The *Hypnum cupressiforme* complex in LBL B Herbarium (Lublin, Poland) - taxonomic revision and some biometric notes.

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Abstract:
The *Hypnum cupressiforme* complex comprises widespread and very variable pleurocarpous mosses. As the basis of revision is an anatomical and morphological analysis of vegetative leaf characters of 414 specimens belonging to the *Hypnum cupressiforme* complex housed in the LBL B Herbarium at the Maria Curie-Sklodowska University. The short historical background of the taxonomic and nomenclature changes within the complex is provided, an ecological preferences of all revised species are given and the suitability of such data for their diagnosis is assessed. Some taxonomically important characters of the gametophytes are reviewed and discussed and the main results of the biometric analysis of selected leaves characters is shortly described.

Key words: Bryophyta, Musci, Hypnaceae, *Hypnum cupressiforme*, biometric analysis, variability, ecology, Poland, Lublin.

Introduction

*Hypnum cupressiforme* is a widely distributed and fairly variable moss. There are only some 15 taxa in the rank of varieties and forms within the complex. The representatives of this group are characterised by a great ecological plasticity and a broad variability amplitude. In Poland *Hypnum cupressiforme* is a very widely distributed too. A great diversity of its varieties and forms is observed here. Zdzisława Wiśniewska was the first to perform a taxonomonic verification of the complex in Poland (only in KRAM - previously Herbarium of Institute of Botany at the Jagiellonian University) and to research it in depth (1957). She collaborated with Professor Bronisław Szafran, who later on also placed it in his moss flora (1961).

Clearly, a great variability of the representatives of the *Hypnum cupressiforme* complex has caused is likely to cause many problems regarding their appropriate classification. Therefore their taxonomic position, classification and nomenclature are differently interpreted.

In the Bryophyte Herbarium (LBL B) at the Maria Curie-Sklodowska University (Lublin, Poland) 414 specimens are housed as *Hypnum cupressiforme*. In the last 25 years world bryologists have proposed many taxonomical and nomenclatural changes on the division of the complex. Arrangement of taxa of the *Hypnum cupressiforme* group in LBL B Herbarium not correspond with our present state of knowledge, so the results of taxonomic revision presented below in connection with a biometric analysis.
put the new light on the variability of *Hypnum cupressiforme* in Poland and Central Europe.

**Historical background**

The taxonomic rank and systematic position of taxa within the complex have changed over the years. Whereas in his study *Species muscorum frondosorum* (1801), Hedwig described a single taxon only, as many as 19 varieties were recorded by Bridel (1827). Four important studies on this moss group, conducted and published in Europe, have come out in the last 60 years. Doignon (1950) described taxa for France, Barkman (1966) for Denmark, Hedenäs (1987, 1991) for Sweden and Smith (1997, 2004) for British Isles.

They treated the *Hypnum cupressiforme* complex in very different ways. However, it seems Ando’s monograph of the entire genus *Hypnum* offers the most comprehensive taxonomic study (1986, 1987, 1989, 1990, 1992). His work was mostly based on the material from Asia, so bryologists from the Old World noticed a few differences between the European material and Ando’s diagnoses (comp. Smith 2004). Still, his conception seems to the most consistent with our knowledge about this complex. It should be noticed that the taxonomic rank and systematic position of intraspecific taxa within the complex have changed over the years, and many have been recognised as species (cf. Smith 1978, 1997, 2004). New varieties have also been described (Smith 1997, 2004).


The eventful taxonomic history of the complex suggests that its division so far is not final. Some selected conceptions of the division of this complex are given below in chronological order (species not occurred in Europe are not listed).

**I. EUROPEAN TAXA**


sectio: *Hypnum*

species:

1) *Hypnum mammillatum* = *Hypnum andoi*
2) *Hypnum jutlandicum*
3) *Hypnum uncinatum*
4) *Hypnum cupressiforme*
   a) var. *cupressiforme*
   b) var. *julaceum*
   c) var. *lacunosum*
   d) var. *subjulaceum*
   e) var. *resupinatum*
   f) var. *filiforme*
II. POLISH TAXA


sectio: Euhypnum

species:
1) Hypnum cupressiforme
   a) fo. typica = var. cupressiforme
   b) var. ericetorum
   c) var. mammillatum
   d) var. subjulaceum
   e) var. resupinatum
   f) var. uncinatum
2) Hypnum vaucheri


sectio: Hypnum

species:
1) Hypnum vaucheri
2) Hypnum cupressiforme
   var. cupressiforme
   var. filiforme
   var. resupinatum
   var. subjulaceum
   var. lacunosum
3) Hypnum andoi
4) Hypnum jutlandicum
5) Hypnum imponens

Material and methods

During the course of study all specimens have been examined. The morphology and anatomy of plants was analyzed using a stereo- and compound microscope. Also the habitat preferences of all examined specimens were noted. Arrangement of taxonomic classifications follows Ando (1987-1992) and Ochyra et al. (2003). Names of liverworts follows Klama (2006). During the examination of the herbarium material 80 specimens were selected for biometric analysis. In total, over 20,000 separate measurements of morphological and anatomical characters are made. Measurements include the vegetative leaf characters like length and width of leaf lamina, alar cell group as well as length and width of mid-leaf and basal cells (Fig 1). Permanent slides were prepared with polyvinyl alcohol solution (Błaszkowski,
Tadych & Madej 1999).

The ecological characterisation of taxa belonging to the complex was made with using the information given on the herbarium labels.

Figure 1. Leaf and cell dimensions and location of measured cells.

Results

After revision, taxonomic or nomenclatural status of 200 specimens has changed. Finally, in revised material, 6 species and 4 varieties were recognized. Only two species and all varieties (over 97% of analysed material) belonging to the *Hypnum cupressiforme* complex including *Hypnum jutlandicum* (12 specimens), typical form of *H. cupressiforme* (344) and three other varieties: *filiforme* (11), *lacunosum* (29) and *subju-laceum* (5). Remained 13 specimens (3%) were excluded from the complex. They contained predominantly the *Hypnum lindbergii* (9 specimens) and additionally four another species like *Herzogiella seligeri, H. pallescens, Platygyrium repens* and *Rhytidium rugosum* (Fig. 2). *Hypnum andoi* belong to the *H. cupressiforme* complex, but specimens of this species are not present in LBL B Herbarium.

Figure 2. *Hypnum cupressiforme* complex in LBL Herbarium after revision.

The results of biometric analysis provided the basis for the checking range of variability observed within the studied material. The variability level of all measured leaf characters is given on Fig 3 and 4. Additionally on figure 5 an ecological preferences of all studied specimens and all analysed taxa are presented.
Figure 3. Range of variation of mean values of selected characters.; solid line - usual values, dotted line - exceptional values.; *H. c. var. filiforme* (A), *H. jutlandicum* (B), *H. c. var. cupressiforme* (C), *H. c. var. subjulaceum* (D) *H. c. var. lacunosum* (E).
Figure 4. Scatter diagram based on the mean values of measurements of selected characters in the *Hypnum cupressiforme* group.

Figure 5. Ecological preferences of the *Hypnum cupressiforme* group based on the revised material.
While revising the herbarium material and examining specimens of the complex in question, I also came across other bryophyte species. They additionally co-occurred in the *Hypnum cupressiforme* herbarium samples. These are mostly epiphytic taxa, and they include 9 moss species and 7 liverwort species:

**Liverworts**
- Blepharostoma trichophyllum
- Lejeunea cavifolia
- Lepidozia reptans
- Lophocolea heterophylla
- Metzgeria furcata
- Plagiochila porelloides
- Ptilidium pulcherrimum

**Mosses**
- Brachytheciastrum velutinum
- Neckera complanata
- Neckera crispa
- Orthodicranum montanum
- Orthotrichum obtusifolium
- Orthotrichum speciosum
- Pylaisia polyantha
- Rosulabryum laevifilum
- Sciuro-hypnum populeum

**Discussion**

The analysis of morphological characters shows that *H.c. var. lacunosum* and *H.c. var. filiforme* are the easiest and the quickest to recognise of all the varieties in the *Hypnum cupressiforme* complex as these taxa are clearly differentiated by the habit and leaf dimensions. The shape and size of leaves vary within the group but are fairly consistent within varieties. *H.c. var. lacunosum* has the largest leaves while *H.c. var. filiforme* has the smallest ones.

The variability analysis of anatomical characters of individual elements of the leaf lamina and leaf cells demonstrates that they may be very useful in differentiating *H.c. var. filiforme, H.c. var. lacunosum* and *H. jutlandicum*. Measurements of individual characters or the ratio analysis of various elements of leaf lamina or leaf cells are not reliable enough in the case of other varieties. They do not give clear-cut and unambiguous results that could provide a correct taxonomic verification of the specimens.

Allies of the *Hypnum cupressiforme* complex display different ranges of ecological preference. Epigeic taxa like *H. jutlandicum* and *H.c. var. lacunosum* as well as epipetric *subjulaceum* and epiphytic *filiforme* are rather stenotopic whereas the *H.c. var. cupressiforme* has widest ecological tolerance and occurs in various site conditions.

Specimens may be determined with much certainty although the ranges of character variability in individual varieties overlap, often significantly. However, it should be remembered that only the combination of morphological and anatomical characters, the size of organs and their parts as well as substrate and habitat data give the full body of information necessary to determine correctly one of the most variable - and at the same time common - mosses, that is *Hypnum cupressiforme*.

**References**
