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Transfer of the Eocene *Jungermannia berendtii* Grolle to *Solenostoma*

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Abstract – The Baltic amber fossil *Jungermannia berendtii* is transferred to *Solenostoma* based on the presence of numerous long rhizoids, distinct trigones, and subquadrate-rotund to elongate-elliptical leaves.

Amber / Cenozoic / Jungermanniales / Jungermanniineae / liverwort / Solenostomataceae

INTRODUCTION

Eocene Baltic amber is well known as a source of diverse bryophyte inclusions (Grolle & Meister, 2004; Frahm, 2010). Currently, twenty-four species of liverworts are recognized from this amber (Heinrichs *et al.*, 2015; Katagiri, 2015), the majority of which are known from multiple specimens. *Jungermannia berendtii* Grolle, however, is known exclusively from the scanty, sterile holotype specimen. This fossil was tentatively placed in *Jungermannia* L. subgenus *Solenostoma* (Mitt.) Amakawa sect. *Desmorhiza* Amakawa (Grolle, 1980) based on the presence of numerous rhizoids that extend from the ventral stem cortex. Moreover, the fossil is characterized by a stem with relatively thin-walled, rectangular cortical cells, subquadrate-rotund to elongate-elliptical, succubously to almost transversally inserted leaves, and +/– isodiametric leaf cells with distinct trigones. Grolle (1980) and Grolle & Meister (2004) accepted a wide genus concept of *Jungermannia* that includes *Solenostoma* Mitt. and *Plectocolea* (Mitt.) Mitt. However, Hentschel *et al.* (2007) demonstrated that *Jungermannia* s.l. is polyphyletic and consequently reinstated the genus *Solenostoma* (incl. subg. *Plectocolea* Mitt.). A recent molecular analysis by Shaw *et al.* (2015) corroborates the status of *Solenostoma* as a separate genus. We therefore conducted a thorough re-investigation of the type specimen of *J. berendtii* (Figs 1-3) and confirm that this fossil in fact belongs to *Solenostoma*.

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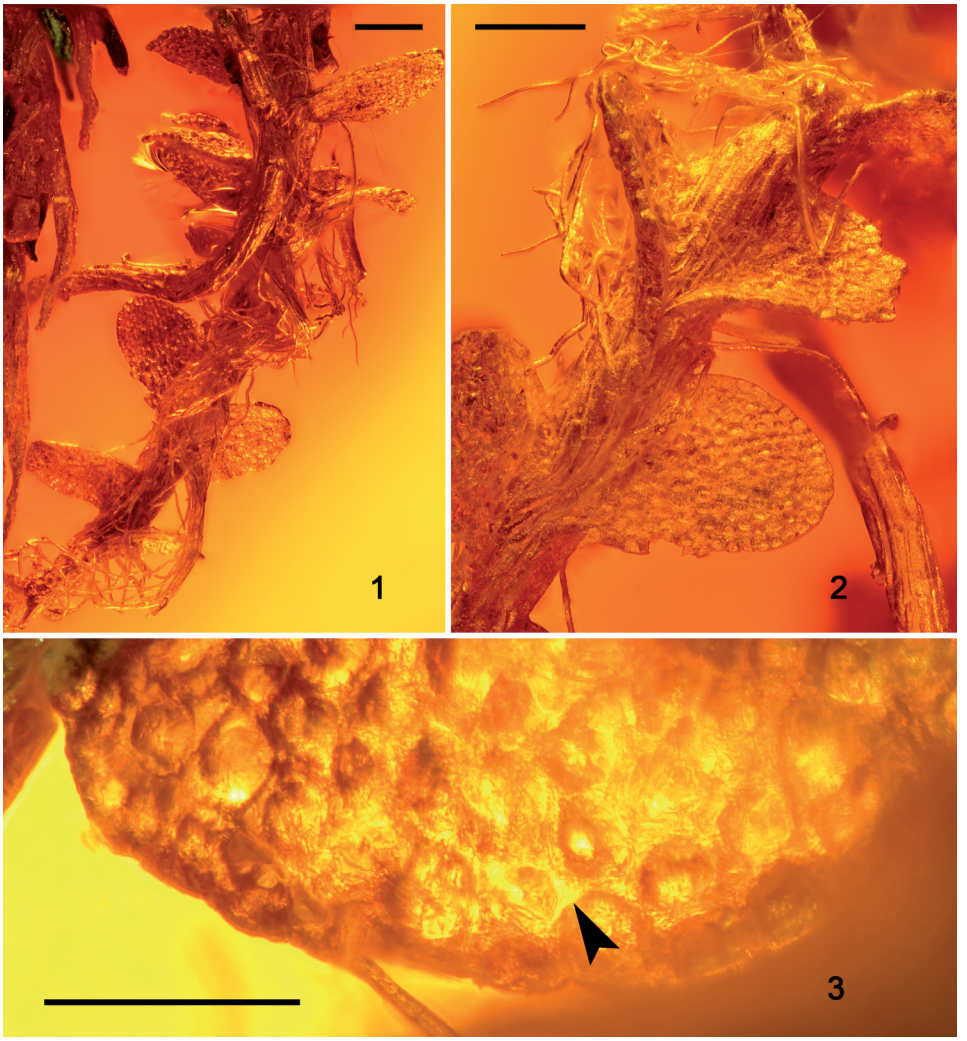

Figs 1-3. Holotype of *Solenostoma berendtii* (BHU-Palaeo no. 1979/477). **1.** Gametophyte with stem-borne rhizoids in ventral view (scale bar = 250 µm). Parts of moss syninclusion visible on left side of image. Curved leafless shoot in foreground does not belong to *Solenostoma berendtii*. **2.** Portion of shoot in dorsal view with two pairs of leaves (scale bar = 200 µm). **3.** Apical portion of leaf in ventral view showing cells with distinct trigones (arrowhead, scale bar = 100 µm).

MATERIALS AND METHODS

Amber piece BHU-Palaeo no. 1979/477 is ashlar-shaped polished. It contains the holotype of *Jungermannia berendtii*, together with syninclusions of a moss and other unidentified plant fragments. The amber platelet is embedded in Canada balsam, with two cover slips glued to its surfaces.

Prior to the investigation, the specimen was covered with a drop of water and another cover slip. Then, the *Jungermannia berendtii* inclusion was analyzed using a Leica M50 dissection microscope and a Carl Zeiss AxioScope A1 compound microscope, the latter equipped with a Canon 60D digital camera. Incident and transmitted light were used simultaneously. The illustrations provided in Figs 1-3 are digitally stacked photomicrographic composites of up to 67 individual focal planes obtained by using the software package HeliconFocus 6.0.

RESULTS AND DISCUSSION

We found that the detailed description of *Jungermannia berendtii* provided in Grolle (1980) is accurate; especially interesting is the presence of leaf cells characterized by distinctive trigones (Fig. 3). Grolle (1980) believed that the rhizoids of the fossil form a wick-like bundle along the stem that however was disheveled during the embedding process. We were unable to determine as to whether the rhizoids in fact occur in the form of a decurrent bundle or are diffusely decurrent. Decurrent bundles on erect shoots would support affinities of the fossil to sect. *Desmorhiza*, whereas diffusely decurrent rhizoids occur in most other lineages of the *Solenostoma/Jungermannia*-complex.

The genus *Jungermannia* (Jungermanniaceae) as currently understood consists of 7 or 8 species, while *Solenostoma* (Solenostomataceae) includes approximately 130–140 species (Söderström *et al.*, 2015). Extant *Jungermannia* species do not produce rhizoid bundles and mostly lack leaf cells with distinct trigones. These two characters, however, are relatively common in *Solenostoma* and are also present in the fossil. With regard to the presence of numerous long rhizoids, distinct trigones, and subquadrate-rotund to elongate-elliptical leaves (Figs 1-3), the fossil resembles the Asiatic *Solenostoma truncatum* (Nees) R.M.Schuster ex Váňa & D.G. Long (Amakawa, 1972) of subg. *Plectocolea* (Shaw *et al.*, 2015). Nevertheless, we agree with Grolle (1980) in that the lack of fertile plants and completely preserved shoots renders a more detailed assessment of the precise biological relationships of the fossil impossible. In any case, available evidence that can be gathered strongly suggests that the fossil in fact belongs to *Solenostoma*. This transfer is formalised below:

Solenostoma berendtii (Grolle) Váňa, Schäf.-Verw. & Heinrichs, *comb. nov.*

Basionym: *Jungermannia berendtii* Grolle, *Feddes Repert.* 91: 401, 1980 (Grolle 1980).
Type: BALTIC STATES. Eocene amber inclusion [holotype BHU-Palaeo inv. no. 1979/477 (coll. Berendt)!]

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