian Forest. Vegetation relevés and detailed water chemistry were investigated at all localities and subsequently compared with data on *H. vernicosus* from different parts of the Czech Republic. The studied species grows in similar vegetation types in all of the Czech localities, including the Bohemian Forest. However, in the Bohemian Forest sites, chemical composition of water differs markedly, particularly in Ca, Mg and NO_3^- contents.

Paper V

Bryonora 49: 5-16, 2012

The distribution of *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Bryophyta) in the Czech Republic

Rozšíření druhu *Hamatocaulis vernicosus* (Calliergonaceae, Bryophyta) v České republice

Táňa Štechová[1], Milan Štech[1], Jan Kučera[1]

[1]Department of Botany, Faculty of Biological Sciences, University of South Bohemia, Branišovská 31, CZ–370 05 České Budějovice, Czech Republic

Abstract

The historical and recent distribution of *Hamatocaulis vernicosus*, a species of Annex II of the Habitats Directive, was studied on the basis of herbarium specimens, a review of published literature and the authors' own survey of potentially suitable biotopes. The species has been recorded recently at 54 localities, while its occurrence was not verified at 75 historical localities supported by specimens, and at 14 unsupported localities. Population size ranges from a few stems to tens of square metres; most of the populations are considered to be adversely affected by various negative factors including unstable water regime, eutrophication, lack of appropriate management, expansion of woodland and other successional changes.

Curriculum vitae

Táňa Štechová (∗ 24th March 1981, Tábor)

Education

1999 – 2003: University of South Bohemia, Faculty of Biological Science, B.Sc. studies, Biology; B.Sc. thesis: Vegetation dynamics of *Pinus rotundata* peatbogs after disturbances [in Czech].

2003 – 2005: University of South Bohemia, Faculty of Biological Science, MSc. studies, Botany – vegetation ecology and systematic of the higher plants; MSc. thesis: Ecology of *Hamatocaulis vernicosus* (*Amblystegiaceae, Bryopsida*) and a proposal of management at its localities [in Czech].

since 2005: University of South Bohemia, Faculty of Biological Science, PhD studies, Botany; dissertation: Ecological study of the moss *Hamatocaulis vernicosus*.

Teaching activities

2005 – 2008: Practices Systematic Botany of the Higher Plants
2005 – 2007: Practices Biological Laboratory Techniques
2005 – 2006: Field Course of Botany
2006 – 2012: Supervising of diploma theses focused on experimental Bryology

Fieldwork and other activities

Since 2005: monitoring of *Hamatocaulis vernicosus* and other threatened peatbog moss species at all sites in the Czech Republic for Nature Conservation Agency of the Czech Republic.

August 2009: Summer course of peatland ecology (Uppsala University, Sweden).

Conference contributions

Štechová T. (2004): Vegetation dynamics of *Pinus rotundata* peatbogs after disturbances. - 11. Österreichisches Botanikertreffen, Wien, Austria (poster).

Štechová T. (2005): Ecology and distribution of *Hamatocaulis vernicosus* (*Bryopsida, Amblystegiaceae*) and management at its localities. - Second Meeting of Czech and Hungarian Ph.D. students in Plant Ecology and Botany, Hrubá Vrbka, Czech Republic (talk).

Štechová T. (2005): Ecology, management and distribution of *Hamatocaulis vernicosus* (Musci, Amblystegiaceae) in the Czech Republic. - Conservation Ecology of Cryptogams, Bispgården, Sweden (poster).

Štechová T. & Manukjanová A. (2009): Distribution, Ecology and Conservation of *Hamatocaulis vernicosus* (Calliergonaceae, Bryophyta) in the Czech Republic. - The 2nd European Congress of Conservation Biology, Prague, Czech Republic (poster).

Grant supports:

2007-2009: Molecular and ecological aspects of the biology of rare bryophytes: baseline data for the effective conservation (GA of the Academy of Sciences of the Czech Republic) – joint investigator

Publications

Štechová T., Kučera J. & Šmilauer P. (2012): Factors affecting population size and vitality of *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Musci). – Wetlands Ecology and Management 20: 329–339.

Bastl M., Štechová T. & Prach K. (2009): The effect of disturbance on the vegetation of peat bogs with *Pinus rotundata* in the Třeboň Basin, Czech Republic. – Preslia 81 (in press).

Kučerová A., Rektoris L., Štechová T. & Bastl M. (2008): Disturbances on a wooded raised bog – How windthrow, bark beetle and fire affect vegetation and soil water quality? – Folia Geobotanica 43: 49–67.

Štechová T., Hájek M., Hájková P. & Navrátilová J. (2008): Comparison of habitat requirements of the mosses *Hamatocaulis vernicosus*, *Scorpidium cossonii* and *Warnstorfia exannulata* in different parts of temperate Europe. – Preslia 80: 399–410.

Štechová T. & Kučera J. (2007): The requirements of the rare moss, *Hamatocaulis vernicosus* (Calliergonaceae, Musci), in the Czech Republic in relation to vegetation, water chemistry and management. – Biol. Cons. 135: 443–449.

Štechová T.: Výskyt ohroženého rašeliništního mechu *Drepanocladus polygamus* v jižních Čechách. Sbor. Jihočes. Muz. v Čes. Budějovicích, Přír. Vědy (in press).

Štechová T., Štech M. & Kučera J. (2012): The distribution of *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Bryophyta) in the Czech Republic. Bryonora 49: 5–16.

Štechová T., Manukjanová A. et Čejková A. (2011): Bryoflóra tří rašelinných luk v Orlických horách [Bryophyte flora of three fen meadows in the Orlické hory Mts.]. Bryonora 47: 52–56.

Štechová T., Manukjanová A., Holá E., Kubešová S., Novotný I. & Zmrhalová M. (2010): Současný stav populací druhů *Helodium blandowii* (Thuidiaceae) a *Scorpidium scorpioides* (Calliergonaceae) v České Republice. – Bryonora 46: 22–32.

Štechová T., Holá E., Gutzerová N., Hradílek Z., Kubešová S., Lysák F., Novotný I. & Peterka T. (2010): Současný stav lokalit druhů *Meesia triquetra* a *Paludella squarrosa* (Meesiaceae) v České Republice. – Bryonora 45: 1–11.

Holá E., Štechová T. & Koval Š. (2010): Ohrožené mechorosty rašelinných biotopů. – Ochrana přírody 6: 19–21.

Štechová T., Holá E., Manukjanová A. & Mikulášková E. (2010): Distribution and habitat requirements of the moss *Hamatocaulis vernicosus* (Mitt.) Hedenäs in the Bohemian Forest. – Silva Gabreta. 16: 1–11.

Štechová T. & Štech M. (2009): Lokality *Hamatocaulis vernicosus* (Mitt.) Hedenäs (Calliergonaceae, Bryophyta) na Českomoravské vrchovině. – Acta Rerum Naturalium 6: 13–24.

Štechová T. & Štech M. (2007): Ohrožené mechorosty rašelinišť České republiky. – Zprávy ČBS, Mater. 22: 113–117.

Štechová T., Holá E., Štech M. & Mikulášková E. (2007): Recentně známé lokality mechu *Hamatocaulis vernicosus* (Mitt.) Hedenäs v západních Čechách a na Šumavě. – Erica 14: 5–12.

Kučera J. & Štechová T. (2006): Nová bryologická literatura XV, Bryonora 37: 45 – 56.

Hofhanzlová E., Ekrt L. & Štechová T. (2005): Floristický a vegetační průzkum rašeliniště Na Klátově. – Acta rerum naturalium 1: 45–52.