Arctoa (2000) **9**: *151-154*

OBSERVATIONS ON STEM SURFACE ANATOMY IN CLIMACIUM AND PLEUROZIOPSIS (CLIMACIACEAE: MUSCI)

О СТРОЕНИИ ПОВЕРХНОСТИ СТЕБЛЯ CLIMACIUM И PLEUROZIOPSIS (CLIMACIACEAE: MUSCI)

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Abstract

Pleuroziopsis was segregated from Climaciaceae into a separate monotypic family Pleuroziopsidaceae by Ireland (1968). According to Ireland, the most important and unique characteristic of *Pleuroziopsis* is a fluting of the stem by streaks of stem lamellae. However, this pattern of stem fluting is shown to be shared with the genus *Climacium,* so *Pleuroziopsis* is returned to Climaciaceae.

Резюме

Pleuroziopsis был выделен из семейства Climaciaceae в самостоятельное монотипное семейство Pleuroziopsidaceae (Ireland, 1968). Основанием для этого послужило наличие продольных 'стеблевых пластин', структуры, как считал Айреланд, не имеющей гомологов. Однако, данное исследование выявило, что структура поверхности стебля у *Climacium* и *Pleuroziopsis* принципиально сходна, так что последний род предлагается вернуть в Climaciaceae.

Many years ago, I (DHN) found myself with R. Ochyra, Krakow, in several very profitable discussions on paraphyllial arrangement in Hypnobryalean mosses. These discussions led in subsequent years to careful observation of the patterns of paraphyllial insertion of moss stems. A recent trip by DHN to Alaska afforded opportunity to study freshly collected material from a population of *Climacium dendroides* (Hedw.) Web. & Mohr mixed with *Pleuroziopsis ruthenica* (Weinm.) Kindb. ex Brid. It might be noted in this regard that the Alaskan collection of *Pleuroziopsis* seems to represent a westward extension of the species on the Alaskan mainland. Data on this collection is: Alaska: 60°26'N X 145°06'W: On moist, diffusely lit soil of creek bank in forest of *Populus* and *Picea sitchensis* along Saddlebag Lake Trail, Chugach National Forest east of Cordova, Elev. 0-200 m., *D. H. Norris 96798*, 24 July 1999 (H).

This collection of *Pleuroziopsis* had its stolons so tightly interwoven with those of *Climacium dendroides* that it became necessary to clean the specimen by following the pattern of intergrowth. Careful monitoring of the stem surface anatomy was first thought to allow easy sorting according to the observations of Ireland (1968). I (DHN) removed the leaves from both the stem and rhizome material of the two species. At that point, the cloaking of rhizoids was so dense as to require plucking of those rhizoids with fine-point forceps. It was with great surprise that we found the denuded stems (split longitudinally to allow increased transparency) to be essentially identical in overall patterns. Both species have closely placed and well-demarcated uniseriate (1-)2-3-stratose longitudinal streaks on the stem. When the denuded stems of the two plants are lightly scraped with a razor blade we find almost identical uniseriate streaks of laterally enlarged short cells on the stem surface (Figs. 1-12).

Traditionally, *Pleuroziopsis* was placed in Climaciaceae, because of dendroid plants, similar leaf structure and laminal areolation, and presence of paraphyllia (e. g. Brotherus, 1925). Ireland (1968) was the first who found inappropriate the application of term paraphyllia to *Pleuroziopsis,* and reinterpreted them as rhizoids (cf. Fig. 1 in Ireland, 1968). Longitudinal rows of cells along the stem were understood by him as "stem

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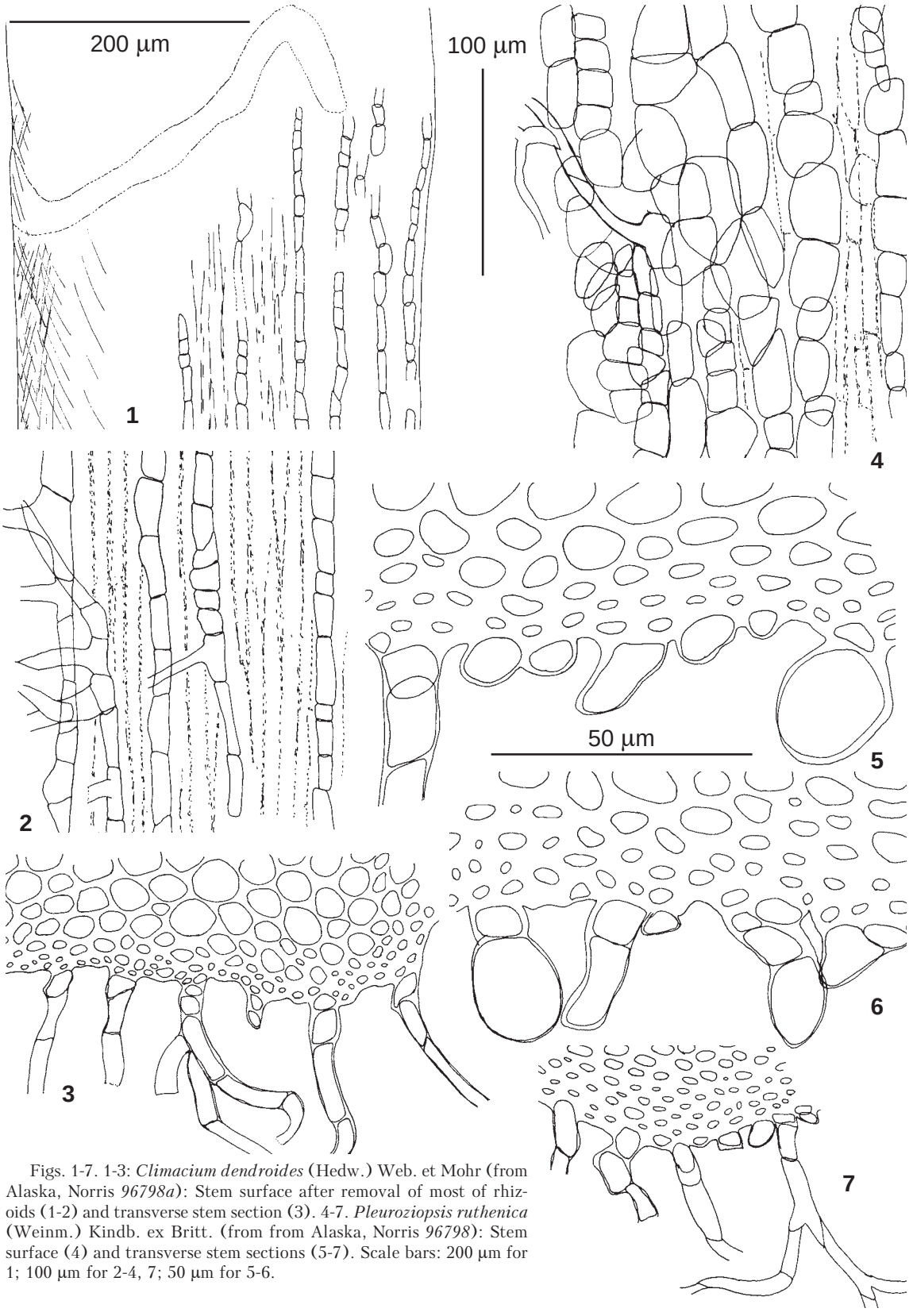
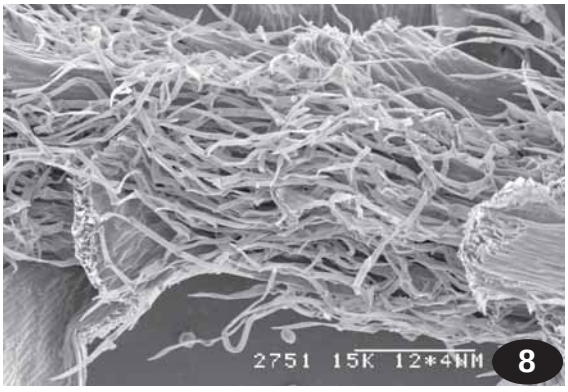
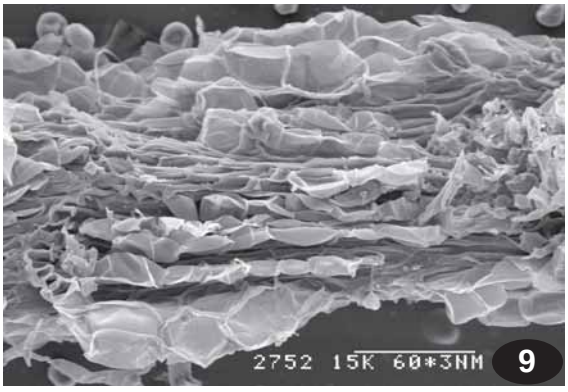
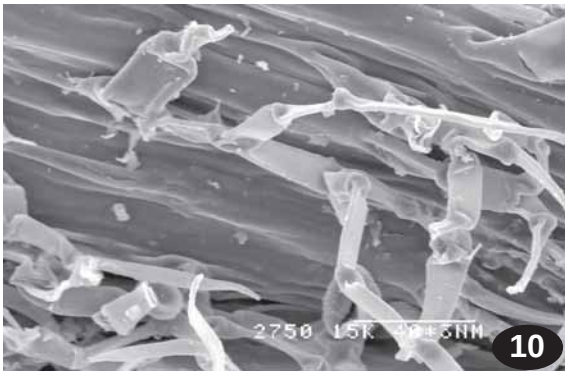
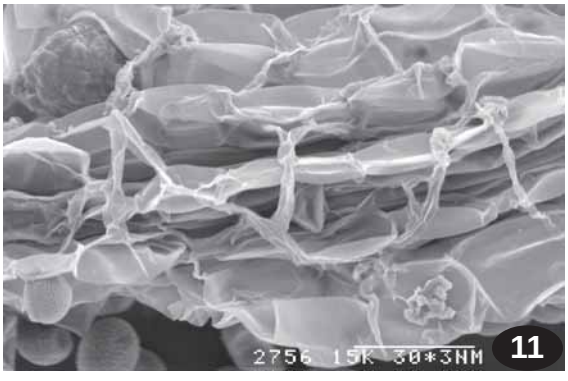


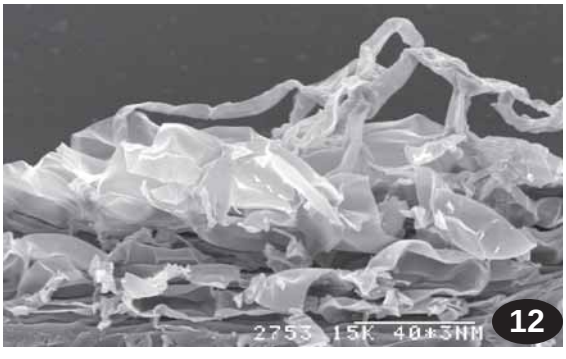
Figs. 1-7. 1-3: *Climacium dendroides* (Hedw.) Web. et Mohr (from Alaska, Norris *96798a*): Stem surface after removal of most of rhizoids (1-2) and transverse stem section (3). 4-7. *Pleuroziopsis ruthenica* (Weinm.) Kindb. ex Britt. (from from Alaska, Norris *96798*): Stem surface (4) and transverse stem sections (5-7). Scale bars: 200 µm for 1; 100 µm for 2-4, 7; 50 µm for 5-6.











Figs. 8-12. SEM photographs of stem surface. 8 & 10: *Climacium dendroides* (Hedw.) Web. et Mohr (from Russia, Vladimir Prov., Nazarov 259, MW): 8 – intact stem surface, with dense rhizoid cover; 10 – stem after removal of most of rhizoids, showing micronemata initials with rhizoids; 9, 11-12: *Pleuroziopsis ruthenica* (Weinm.) Kindb. ex Britt. (from Russia, Primorsky Territory, Makarov, X.1972 , MHA): 9, 11 – stem with inflated micronemata initials ('stem lamellae'); 12 – same with micronemata.

lamellae", a structure without any homology in the other groups of mosses, which allow to segregate *Pleuroziopsis* into a separate family. The nearly identical stem pattern of *Climacium* (Fig. 10) was not found by Ireland apparently due to very dense "paraphyllia" cover (Fig. 8). In contrast to *Climacium*, *Pleuroziopsis* has rather few rhizoids and much enlarged terminal cell of "lamellae", which are easy to observe (Figs. 9, 11-12).

The differences between rhizoids and paraphyllia can be summarized as follow:

Character	Paraphyllia	Rhizoids
Color	green	brown, rare colorless
Growth	±determined	±indetermined
Width	at least at base 2- or pluriseriate	always uniseriate
Transverse cell walls	±perpendicular	oblique
Surface ornamentation	smooth or similar to that of leaf cells	smooth or granulose

According to this set of characters, stem structures of *Climacium* & *Pleuroziopsis* have more common character states with rhizoids. This interpretation disagrees only with their green color, apparent in *Climacium*, and less so in *Pleuroziopsis* due to rhizoid rarity. We do not think, that the presence of chlorophyll is the most important character in this case. The reinterpretation of *Climacium*' stem outgrowth as rhizoids leads in reward to the more narrow definition of paraphyllia as a foliose structure (i. e. at least 2 cell wide at base), because, as far as we know, *Climacium* was the only genus with totally filamentose paraphyllia.

However, the detail comparison of paraphyllia and rhizoids are out of scope of this paper.

Our main thesis is the principal similarity of the longitudinal streaks in *Climacium* and *Pleuroziopsis* with micronematous initials as they were described by Koponen (1968) for Mniaceae. As with the Mniaceae, an initially long cell of the outer stem cortex forms a series of transverse walls defining a row of a relatively short cells. Each of such cells may now produce the outgrowths which we interpret as micronemata: at least some more distal cell walls are clearly oblique (cf. Figs. 3, 7). However both *Climacium* and *Pleuroziopsis* differ from Mniaceae in that the micronemata initials are raised above stem surface, whereas in the latter family, rows of micronematous initials remain at the stem surface level.

The primary aim of this paper is to argue that Ireland's (1968) distinction of the two families is probably inappropriate. These are two plants of temperate and subarctic regions of the northern hemisphere. It is notable that truly dendroid (as opposed to frondose[1]) mosses are represented in this area only by *Climacium* and *Pleuroziopsis*, which strengthen the view of their close relationship.

It is interesting that the exclusion of *Pleuroziopsis* from the Climaciaceae by Ireland (1968) has spawned a spate of papers placing the genus quite distant from *Climacium.* Buck & Vitt (1986) recognize *Climacium* in an order Leucodontales with a suborder Climaciineae (Trachylomataceae & Climaciaceae) which is sister to their Neckerineae. In contrast, they place *Pleuroziopsis* in an order Hypnales with a suborder Hypnodendrineae (Pterobryellaceae, Hypnodendraceae, Pleuroziopsidaceae, and Thamnobryaceae). This treatment centers upon the sporophyte modification in *Climacium*, including erect cylindric capsule; gradually tapered teeth with nearly straight median-line and papillose rather than striolate outer teeth below; narrow segments, lack of ciliae, and very low basal membrane. The modification of peristome from the basic Hypnoid-type in *Pleuroziopsis* is much smaller and include only complete reduction of ciliae. However, the peristome modifications, or reduction, are known within many families of pleurocarps, but usually do not lead to a familial segregation (cf. Ignatov & al., 1998).

In recent discussion (April, 2000), Hedenäs called our attention that such features as the reduced/±complete peristome and the straight/reflexed perichaetial leaves might argue against a close relationship between *Climacium* and *Pleuroziopsis.* However, erect perichaetial leaves are often associated with taxa with erect capsules in families where taxa with curved capsules have reflexed perichaetial leaves (for example, *Homalothecium* and *Rhynchostegiella* have often straight perichaetial leaves and erect capsules, in contrast to most other species of Brachytheciaceae, etc). So, we believe that separation of the family Pleuroziopsidaceae from the Climaciaceae is not sufficiently demonstrated and we return *Pleuroziopsis* to its classical position in the Climaciaceae.

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[1] – Enroth (1994) gives perhaps the most clear distinction between the "frondose" and the "dendroid" growth forms in mosses: stoloniferous primary axes from which arise erect axis from which a radiate pattern of branching appears.