

Final statements

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Out of 48 species, 23 can be grouped by more than two characters (see sections “groups with more than two characters”): *G. anodon*, *G. plagiopodia*; *G. alpestris*, *G. asperitricha*, *G. caespiticia*, *G. nivalis*; *G. anomala*, *G. hartmanii*; *G. donniana*, *G. elongata*, *G. incurva*; *G. donniana*, *G. tortuosa*; *G. funalis*, *G. torquata*; *G. funalis*, *G. fuscolutea*, *G. meridionalis*, *G. pygmaea*; *G. khasiana*, *G. laevigata*, *G. mammosa*; *G. khasiana*, *G. laevigata*, *G. unicolor*; *G. khasiana*, *G. laevigata*, *G. mammosa*, *G. ovalis*, *G. tergestina*, *G. unicolor*; *G. ovalis*, *G. unicolor*.

Note.— *Grimmia handelii*, *G. maido* and *G. nepalensis* are excluded from the taxonomic arrangement because their sporophytes are unknown.

A connection to the genus *Racomitrium* may be seen in the peristome of *G. ramondii*. The peristome teeth are not completely separated down to the insertion but are connected by the two lowermost ventral cell plates. However, the cell pattern 2:3, following the peristomial formula for Haplolepidous moss peristomes, defined by EDWARDS (1979: 322), is not altered. The paradental triseriate tissue constituted of several rows of hyaline transversely arranged cells, seen on the outer side of the teeth of *G. ramondii* (Fig. 45.14) is a feature that may be compared with structures observed by BEDNAREK-OCHYRA (1995: 47, Fig. 17) in *Racomitrium lanuginosum* (Hedw.) Brid. and considered to be a preperistome. A similar structure can be seen in the longitudinal section of a tooth of *Racomitrium fasciculare* (Hedw.) Brid., illustrated in DEGUCHI (1979: 141, Fig. 6.11). Regarding these features, and taking into account the lack of a central strand in *G. ramondii*, a connection between *G. ramondii* and the genus *Racomitrium* Brid. should be considered.

Final statements

The genus *Grimmia*, based on Limpricht’s defining characters, is considered here to be a well-defined entity. The characters ‘smooth capsule, straight seta’ and ‘ribbed capsule, arcuate seta’, divide the taxa into ‘*Grimmia*’ and ‘*Rhabdogrimmia*’. Within these groupings the taxa appear as entities with specific characters that distinguish one from the other. By the diagnostic characters they can be arranged in groups as given in the chapter ‘reflections on taxonomic arrangements’.

When comparing the results of this study that was based on morphological and anatomical characters with recent molecular phylogenetic studies of the genus *Grimmia* (STREIFF, 2006: 224-235) some findings are congruent: *G. anodon* and *G. plagiopodia*, *G. alpestris* and *G. caespiticia*, as well as *G. donniana* and *G. elongata*, appear to be closely related (STREIFF, 2006: 229, Fig. 1). The tree (STREIFF, 2006: 230, Fig. 2) obtained by the combination of chloroplast DNA sequences with morphological characters produces a clade that corresponds to the group *Litoneurum* I. Hagen, one that does not appear in the phylogenetic tree (Fig. 1) based on DNA characters alone. Discussing the results, STREIFF (2006: 231) stated that ‘the basal branch of the clade “*Rhabdogrimmia*” was not supported’. ‘The presence of gemmae was the only morphological synapomorphy of this clade’. However, some of the species

in question do not develop gemmae (*G. decipiens*, *G. fuscolutea*, *G. ramondii*). In addition, *G. anomala* and *G. hartmanii*, which were present in the “Rhabdogrimmia”-clade, have smooth capsules. Several taxa with ribbed capsules (*G. elatior*, *G. orbicularis*, *G. pulvinata*) appear between species having smooth capsules. STREIFF (2006: 233) concluded that ‘it is not appropriate to decide upon their [the subclades ‘*Grimmia*’ and ‘Rhabdogrimmia’] taxonomic status’.

HERNÁNDEZ-MAQUEDA & al. (2007: 89-94), studied the positions of *Campylostelium* Bruch & Schimp. and *Grimmia pitardii* Corb. based on chloroplast data. The ML tree (HERNÁNDEZ-MAQUEDA & al., 2007: 92, Fig. 3) showed *G. hartmanii* (smooth capsules), on the same branch as *G. trichophylla* (ribbed capsules), and *G. incurva* (smooth capsules) together with *G. funalis* (ribbed capsules). It is interesting to note the connection of *G. pulvinata* (ribbed capsules) to species of the genus *Schistidium* Bruch & Schimp. which all have smooth capsules, and are also defined by an operculum that detaches with the columella, traits which are not found in the genus *Grimmia*.

A connection of *Schistidium* species with *G. pulvinata* appears also in HEDDERSON & al. (2004: 32, Fig. 1-2). For the characters defining *G. pulvinata*, HEDDERSON & al. (2004: 37) refer to the introduction of CRUM (1994: 386). Unfortunately, the characters given in this publication are erroneous (see explanation under 43. *Grimmia pulvinata*).

The cited examples demonstrate that the results obtained by studies based on cpDNA sequences are not always in accordance with the results obtained by classic taxonomic investigation methods, as used here. They are, at least at present, not appropriate to address the questions on the infrageneric classification of the genus *Grimmia*. KELLER (2000) provides new insights into molecular genetics and draws attention to future developments in molecular biology. In the work of STREIFF (2006: 233), partly based on the inconclusiveness of molecular data, *Grimmia* is treated as a unit. Morphologically-anatomically *Grimmia* can be considered as a unit based on the gametophytic character of ‘ventrally arranged guide cells’, combined with sporophyte characters that are specific to it. CROSBY (1980: 121) states that ‘The peristome appears to be the best feature on which to construct a classification’, and that ‘mosses with similar peristomes must be grouped together, regardless of the morphology of their gametophytes’.

In the same decade that LANTZIUS-BENINGA (1844, 1850) studied the anatomy of the moss capsule, SCHIMPER (1850) published ‘Recherches anatomiques et morphologiques sur les Mousses’ summarizing his work by an allusion to the moss capsule:

‘Quelle admirable structure, quelle sagesse, quelle toute-puissance dans le moindre objet sorti des mains du Créateur!’