Paludella squarrosa observed as a sub-fossil in fens of the Semois Valley (Belgium)

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Photographs by the author.

Résumé. – Découverte de *Paludella squarrosa* sub-fossile dans la tourbe des marais alcalins de la vallée de la Semois (Belgique). Lors d'opérations de carottage et d'analyse de tourbe réalisées en 2017 dans les marais de la Semois, des fragments des mousses *Tomentypnum nitens* (Hedw.) Loeske et *Paludella squarrosa* (Hedw.) Brid. ont été trouvés; il est très probable que ces fragments datent d'une époque comprise entre 2.000 et 5.000 B.P. La seconde espèce ne fait pas partie de la bryoflore belge actuelle et n'avait également jamais été trouvée à l'état sub-fossile en Belgique. Par contre elle a déjà été trouvée à l'état sub-fossile ailleurs en Europe et dans le monde.

Samenvatting. – Een subfossiele vondst van *Paludella squarrosa* in veen in de vallei van de Semois (België). In de kernen van boringen in veengebieden in de Semoisvallei, uitgevoerd in 2017, werden fragmenten gevonden van de mossoorten *Tomentypnum nitens* (Hedw.) Loeske en *Paludella squarrosa* (Hedw.) Brid.; ze dateren vermoedelijk van ca. 2.000 tot 5.000 B.P. De tweede soort maakt geen deel uit van de recente Belgische mosflora en subfossiel materiaal ervan werd niet eerder in België aangetroffen. Evenmin waren tot nog toe subfossiele vondsten bekend.

Introduction

In the framework of the restoration of areas of the rich-fen habitat in Wallonia (Habitat of Community Interest 7230) which is one of the goals of the Belgian Integrated Project (LIFE14 IPE/BE/000002 BNIP) a series of peat cores were drilled in three fens of the Semois Valley: Fouches (IFBL L7.46.34), Sampont (IFBL L7.55.22) and Heinsch (IFBL L7.46.41) all being located in the commune of Arlon. These cores were meant to give an insight into the past history of these fen areas and to help indicate possible restoration actions in accordance to past and current vegetation and hydrology. Indeed, applied paleoecological research using plant macrofossil data has provided long-term baseline data for the origin and nature of vegetation changes and can be used to guide conservation management in environmentally sensitive areas (Landwehr 1951; Mauquoy & Van Geel 2007).

Description of the corings and the moss fragments

The peat cores were drilled on 22nd February 2017 at the Fouches and the Sampont fens, and on 6th March in the Heinsch fen. The soil profiles were analysed *in situ* by Ruurd van Diggelen (University of Antwerp). In five of them a layer 5 cm thick of well-preserved peat containing brown plant material ("brown mosses") was taken for analysis. This layer was found at a depth of 40, 70 and 100 cm in the three Fouches cores, at a depth of 80 cm in the Sampont core and at a depth of 50 cm in the Heinsch core.

The samples were analysed under binocular microscope after carefully diluting them in fresh water.

Two bryophyte species could be identified in four of the five corings, whereas no bryophyte was found in the 40 cm deep brown layer in Fouches. In all other five corings many stem fragments with entire leaves of *Tomentypnum nitens* (Hedw.) Loeske were found. The second species that was identified is *Paludella squarrosa* (Hedw.) Brid. It was found in the 70 cm deep brown layer in Fouches and in the 80 cm deep brown layer in Sampont. The species was less preserved than *Tomentypnum nitens* as only small dark brown stem fragments were found with almost no leaves left. All fragments were very fragile and special care was taken when manipulating them. Fortunately we also found some rare intact leaves that allowed identification. Most of the *P. squarrosa* stem fragments were 2 to 5 mm long but some were up to 1 cm. The intact leaves were approximately 1.5 mm long and 0.8 mm wide. The isodiametric cells of the distal part of the leaves were 8 to 12 µm wide.

Figure 1A shows the general aspect of a stem fragment 8 mm long with some squarrose leaves still visible. Figures 1B to 1D show closer views of some intact leaves.

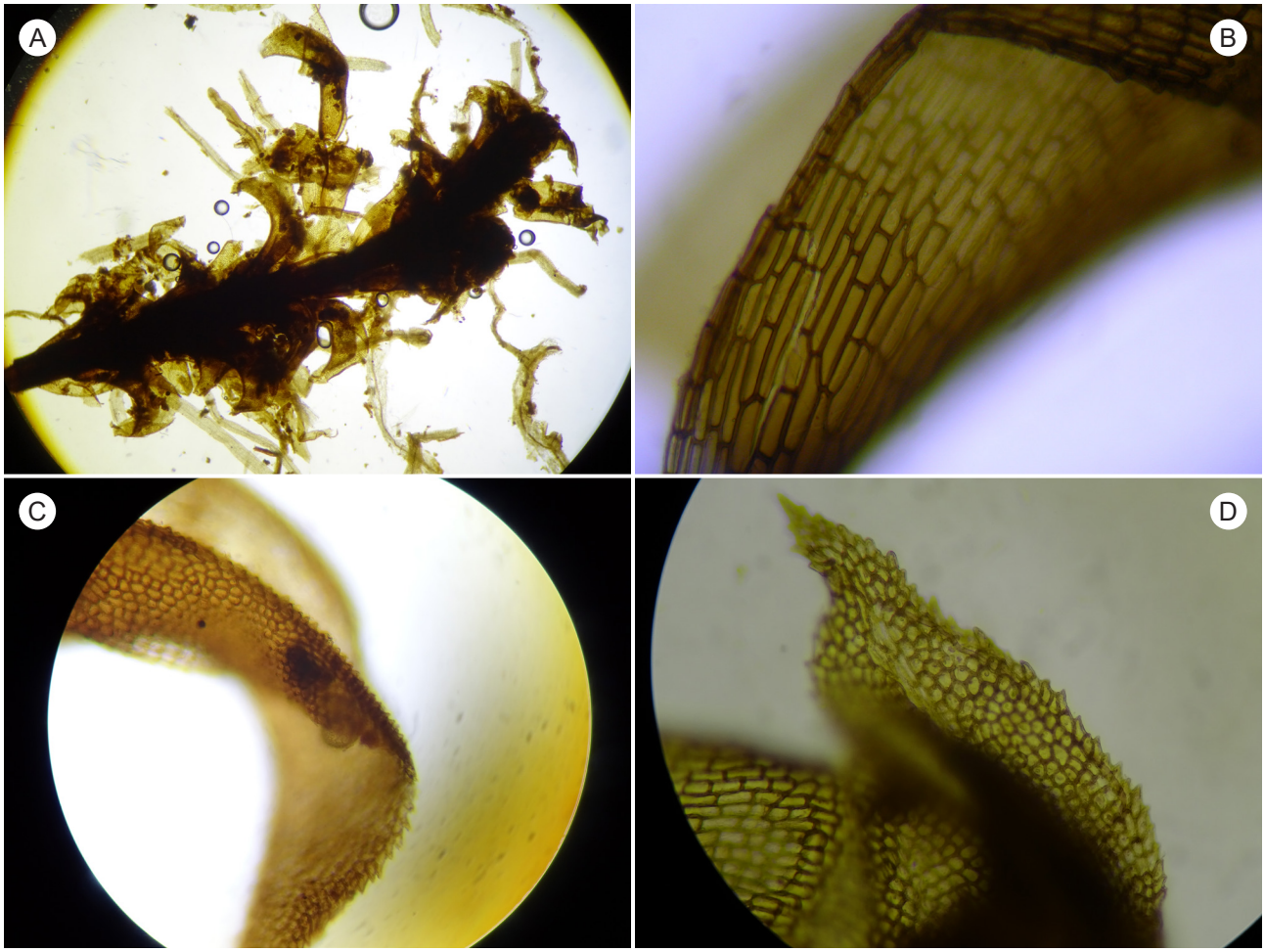


Figure 1. *Sub-fossil material of* Paludella squarrosa *from the Sampont fens (valley of the Semois). – A: fragment from the "brown moss" layer at the Sampont fen with characteristic squarrose leaves. – B: basal part of an intact leaf showing the smooth elongate cells. – C: distal part of an intact leaf showing the isodiametric and strongly papillose cells. – D: distal part of an intact leaf showing the strongly crenulate border.*

All fragments are dark brown and show the characteristic features of this species (Smith 1980): the conspicuous squarrose leaves, the elongate smooth and thin-walled cells in the proximal half, the isodiametric strongly papillose thick-walled cells in the distal half of the leaf, the crenulate leaf border and finally a nerve which ends below the apex.

Discussion

This is the first observation of *Paludella squarrosa* as a sub-fossil in Belgium. *Paludella squarrosa* has already been mentioned in peaty sub-fossil remains by some authors in the past and the species is almost always accompanied by *Tomentypnum nitens,* both species being characteristic of rich-fens (Dierssen 2001). As far as Europe is concerned, Landwehr (1951) found a sub-fossil tussock on a peat "outcrop" in the Amstelveen bog near Amsterdam (The Netherlands) together with *Tomentypnum nitens.* In Great-Britain *Paludella squarrosa* and *Tomentypnum nitens* are known from Pleistocene deposits (2,580,000 to 11,700 B.P.) from over 20 localities in England, Ireland and Scotland and are assumed to have been two common species in the lowlands of northern Britain during the Flandrian (17,000 to 10,000 B.P.), extending south to the Norfolk Broads (Dickson 1973; Porley & Hudgetts 2005).

In the Eastern European Russian Arctic sub-fossil leaves of *Paludella squarrosa* have been used to identify a wet and mesotrophic phase in the local peatland succession (Mauquoy & Van Geel 2007) and in Canada the two species have been recorded in peat cores (Arlen-Pouliot & Bhiry 2005; Fillion *et al*. 2014).

Nowadays *Paludella squarrosa* has a highly disjunct distribution in the temperate zone around the globe where it occurs in rich to intermediately rich spring fens in sites with mineral-rich spring or seepage water percolating the peatland (Dierssen 2001; Bonte *et al*. 2012; Lamentowicz *et al*. 2013). In temperate Europe it is considered a glacial relict (Wilczek 1946; Touw & Rubers 1989; Dierssen 2001; Porley & Hudgetts 2005; Blasi *et al*. 2010) and is still widely distributed today in Scandinavia (Nyholm 1998) and in some Central European countries, includ-

ing Poland (Wilczek 1946; Lamentowicz *et al*. 2013), the Slovak Republic (Pleskova *et al*. 2011) and Germany (http://www.moose-deutschland.de/organismen/paludella-squarrosa-hedw-brid-1). In Western Europe *Paludella squarrosa* is restricted to scattered localities in the alpine zone and other mountain areas in France (Bonte *et al*. 2012), Italy (Cortini-Pedrotti 2006; Blasi *et al*. 2010) and Switzerland (http://www.swissbryophytes.ch/index.php/de/verbreitung?taxon_id=nism-1795).

In the British Isles, where it was assumed to be extinct since 1916, the species was discovered in Ireland in 1998 at the Bellacorick Bog mire where it was growing with *Tomentypnum nitens* (Porley & Hodgetts 2005).

In The Netherlands the species was last recorded from two localities in Drenthe in 1859 and is now considered an extinct species (Touw & Rubers 1989; BLWG 2007).

In Belgium *Paludella squarrosa* has never been observed as part of the extant vegetation and is not included in the most recent Bryophyte check-list (Sotiaux *et al*. 2007). *Tomentypnum nitens* is rare in Belgium and is only known from some rich-fens in Wallonia (Sotiaux & Vanderpoorten 2015; Sotiaux *et al*. 2007) and is considered extinct in Flanders (Dirk De Beer, *pers. com*.).

In the absence of a precise dating of the peat where the cores were taken we can only use indirect information to approximately determine when the two species were growing in these Semois fens. The most reliable information found is derived from peat cores that were taken in 1969 by Heim-Thomas (1969) to analyse the pollen diagram of the "Vance-Sampont" fen which corresponds to the Sampont fen today as it can be deduced from the map published in her work. The Heim-Thomas study gives a precise indication on the age of the different layers in connection to the depth of layers inside the cores based on pollen diagrams and confirmed by ^{14}C dating. We can deduce from this work that the depths at which *Paludella squarrosa* was found (70 cm at Fouches and 80 cm at Sampont) correspond to a period extending from the end of the Atlantic period (4300 BP) to the beginning of the Subatlantic period (2700 BP).

Interestingly two other studies carried out in Canada and using the same kind of techniques have shown that *Paludella squarrosa* and *Tomentypnum nitens* were present in peat cores during a period running from 5000 years BP to 2100 BP (Arlen-Pouliot & Bhiry 2005; Fillion *et al*. 2014). Landwehr (1951) dated his finding in the Netherlands on the basis of old maps to a period of 500 to 700 B.P. but no precise dating using ^{14}C technique was used in this case for confirmation.

Of course these assessments can only give an indication. The accumulation rates of peat layers are known to vary much with time and from site to site (Mauquoy & Van Geel 2007). For example, Arlen-Pouliot & Bhiry (2005) and Fillion *et al*. (2014) calculated that the peat accumulation rates were ranging from 0.18 mm/year to 1.34 mm/year in their study, which would give in our case a theoretical dating of 2000 to 5000 years B.P. depending on the rates of peat accumulation. This dating range fits the above-mentioned assessment by Heim-Thomas (1969). Anyway, the only reliable and final answer to this question should come from a precise ^{14}C dating.

The finding of sub-fossil moss fragments which are typical of post-glacial times helps interpreting the very long history of the Semois rich-fens. An analysis of the peat cores (pollen diagram, identification of sub-fossil plant remains) yields information about the changes that have occured in the past, and this leads to the conclusion that the present vegetation is not only the result of the today's hydrology and topography but also of events that occurred in the past centuries and millennia.

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