

## Liverworts, mosses and hornworts of Afghanistan - our present knowledge

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Liverworts, mosses and hornworts of Afghanistan – our present knowledge. – Acta Mus. Siles. Sci. Natur., 68: 11-24, 2019.

**Abstract:** A new bryophyte checklist for Afghanistan is presented, including all published records since the beginning of collection activities in 1839–1840 by W. Griffith till present. Considering several unidentified collections in various herbaria, 23 new records for Afghanistan together with the collection data can be added to the flora. Beside a new genus, *Asterella*, the new records include *Amblystegium serpens* var. *serpens*, *Brachythecium erythrorrhizon*, *Bryum dichotomum*, *B. elwendicum*, *B. pallens*, *B. weigeli*, *Dichodontium palustre*, *Didymodon luridus*, *D. tectorum*, *Distichium inclinatum*, *Entosthodon muhlenbergii*, *Hygroamblystegium fluviatile* subsp. *fluviatile*, *Oncophorus virens*, *Orthotrichum rupestre* var. *sturmii*, *Pogonatum urnigerum*, *Pseudocrossidium revolutum*, *Pterygoneurum ovatum*, *Schistidium rivulare*, *Syntrichia handelii*, *Tortella inflexa*, *T. tortuosa*, and *Tortula muralis* subsp. *obtusifolia*. Therewith the number of species increase to 24 liverworts, 246 mosses and one hornwort. In addition, a historical overview of the country's exploration and a full biogeography of Afghan bryophytes is given.

**Key words:** Bryophytes, checklist, flora, phytodiversity.

### Introduction

Recording, documentation, identification and classification of organisms is a primary tool and essential step in plant sciences and ecology to obtain detailed knowledge on the flora of a country. In many countries, such as Afghanistan, however, our knowledge on plant diversity, function, interactions of species and number of species in ecosystems is very limited and far from being complete. Especially bryophytes (liverworts, mosses, hornworts) are often widely neglected and only seldom in the focus of scientific interest and research (e.g., Frey & Kürschner 2009).

Although large areas of Afghanistan consist of high mountain regions, bryophytes - especially mosses, may form extensive cover, especially on rocks in mountainous regions, in flushes, near watercourses and springs, and in sites where snow-melt moisture is available for an extended part of the growing season. There they often dominate the vegetation cover and control the vegetation pattern and dynamics of associated flowering plants. Even in the semi-humid or semi-arid forests and woodland of NE- and SW-Afghanistan and in the arid and semiarid steppes and deserts of W- and S-Afghanistan, bryophytes are widely distributed on marly or clayey soils and are an important part of the often sparsely vegetated microphytic crusts. Especially Pottiaceae, the 'mosses of harsh environments' (Zander 1993) play an essential role in soil and crust stabilization of deserts, hindering soil erosion.

As bryophytes are perfect organisms to serve as indicators for ecological disturbances and air pollution (Frey 1989, Frahm 1998, Frahm *et al.* 2008) the knowledge of species is of fundamental importance for understanding ecosystem development (succession stages), phytodiversity and nature conservation, especially with respect to the increasing human impact and global warming effects.

In the following a new species catalogue for Afghanistan is presented to give inside in the bryophyte diversity of the country. It is based on all published records since the beginning of bryophyte research in Afghanistan (Griffith 1849), various till present unidentified collect-

ions and the 'Conspectus Bryophytorum Orientalum et Arabicorum' (Frey & Kürschner 1991).

The new checklist responds to the tools of the Conservation on Biological Diversity and the Target 1 of the updated Global Strategy for Plant Conservation to achieve a list of all known plants. It is a further step to integrate Afghanistan into the Global Network of floristic knowledge and provide easy access to taxonomic information.

### **Bryological exploration and collectors** (following Frey & Kürschner 2009)

The bryological exploration of Afghanistan dates back to 1839–1840, when W. Griffith collected and reported 80 taxa from the area, unfortunately without locality data (Griffith 1849). He was followed by Surgeon-Major J.E.T. Aitchison in 1879 and 1880, who collected plants in the Kuram Valley during the 2<sup>nd</sup> Anglo-Afghan war, adding two taxa to the country's flora (Aitchison 1881–1882). A third taxon collected by Aitchison in Afghanistan 1884–1885 is *Pterygoneurum media*, described as new to science by Salmon (1899; basionym *Tortula media*, sine loco, herb K, no. 183).

After those early collections in the 19<sup>th</sup> century, no others are known till in 1938 Th. Herzog published the bryological result of the 'Deutsche Hindukusch-Expedition 1935'. He recorded two liverworts and 31 mosses (Herzog 1938).

From 1949 to 1951, intensive phytosociological field studies on the high mountain vegetation of central, east and north Afghanistan were carried out by the Austrian botanist A. Gilli. He also collected bryophytes, which were identified by J. Fröhlich at Vienna (Fröhlich 1955). Within this collection, six taxa were described as new to science, some of them known at present only from the type locality.

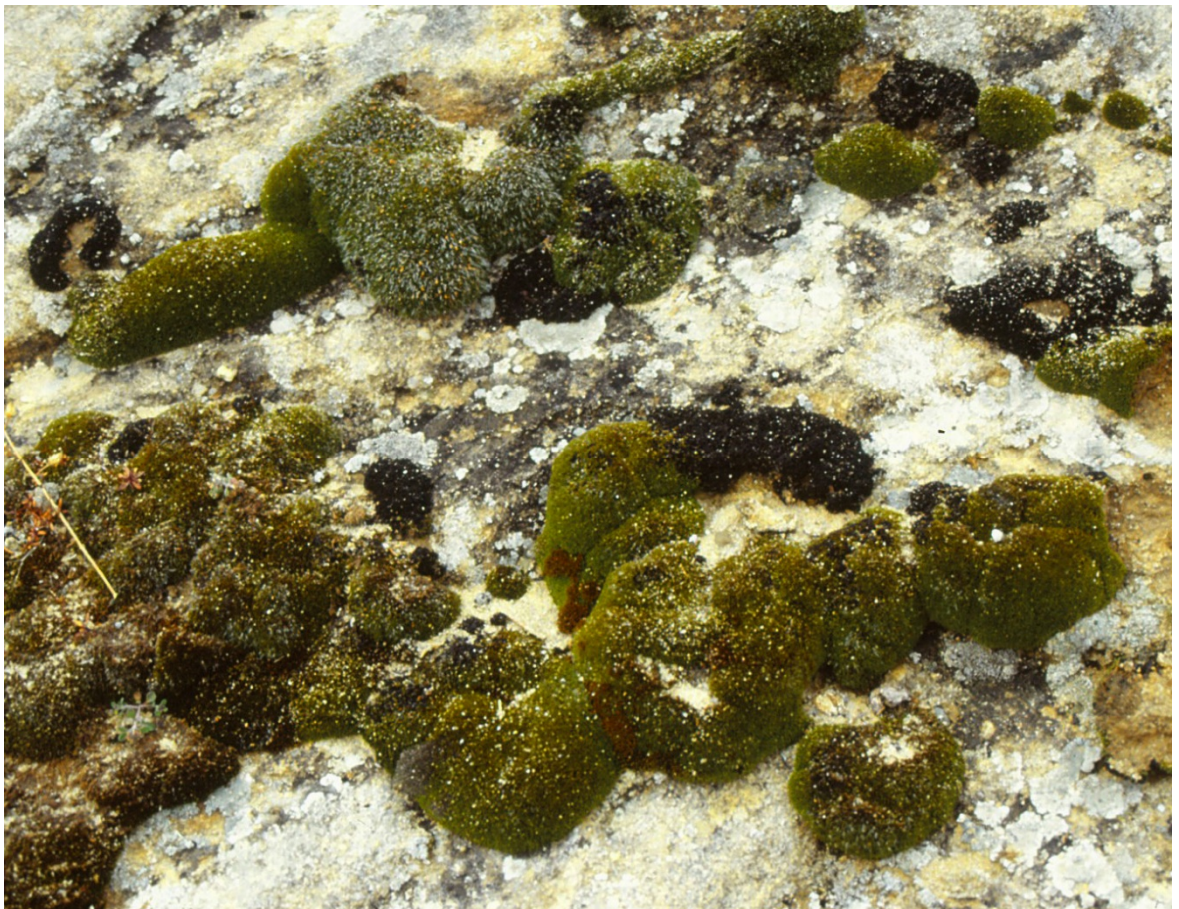
In 1955, S. Kitamura visited Afghanistan as a member of the 'Kyoto University Scientific Expedition'. His collections include three liverworts and 27 mosses from Nuristan, published by Kitagawa (1964). With the beginning of the 60s and 70s of the last century, there was an increasing interest on the flora and vegetation of this fascinating country. Several botanists took the opportunity to visit Afghanistan and collect plants within the framework of various research projects. This period of intensive exploration starts with the field trips by C. v. Regel in 1958 and 1960 (results presented by Bizot 1962), followed by I. C. Hedge and P. Wendelbo (April–July) in 1962 (21 taxa published by Henderson & Prentice (1963), and K. H. Rechinger in May–August 1962. Rechinger's collection again was identified by J. Fröhlich who described 10 taxa as new to science (Fröhlich 1964). Altogether, Fröhlich described 14 new species and two new varieties from Afghanistan – six of them, however, are sunk in synonymy and three remain doubtful. The other five taxa are known only from the type localities and mostly refer to critical or somewhat problematical taxa of uncertain taxonomic position.

Next to be mentioned are Admiral Paul and Mrs Furse (April–May 1964, cf. Townsend 1966), followed by W. Frey 1965 (cf. Frey 1969). Further collections during this period came from S.-W. Breckle 1968–1969 (herb. S.-W. Breckle), D. Dieterle 1969, 1970 (herb. M), E. Koblmüller 1968 (herb. M), I. Kukkonen 1972 (herb. H), D. Podlech 1965–1971 (herb. M), M. Steiner 1970 (herb. M. Steiner, M), W. Frey 1974 and P. Uotila 1972 (herb. H). Together with the older collections of H. O. Volk (1950, 1952; dupl. herb. W. Frey), the results partly were published in Frey (1972, 1974) and Frey & Kürschner (1991, 2009). At the end of the 60s, M. Bizot and G. Kilbertus travelled and collect in the country (Kilbertus & Bizot 1971).

As far as we know, the last bryophyte collections from the country comes from H. Huss 1975, a member of the Austrian 'Exploration Pamir '75 – Österreichisches Forschungsunternehmen' (herb. GZU), who collected in the Wakhan corridor (Darrah-e Issik, Koh-e Pamir; cf. Frey & Kürschner 2009) and V. Plášek (Ostrava) from the Tajik–Afghan border (June 2011, cf. Plášek *et al.* 2014).



**Fig 1:** Landscape of Central Afghanistan. Valley near Band-e Amir.



**Fig 2:** Typical bryophyte rock community with various acrocarpous mosses from the Grimmiaceae family.

At present, in cooperation with the United Nations Environment in Afghanistan and the National Environmental Protection Agency a field guide and textbook of bryophytes of Afghanistan is in press, which is useful for educational purposes and the re-established Afghan institutions in Kabul (Kürschner *et al.* 2019).

### Taxa described from Afghan plant material

Based on plant material collected in Afghanistan, 19 taxa have been described as species new to science. Especially J. Fröhlich (Vienna) recorded many new species based on material collected by K. H. Rechinger in 1962. Most of them are known only from a single collection, represented by the type specimen (holotype) and kept at Vienna (herb. W). With increasing knowledge on the taxonomy and distribution of species, however, quite a number of these former 'endemics' have sunken into synonymy and turned out to be conspecific with more widely distributed and/or common species in South-West Asia.

For historical and taxonomical reasons, we present an overview of the taxa which have been described from Afghan plant material. At present accepted names are given both, in **bold** and *italic*.

*Anoetangium pleuroweisioides* J.Fröhl. = ***Molendoa hornschuchiana*** (Hook.) Lindb. ex Limpr.

*Barbula cucullata* J.Fröhl. = ***Didymodon nicholsonii*** Culm.

***Brachythecium plumosum*** (Hedw.) Schimp. var. *laxoalare* Herzog

Known only from the type. If this taxon merits taxonomic recognition, a new combination under *Sciuro-hypnum plumosum* (Hedw.) Ignatov & Huttunen is required.

***Bryum funckioides*** J.Fröhl.

Known only from the type.

***Bryum purpureo-lucidum*** J.Fröhl.

Known only from the type.

***Dicranoweisia brevifolia*** Dixon & Herzog

Known only from the type.

***Didymodon recurvirostris*** (Hedw.) Jenn. var. *obtusifolius* J.Fröhl.

The identity of this name has not been reviewed. If it merits recognition, a new combination under *Bryoerythrophyllum recurvirostrum* (Hedw.) P.C.Chen may be required. However, in contrast, Kürschner (2007) stated that it may be conspecific with *B. rubrum* (Jur. ex Geh.) P.C.Chen

***Grimmia cardotii*** var. *gymnostoma* J.Fröhl.

Known only from the type. If this taxon deserves taxonomic recognition, a new combination under *G. poecilostoma* Cardot & Sebille is required.

***Hydrogonium heterophyllum*** J.Fröhl. = ***Splachnobryum aquaticum*** Müll.Hal.

***Hydrogonium patulifolium*** J.Fröhl.

***Hygrohypnum smithii*** (Sw.) Broth. var. *denticulata* Kilbert.

Known only from the type.

***Hymenostylium diversifolium*** J.Fröhl. = ***Hymenostylium recurvirostrum*** (Hedw.) Dixon

***Mniobryum tortifolium*** J.Fröhl. = ***Pohlia tortifolia*** (J.Fröhl.) W.Frey & Kürschner

***Tortula cabulica*** J.Fröhl. = ***Didymodon australasiae*** (Hook. & Grev.) R.H.Zander

***Tortula cucullifolia*** J.Fröhl. = ***Didymodon australasiae*** (Hook. & Grev.) R.H.Zander

***Tortula pseudodesertorum*** J.Fröhl. = ***Syntrichia caninervis*** var. *caninervis* Mitt.

***Tortula pseudohandelii*** J.Fröhl. = ***Syntrichia caninervis*** var. ***pseudodesertorum*** (Vondr.) M.T.Gallego

***Tortula subtranscaspica*** J.Fröhl.

***Weissia viridula*** var. *remotidens* Herzog

If this variety deserves taxonomic recognition, a new combination under *Weissia controversa* Hedw. is necessary.

### Checklist of Afghan bryophytes

Within bryophyte taxonomy, a strong segregation can be observed during the last years, where recent molecular data lead to a splitting of many 'traditional, old groups' and families (Kürschner & Frey 2011). To a great extent, the treatment of families and genera in the following checklist strictly follows these studies and the most recent tentative system proposed by Frey & Stech (2009).

The sequence of families, genera and species is strictly alphabetical to make using the checklist easier.

Nomenclature is in accordance with Ros *et al.* (2007) in liverworts and Ros *et al.* (2013) in mosses, except for extra-European taxa or when these lists differ greatly from modern concepts. In these cases, TROPICOS ([www.tropicos.org](http://www.tropicos.org)) was consulted. The following list include all published records from Afghanistan since the beginning of collection activities (Griffith 1849) till present. The references given in brackets refer to the literature where the records were published for the first time. Altogether, 271 taxa are listed (24 liverworts, 246 mosses and one hornwort).

In addition, 23 new records for Afghanistan were presented, together with the collection data and collectors.

## MARCHANTIOPHYTA

### Aneuraceae

*Riccardia palmata* (Hedw.) Carruth. (Frey & Kürschner 2009)

### Aytoniaceae

*Asterella* spec. (Genus new to Afghanistan); KABUL: 10 km W Sarobi, 34°35'N 69°38'E, 1200 m, Kalkfels-spalten, 18. April 1969 S.-W.Breckle

*Mannia androgyna* (L.) A.Evans (Fröhlich 1955)

*M. fragrans* (Balb.) Frye & L.Clark (Frey 1974)

*Plagiochasma appendiculatum* Lehm. & Lindenb. (Bischler 1978)

*P. cordatum* Lehm. & Lindenb. (Bischler 1979)

*Reboulia hemisphaerica* (L.) Raddi (Kitagawa 1964)

### Cleveaceae

*Athalamia hyalina* (Sommerf.) S.Hatt. (Frey 1974)

*A. spathysii* (Lindenb.) S.Hatt. (Frey 1974)

### Conocephalaceae

*Conocephalum conicum* (L.) Dumort. (Fröhlich 1955)

### Lophocoleaceae

*Chiloscyphus polyanthos* (L.) Corda (Kitagawa 1964)

### Marchantiaceae

*Marchantia paleacea* Bert. (Bischler-Causse 1989)

*M. papillata* subsp. *grossibarba* (Steph.) Bischl. (Bischler-Causse 1989)

*M. polymorpha* subsp. *polymorpha* (Griffith 1849)

*M. quadrata* Scop. (Fröhlich 1955) [Syn. *Preissia quadrata* (Scop.) Nees]

### Pelliaceae

*Pellia endiviifolia* (Dicks.) Dumort. (Fröhlich 1955)

### Porellaceae

*Porella cordaeana* (Hübener) Moore (Müller 1954–1957, p. 1219, in Frey 1974)

*P. platyphylla* (L.) Pfeiff. [Herzog 1939 as *P. decurrens* (Steph.) Hattori, cf. Hattori 1969, 1978]

*P. trigonifolia* (Steph.) Paris (Herzog 1938). The record is doubtful and probably refers to *P. platyphylloidea* (Schweinf.) Lindb.

### Radulaceae

*Radula complanata* (L.) Dumort. (Müller 1954–1957, p. 1192, in Frey 1974)

### Ricciaceae

*Riccia bifurca* Hoffm. (Kürschner 1996)

*R. fluitans* L. (Fröhlich 1955)

### Targioniaceae

*Targionia hypophylla* L. (Frey 1974)

### Wiesnerellaceae

*Wiesnerella denudata* (Mitt.) Steph. (Kitagawa 1964)

## BRYOPHYTA

### Amblystegiaceae

- Amblystegium serpens* (Hedw.) Schimp. var. *juratzkanum* (Schimp.) Rau & Herv. (Fröhlich 1964)  
*A. serpens* (Hedw.) Schimp. var. *serpens* (Hedw.) Schimp. (new to Afghanistan); KAPISA: Tagab–Alisang, way to Kotal Spe, 7 September 1974 W. Frey 74-80  
*Callialaria curvicaulis* (Jur.) Ochyra [Gilli 1971, as *Cratoneuron curvicaule* (Jur.) G.Roth]  
*Campylium stellatum* (Hedw.) C.E.O.Jensen (Fröhlich 1955)  
*Cratoneuron filicinum* (Hedw.) Spruce (Fröhlich 1955)  
*Drepanocladus aduncus* (Hedw.) Warnst. (Herzog 1938)  
*D. turgescens* (T.Jensen) Broth. (Frey 1972)  
*Hamatocaulis vernicosus* (Mitt.) Hedenäs (Kilbertus & Bizot 1971)  
*Hygroamblystegium fluviatile* (Hedw.) Loeske subsp. *fluviatile* (new to Afghanistan); BADAQSHAN: Darrah-i Jokham, Hazarat-i Sayet, 2700 m, Bewässerungskanal, 3. August 1974 W. Frey M27; NURISTAN: Bashgal Quelltäler, unteres Darrah-i Pushal, 3300 m, in einem Bach, 5. September D.Podlech (M)  
*H. fluviatile* (Hedw.) Loeske subsp. *noterophilum* (Sull. & Loeske) Grout (Fröhlich 1964)  
*H. humile* (P.Beauv.) Vanderp., Goffinet & Hedenäs [Fröhlich 1964, incl. *Leptodictyum kochii* (Schimp.) Warnst. var. *curvipes* (Schimp.) Warnst.]  
*H. tenax* (Hedw.) Jenn. (Kürschner & Frey 2006)  
*H. varium* (Hedw.) Mönk. (Fröhlich 1955)  
*Hygrohypnum luridum* (Hedw.) Jenn. var. *subsphaericarpon* (Brid.) C.O.E.Jensen (Herzog 1938)  
*H. smithii* (Sw.) Broth. var. *denticulata* Kilbertus (Kilbertus & Bizot 1971, holotype)  
*Leptodictyum riparium* (Hedw.) Warnst. (Fröhlich 1955)  
*Palustriella commutata* (Hedw.) Ochyra (Herzog 1938)  
*P. decipiens* (De Not.) Ochyra (Frey & Kürschner 2009)  
*P. falcata* (Brid.) Hedenäs (Fröhlich 1955)  
*Sanionia uncinata* (Hedw.) Loeske (Herzog 1938)

### Amphidiaceae

- Amphidium lapponicum* (Hedw.) Schimp. (Kitagawa 1964)

### Aongstroemiaceae

- Dichodontium palustre* (Dicks.) M.Stech (new to Afghanistan); HERAT: Ziarat-i Mullah-i Khwaja-i Koh, 20–30 km NW Herat, c. 34,5°N 61,9°E, 1180 m, Wasserfall, 14. März 1969 S.-W.Breckle

### Aulacomniaceae

- Aulacomnium palustre* (Hedw.) Schwägr. (Herzog 1938)

### Bartramiaceae Schwägr.

- Bartramia aprica* Müll.Hal. (Kitagawa 1964, as *B. stricta* Brid.)  
*Philonotis caespitosa* Jur. (Fröhlich 1955)  
*P. calcarea* (Bruch & Schimp.) Schimp. (Fröhlich 1955)  
*P. falcata* (Hook.) Mitt. (Fröhlich 1955)  
*P. fontana* (Hedw.) Brid. (Aitchison 1881–1882)  
*P. marchica* (Hedw.) Brid. (Herzog 1938)  
*P. seriata* Mitt. (Frey 1969)  
*P. thwaitesii* Mitt. (Kitagawa 1964)  
*P. turneriana* (Schwägr.) Mitt. (Fröhlich 1955)

### Brachytheciaceae

- Brachytheciastrum collinum* (Schleich. ex Müll.Hal.) Ignatov & Huttunen (Frey 1972)  
*B. olympicum* (Jur.) Vanderp., Goffinet & Hedenäs (Fröhlich 1955)  
*B. trachypodium* (Brid.) Ignatov & Huttunen (Henderson & Prentice 1963)  
*B. velutinum* (Hedw.) Ignatov & Huttunen (Fröhlich 1955)  
*Brachythecium campestre* (Müll.Hal.) Schimp. (Fröhlich 1964)  
*B. erythrorrhizon* Schimp. (new to Afghanistan); KABUL: Paghman, Begtut, 2500 m, 21. August 1951 O.H.Volk s.n.  
*B. microsericeum* Dixon (Herzog 1938)  
*B. mildeanum* (Schimp.) Schimp. (Frey & Kürschner 2009)  
*B. myurelliforme* Dixon (Herzog 1938)  
*B. rivulare* Schimp. (Kitagawa 1964)  
*B. rutabulum* (Hedw.) Schimp. (Henderson & Prentice 1963) [Incl. *B. rutabulum* var. *turgescens* Limpr.]  
*B. salebrosum* (Hoffm. ex F.Weber & D.Mohr) Schimp. var. *sericeum* (Fröhlich 1964)  
*Eurhynchium striatum* (Hedw.) Schimp. (Kürschner & Frey 2006)

*Eurhynchiastrum pulchellum* (Hedw.) Ignatov & Huttunen var. *diversifolium* (Schimp.) Ochyra & Żarnowiec (Fröhlich 1955)  
*Homalothecium sericeum* (Hedw.) Schimp. (Kitagawa 1964)  
*Oxyrrhynchium hians* (Hedw.) Loeske (Frey & Kürschner 2009)  
*Platyhypnidium riparioides* (Hedw.) Cardot (Fröhlich 1955)  
*Rhynchostegiella tenella* (Dicks.) Limpr. (Frey & Kürschner 2009)  
*Rhynchostegium confertum* (Dicks.) Schimp. (Frey & Kürschner 2009)  
*R. murale* (Hedw.) Schimp. (Fröhlich 1964)  
*R. patulifolium* Cardot & Thér. (Fröhlich 1964)  
*Sciuro-hypnum plumosum* (Hedw.) Ignatov & Huttunen (Herzog 1938) [Incl. *Brachythecium plumosum* (Hedw.) Schimp. var. *laxoalare* Herzog (Herzog 1938, holotype)]  
*S. populeum* (Hedw.) Ignatov & Huttonen (Kilbertus & Bizot 1971)  
*Scorpiurium deflexifolium* (Solms) M.Fleisch. & Loeske (Kilbertus & Bizot 1971)

### Bryaceae Schwägr.

*Brachymenium exile* (Dozy & Molk.) Bosch & Sande Lac. (Kitagawa 1964) [Syn. *Gemmabryum exile* (Dozy & Molk.) J.R.Spence & H.P.Ramsay]

*Bryum* Hedw.

Note: *Bryum* is a large and exceedingly difficult genus and treated here in a traditional way. Based on molecular data it is split into five genera: *Bryum* Hedw. s.str., *Gemmabryum* J.R.Spence & H.P.Ramsay, *Imbribryum* N.Pedersen, *Ptychostomum* Hornsch. and *Rosulabryum* J.R.Spence.

*Bryum algovicum* Sendtn. ex Müll.Hal. (Kilbertus & Bizot 1971) [Syn. *Ptychostomum compactum* Hornsch.]  
*B. alpinum* Huds. ex With. (Fröhlich 1955, as *B. alpinum* var. *viride* Husn.) [Syn. *Imbribryum alpinum* (Huds. ex With.) N.Pedersen]  
*B. archangelicum* Bruch & Schimp. [Henderson & Prentice 1963, as *B. inclinatum* (Brid.) Turton] [Syn. *Ptychostomum archangelicum* (Bruch & Schimp.) J.R.Spence]  
*B. argenteum* Hedw. (Fröhlich 1955)  
*B. caespiticium* Hedw. (Fröhlich 1955) [Syn. *Ptychostomum imbricatulum* (Müll.Hal.) D.T.Holyoak & N.Pedersen]  
*B. capillare* Hedw. (Fröhlich 1955) [Syn. *Rosulabryum capillare* (Hedw.) J.R.Spence]  
*B. cellulare* Hook. in Schwägr. (Fröhlich 1964)  
*B. creberrimum* Taylor (Fröhlich 1955) [Syn. *Ptychostomum creberrimum* (Taylor) J.R.Spence & H.P.Ramsay]  
*B. dichotomum* Hedw. (new to Afghanistan) [Syn. *Gemmabryum dichotomum* (Hedw.) J.R.Spence & H.P.Ramsay]; BADAQSHAN: Wakhan, Großer Pamir, Issiktal, 4900 m, zwischen Blockwerk, 3. August 1975 H.Huss 16 (GZU), Exploration Pamir 1975; HELMAND: 90 km N Girishk, 35 km N Musa Qala, 32°48'N 64°50'E, 1200 m, feuchter *Carex stenophylla* Rasen, 18. März 1969 S.-W.Breckle  
*B. elegans* Nees (Fröhlich 1964) [Syn. *Rosulabryum elegans* (Nees) Ochyra]  
*B. elwendicum* C.Fehlner (new to Afghanistan); BADAQSHAN: Darrah-i Shahrān, 3500 m, feuchte Stelle, 18. August 1974 W.Frey 74-63; GHAZNI: Dasht-i Nawor, S-Umrahmung, 33°22'E 67°50'E, 4100 m, Vulkanit-Tuffe, Blockhalde, 04. Juni 1969 S.-W.Breckle s.n.  
*B. funckioides* J.Fröhl. (Fröhlich 1955, holotype)  
*B. funkii* Schwägr. (Frey & Kürschner 2009) [Syn. *Gemmabryum funkii* (Schwägr.) J.R.Spence]  
*B. kunzei* Hornsch. (Fröhlich 1955) [Syn. *Ptychostomum kunzei* (Hornsch.) J.R.Spence]  
*B. lanatum* (P.Beauv.) Brid. (Fröhlich 1955)  
*B. neodamense* Itzigs. (Kilbertus & Bizot 1971) [Syn. *Ptychostomum neodamense* (Itzigs.) J.R.Spence]  
*B. pallens* Sw. ex anon. (new to Afganistan) [Syn. *Ptychostomum pallens* (Sw. ex anon.) J.R.Spence]; BADAQSHAN: Darrah-i Parshui, 4100 m, Flußufer, auf Urgestein, 27. Juli 1965 W.Frey; BAGHLAN: Salang pass, 2 km N of Salang tunnel, 3000 m, in small brook running from snow lay, 23. July 1972 P.Uotila 18791 (H)  
*B. pallescens* Schwägr. (Fröhlich 1955) [Syn. *Ptychostomum pallescens* (Schwägr.) J.R.Spence]  
*B. pseudotriquetrum* (Hedw.) P.Gaertn., E.May. & Scherb. var. *bimum* (Schreb.) D.T.Holyoak & N.Pedersen (Fröhlich 1955) [Syn. *Ptychostomum bimum* (Schreb.) J.R.Spence]  
*B. pseudotriquetrum* (Hedw.) P.Gaertn., E.May. & Scherb. var. *pseudotriquetrum* (Fröhlich 1964) [Syn. *Ptychostomum pseudotriquetrum* (Hedw.) J.R.Spence & H.P.Ramsay ex D.T.Holyoak & N.Pedersen]  
*B. purpureo-lucidum* J.Fröhl. (Fröhlich 1955, holotype)  
*B. recurvulum* Mitt. (Kürschner 1996)  
*B. schleicheri* Schwägr. (Fröhlich 1955) [Syn. *Ptychostomum schleicheri* (Schwägr.) J.R.Spence]  
*B. syriacum* Lorentz var. *humile* Schiffn. (Fröhlich 1964)  
*B. syriacum* Lorentz var. *syriacum* (Fröhlich 1955)  
*B. torquescens* Bruch & Schimp. (Fröhlich 1964) [Syn. *Rosulabryum torquescens* (Bruch & Schimp.) J.R.Spence]

- B. turbinatum* (Hedw.) Turner (Fröhlich 1955, as *B. syriacum*) [Syn. *Ptychostomum turbinatum* (Hedw.) J.R.Spence]  
*B. weigelii* Spreng. (new to Afghanistan) [Syn. *Ptychostomum weigelii* Spreng.) J.R.Spence]; BADAQSHAN: Darrah-i Parshui, 3700 m, feuchter Granit, 14. Juli 1965 W. Frey 1812  
*Plagiobryum demissum* (Hook.) Lindb. (Kitagawa 1964) [Syn. *Ptychostomum demissum* (Hook.) Holyoak & N.Pedersen]

#### Dicranellaceae

- Dicranella howei* Renaud & Cardot [Fröhlich 1964, as *D. varia* (Hedw.) Schimp.] var. *tenuifolia* (Bruch) Bruch & Schimp.; cf. Crundwell & Nyholm 1977]  
*D. varia* (Hedw.) Schimp. (Kilbertus & Bizot 1971)

#### Ditrichaceae

- Ceratodon purpureus* (Hedw.) Brid. (Fröhlich 1955)  
*Distichium capillaceum* (Hedw.) Bruch & Schimp. var. *capillaceum* (Fröhlich 1955)  
*D. capillaceum* (Hedw.) Bruch & Schimp. var. *compactum* (Hueb.) Torre & Sarnth. (Fröhlich 1955)  
*D. inclinatum* (Hedw.) Bruch & Schimp. (new to Afghanistan); BADAQSHAN: Wakhan, Wazitpass-Seitental Sabazkatsch, 37°02'N, 72°54'E, 4900 m, 04.08.1968 S.-W.Breckle; BADAQSHAN: Darrah-i Shahrān, 4200 m, Felsspalten, 18. August 1974 W. Frey 74-66; BADAQSHAN: Darrah-i Jokham, 4400 m, Steinschutt, 4. August 1974 W. Frey 74-81  
*Ditrichum flexicaule* (Schwäger.) Hampe (Kilbertus & Bizot 1971)  
*D. pusillum* (Hedw.) Hampe (Bizot 1962)

#### Drummondiaceae

- Drummondia sinensis* Müll.Hal. [Fröhlich 1955, misnamed as *D. prorepens* (Hedw.) E.Britton]  
*D. thomsonii* Mitt. (Herzog 1938)

#### Encalyptaceae

- Encalypta alpina* Sm. (Kürschner 1996)  
*E. intermedia* Jur. (Fröhlich 1955)  
*E. rhaptocarpa* Schwäger. (Townsend 1966)  
*E. vulgaris* Hedw. (Herzog 1938)

#### Fabroniaceae Schimp.

- Fabronia pusilla* Raddi (Fröhlich 1955)

#### Fissidentaceae

- Fissidens diversifolius* Mitt. (Fröhlich 1955)  
*F. grandifrons* Brid. (Herzog 1938)  
*F. schmidii* Müll.Hal. (Herzog 1938)  
*F. viridulus* (Sw. ex anon.) Wahlenb. (Kürschner 1996)

#### Fontinalaceae

- Fontinalis antipyretica* Hedw. (Kilbertus & Bizot 1971)  
*F. hypnoides* C.Hartm. var. *duriaei* (Schimp.) Husn. (Kitagawa 1964)

#### Funariaceae

- Entosthodon angustifolius* Jur. & Milde (Fröhlich 1964)  
*E. attenuatus* (Dicks.) Bryhn (Fröhlich 1955)  
*E. buseanus* Dozy & Molk. (Fröhlich 1955, as *Funaria wallichii* Mitt.)  
*E. handelii* (Schiffn.) Laz. (Fröhlich 1955)  
*E. muhlenbergii* (Turner) Fife (new to Afghanistan); BADAQSHAN: Kokca-Gebiet, Darrah-i Jokham, 2500 m, Bachrand, 31. Juli 1974 W. Frey 74-29a  
*Funaria brotherusii* J.Fröhl. (Herzog 1938)  
*F. hygrometrica* Hedw. (Fröhlich 1955)  
*F. microstoma* Bruch ex Schimp. (Kürschner 1996)  
*Physcomitrium pyriforme* (Hedw.) Bruch & Schimp. (Fröhlich 1955)

#### Grimmiaceae

- Coscinodon cribrosus* (Hedw.) Spruce (Henderson & Prentice 1963)  
*Grimmia alpestris* (F.Weber & D.Mohr) Schleich. (Muñoz 1998)  
*G. anodon* Bruch & Schimp. (Fröhlich 1964)  
*G. capillata* De Not. [Fröhlich 1964, as *G. mesopotamica* Schiffn.; Greven 1995, as *G. crinita* Brid. var. *capillata* (De Not.) De Not.]  
*G. cardotii* Hérib. var. *gymnostoma* J.Fröhl. (Fröhlich 1964, holotype)



*G. crassifolia* Broth. var. *crassifolia* Li (Fröhlich 1964)

A taxon with a somewhat confusing synonymy. Lectotypified and synonymized with *G. poecilostoma* Cardot & Sebille ex Limpr. by Muñoz (1999), respectively *G. tergestina* Bruch & Schimp. (Maier 2010), both synonyms of *G. crinitoleucophaea* Cardot (cf. Greven 2003)

*G. crassifolia* Broth. var. *cucullata* Baumgartner (Greven 1995)

According to Muñoz & Pando (2000) a synonym *G. tergestina* Bruch & Schimp. = *G. crinitoleucophaea* Cardot. The identity of both varieties, however is uncertain (cf. Ros *et al.* 2013)

*G. crinita* Brid. (Kitagawa 1964)

*G. crinitoleucophaea* Cardot (Fröhlich 1964)

*G. donniana* Sm. (Kilbertus & Bizot 1971)

*G. laevigata* (Brid.) Brid. (Fröhlich 1955)

*G. montana* Bruch & Schimp. (Henderson & Prentice 1963)

*G. orbicularis* Bruch ex Wilson (Fröhlich 1964, as var. *persica*)

*G. ovalis* (Hedw.) Lindb. (Herzog 1938)

*G. plagiopoda* Hedw. (Kilbertus & Bizot 1971)

*G. pulvinata* (Hedw.) Sm. (Fröhlich 1955)

*G. sessitiana* De Not. (Muñoz 1998)

*G. tergestina* Tomm. ex Bruch & Schimp. (Fröhlich 1955)

*G. trichophylla* Grev. (Fröhlich 1964)

*Schistidium apocarpum* (Hedw.) Bruch & Schimp. (Fröhlich 1964; cf. Blom 1996)

*S. flaccidum* (De Not.) Ochyra (Fröhlich 1955)

*S. platyphyllum* (Mitt.) H.Perss. [Fröhlich 1964, as *S. alpicola* auct. non (Hedw.) Limpr. var. *latifolia* (J.E.Zetterst.) H.A.Crum & L.E.Anderson]

*S. rivulare* (Brid.) Podp. (new to Afghanistan); HELMAND: Shersad bei Baghran, 2000 m, feuchte schattige Kalkfelsen, 16. März 1969 S.-W.Breckle

#### Hedwigiaceae

*Hedwigia ciliata* (Hedw.) P.Beauv. (Herzog 1938)

#### Hypnaceae

*Calliargonella cuspidata* (Hedw.) Loeske (Frey & Kürschner 2009)

*Hypnum cupressiforme* Hedw. (Herzog 1938)

*H. revolutum* (Mitt.) Lindb. (Frey 1972)

*H. vaucheri* Lesq. (Ando 1976)

*Taxiphyllum maniae* (Renauld & Paris) M.Fleisch. (Herzog 1938)

#### Leskeaceae

*Haplocladium angustifolium* (Hampe & Müll.Hal.) Broth. (Kitagawa 1964)

*Leskea polycarpa* Hedw. (Frey & Kürschner 2009)

*Pseudoleskea incurvata* (Hedw.) Loeske (Fröhlich 1955)

*Pseudoleskeella tectorum* (Funck ex Brid.) Kindb. ex Broth. (Fröhlich 1955)

#### Leucodontaceae

*Leucodon sciuroides* (Hedw.) Schwägr. (Herzog 1938)

#### Meesiaceae

*Leptobryum pyriforme* (Hedw.) Wilson (Herzog 1938)

#### Mniaceae

*Mnium heterophyllum* (Hook.) Schwägr. (Herzog 1938)

*M. marginatum* (Dicks.) P.Beauv. (Herzog 1938)

*Pohlia andalusica* (Höhm.) Broth. (Frey & Kürschner 2009)

*P. camptotrachela* (Renauld & Cardot) Broth. (Frey & Kürschner 2009)

*P. cruda* (Hedw.) Lindb. (Fröhlich 1955)

*P. obtusifolia* (Vill. ex Brid.) L.F.Koch (Fröhlich 1955)

*P. tortifolia* (J.Fröhl.) W.Frey & Kürschner [Fröhlich 1964, as *Mniobryum tortifolium* J.Fröhl. (holotype)]

*P. wahlenbergii* (F.Weber & D.Mohr) A.L.Andrews var. *glacialis* (Brid.) E.F.Warb. (Fröhlich 1964)

*P. wahlenbergii* (F.Weber & D.Mohr) A.L.Andrews var. *wahlenbergii* (Fröhlich 1955)

#### Orthotrichaceae

*Nyholmiella gymnostoma* (Bruch ex Brid.) Holmen & Warncke (Fröhlich 1955)

*N. obtusifolia* (Brid.) Holmen & Warncke (Fröhlich 1955)

*Orthotrichum anomalum* Hedw. (Herzog 1938)

*O. crenulatum* Mitt. (Lewinsky 1992)

*O. cupulatum* Hoffm. ex Brid. var. *cupulatum* (Fröhlich 1964)

*O. cupulatum* Hoffm. ex Brid. var. *sardagnanum* (Venturi) Venturi (Fröhlich 1964)

- O. diaphanum* Schrad. ex Brid. (Fröhlich 1955)  
*O. pamiricum* Plášek & Sawicki (Plášek *et al.* 2014)  
*O. rupestre* Schleich. ex Schwägr. var. *rupestre* (Fröhlich 1964)  
*O. rupestre* Schleich. ex Schwägr. var. *sturmii* (Hoppe & Hornsch.) Boulay (new to Afghanistan); KAPISA: Tagab–Alisang, Seken valley, way to Kotal Spe, 2500 m, on rock, 10 September 1974 W. Frey 74-112; Tagab–Alisang, Kotal Spe, 2150 m, on dry rock, 7 September 1994 W. Frey 74-101  
*O. tenellum* Bruch ex Brid. (Frey & Kürschner 2009)  
*O. urnigerum* Myrin (Henderson & Prentice 1963)

#### Plagiomniaceae

- Plagiomnium rostratum* (Schrad.) T.J.Kop. (Kitagawa 1964; cf. Koponen 1982)

#### Polytrichaceae

- Pogonatum urnigerum* (Hedw.) P.Beauv. (new to Afghanistan); BADAQSHAN: Wakhan, Kotal-i Wazit, 37°04'N 72°52'E, 4600 m, feuchte Stelle, 7. August 1968 S.-W.Breckle 1370a  
*Polytrichum juniperinum* Hedw. (Fröhlich 1955)

#### Pottiaceae

- Aloina ambigua* (Bruch & Schimp.) Limpr. (Aitchison 1881–1882)  
*Anoetangium handelii* Schiffn. (Fröhlich 1964)  
*A. thomsonii* Mitt. (Herzog 1938)  
*Barbula bolleana* (Müll.Hal.) Broth. (Frey & Kürschner 2009)  
*B. unguiculata* Hedw. (Fröhlich 1964)  
*Bryoerythrophyllum recurvirostrum* (Hedw.) P.C.Chen [Herzog 1938, Fröhlich 1955, as *Didymodon recurvirostris* (Hedw.) Jenn. var. *obtusifolius* J.Fröhl. (holotype)]  
*B. rubrum* (Jur. ex Geheeb) P.C.Chen [Fröhlich 1964, as *B. compactum* J.Fröhl. (holotype)]  
*Cinclidotus riparius* (Host. ex Brid.) Arn. (Fröhlich 1964, as *C. acutifolius* Broth.) [Syn. *C. acutifolius* Broth. (Erdağ & Kürschner 2011)]  
*Crossidium squamiferum* (Viv.) Jur. var. *pottioideum* (De Not.) Mönk. (Kürschner 1996)  
*C. squamiferum* (Viv.) Jur. var. *squamiferum* (Fröhlich 1964)  
*Didymodon acutus* (Brid.) K.Saito (Fröhlich 1964)  
*D. australasiae* (Hook. & Grev.) R.H.Zander [Fröhlich 1955, as *Tortula cabulica* J.Fröhl. (holotype) and *T. cucullifolia* J.Fröhl. (holotype); cf. Jiménez *et al.* 2005]  
*D. fallax* (Hedw.) R.H.Zander (Fröhlich 1955)  
*D. icmadophilus* (Müll.Hal.) K.Saito (Fröhlich 1964)  
*D. luridus* Hornsch. (new to Afghanistan); BADAQSHAN: Wakhan, Pamir, Issiktal, 5630 m, 10. August 1975 W.Kuschel 1 (GZU), Exploration Pamir 1975; BAGHLAN: Doshi, 1 km from the village towards Bamyan, 900 m, N-facing slope, 21 May 1972 P.Uotila 17090 (H), KANDAHAR: 55 km W Kandahar, 31°41'N 64°53'E, 900 m, Felsrippen, 9 March 1959 S.-W.Breckle; KAPISA: Tagab–Alisang, Kotal Spe, 2000 m, Bewässerungskanal, 7. September 1974 W. Frey 74-72b  
*D. nicholsonii* Culm. [Fröhlich 1964, as *Barbula cucullata* (holotype)]  
*D. rigidulus* Hedw. (Jiménez 2006)  
*D. tectorum* (Müll.Hal.) K.Saito (new to Afghanistan); BALKH: Mazar-i Sharif, über Aq Kupruk, 700–800 m, K.H.Rechinger 19670b, 19678, 19679, 19680  
*D. tophaceus* (Brid.) Lisa (Fröhlich 1955)  
*D. vinealis* (Brid.) R.H.Zander (Fröhlich 1955)  
*Eucladium verticillatum* (With.) Bruch & Schimp. (Fröhlich 1955)  
*Gymnostomum calcareum* Nees & Hornsch. (Henderson & Prentice 1963)  
*G. mosis* (Lorentz) Jur. & Milde (Townsend 1966)  
*G. viridulum* Brid. (Whitehouse & Crundwell 1992)  
*Hydrogonium gracilentum* (Mitt.) P.C.Chen (Fröhlich 1964)  
*H. patulifolium* J.Fröhl. (Fröhlich 1964, holotype)  
*Hymenostylium recurvirostrum* (Hedw.) Dixon var. *commutatum* (Mitt.) Podp. (Fröhlich 1955)  
*H. recurvirostrum* (Hedw.) Dixon var. *latifolium* (J.E.Zetterst.) Wijk & Margad. (Fröhlich 1955)  
*H. recurvirostrum* (Hedw.) Dixon var. *recurvirostrum* [Fröhlich 1964, as *H. diversifolium* J. Fröhl. (holotype)]  
*Molendoa hornschuchiana* (Hook.) Lindb. ex Limpr. [Fröhlich 1964, as *Anoetangium pleuroweisioides* J. Fröhl. (holotype); Sollman 2006]  
*Oxystegus tenuirostris* (Hook. & Taylor) A.J.E.Smith (Frey & Kürschner 2009)  
*Pseudocrossidium revolutum* (Brid.) R.H.Zander (new to Afghanistan); HELMAND: 60 km N Girishk, 32°31'N 64°46'E, 1400 m, in Felsspalten, 18. März 1969 S.-W.Breckle s.n.; BALKH: Mazar-i Sharif, über Aq Kupruk, 700–800 m, K.H.Rechinger 19671; KANDAHAR: 10 km S Boldak, 1250 m, Felsspalten, 21. März 1969 S.-W.Breckle

*Pterygoneurum medium* (Salm.) Broth. (Fröhlich 1955)  
*P. ovatum* (Hedw.) Dixon (new to Afghanistan); HERAT: 35 km N Herat, 34°41'N 62°07'E, 1520 m, on soil beneath *Iris* sp., 15 March 1969 S.-W.Breckle  
*Stegonia latifolia* (Schwägr.) Venturi ex Broth. var. *pilifera* (Dicks.) Broth. (Fröhlich 1964)  
*Syntrichia caninervis* Mitt. var. *caninervis* [Fröhlich 1955, 1964, as *Tortula pseudodesertorum* J.Fröhl. (holotype)]  
*S. caninervis* Mitt. var. *gypsophila* (J.J.Amann ex G.Roth) Ochyra (Kramer 1978, 1980)  
*S. caninervis* Mitt. var. *pseudodesertorum* (Vondr.) M.T.Gallego [Fröhlich 1964, as *Tortula pseudohandelii* (J.Fröhl.) S.Agnew & Vondr. (holotype)]  
*S. handelii* (Schiffn.) S.Agnew & Vondr. (new to Afghanistan); HERAT: 30km W Herat, Ziaret-e Khwaja Koh, c.34°25'N 61°55'E, 20 km NW von Herat, 1150 m, unter Brecchien-Felsblöcken, 14 März 1969, S.-W.Breckle 4460a, F1-189; LOGAR: bei Sarobi, *Cymbopogon*-Steppe, März–Juni 1971 O.H.Volk 71253  
*S. laevipila* Brid. [Fröhlich 1955, as *Tortula pagorum* (Milde) De Not.]  
*S. princeps* (De Not.) Mitt. (Kramer 1980)  
*S. ruralis* (Hedw.) F.Weber & D.Mohr (Henderson & Prentice 1963)  
*S. sinensis* (Müll.Hal.) Ochyra (Kilbertus & Bizot 1971)  
*S. virescens* (De Not.) Ochyra [Kramer 1980, as *Tortula ruralis* (Hedw.) P.Gaertn., E.Mey. & Schreb. subsp. *ruralis* var. *substereidosa* W.Kramer]  
*Timmiella anomala* (Bruch & Schimp.) Limpr. (Herzog 1938)  
*T. barbulooides* (Brid.) Mönk. (Herzog 1938, as *T. subintegra* Dixon, Townsend 1993)  
*Tortella fragilis* (Drumm.) Limpr. (Frey & Kürschner 2009)  
*T. inflexa* (Bruch) Broth. (new to Afghanistan); HERAT: 45 km S Herat, 34°00'N 62°13'E, 1440 m, 14 March 1969 S.-W.Breckle  
*T. tortuosa* (Hedw.) Limpr. (new to Afghanistan); LAGHMAN: Alingar-Seitental, 6 km W Nangaresh, 34°58'N 70°19'E, 2400 m, Fels, 9. April 1969 S.-W.Breckle s.n.  
*Tortula atrovirens* (Sm.) Lindb. (Fröhlich 1955)  
*T. cernua* (Huebener) Lindb. (Kilbertus & Bizot 1971)  
*T. cuneifolia* (Dicks.) Turner (Frey & Kürschner 2009)  
*T. inermis* (Brid.) Mont. (Henderson & Prentice 1963)  
*T. laureri* (Schultz) Lindb. (Fröhlich 1964)  
*T. mucronifolia* Schwägr. (Kramer 1975)  
*T. muralis* Hedw. subsp. *muralis* (Fröhlich 1955)  
*T. muralis* Hedw. subsp. *obtusifolia* (Schwägr.) Culm. (new to Afghanistan); BADAQSHAN: Wakhan, Khandud-Tal, 4370 m, Grauschiefer, 15. August 1968 E. Koblmüller  
*T. subulata* Hedw. var. *subinermis* (Bruch & Schimp.) Wilson (Herzog 1938)  
*T. subtranscaspica* J.Fröhl. (Fröhlich 1955, holotype)  
*T. systylia* (Schimp.) Lindb. (Fröhlich 1955)  
*Weissia condensa* (Voit) Lindb. (Bizot 1962)  
*W. controversa* Hedw. var. *controversa* [Herzog 1938, as *W. viridula* Brid. var. *remotidens* Herzog (holotype)]  
*W. controversa* Hedw. var. *crispata* (Nees & Hornsch.) Nyholm (Frey & Kürschner 2009)  
*W. edentula* Mitt. (Fröhlich 1955)  
*W. norkettii* Chopra (Fröhlich 1955)

#### **Ptychomitriaceae**

*Campylostelium saxicola* (F.Weber & D.Mohr) Bruch & Schimp. (Frey & Kürschner 2009)

#### **Rhabdoweisiaceae**

*Dicranoweisia brevifolia* Dixon & Herzog (Herzog 1938, holotype)  
*Oncophorus virens* (Hedw.) Brid. (new to Afghanistan); BADAQSHAN: Darrah-i Parshui, 3700 m, 21. Juli 1965 W. Frey 1624

#### **Splachnobryaceae**

*Splachnobryum aquaticum* Müll.Hal. [Fröhlich 1955, as *Hydrogonium heterophyllum* (holotype), as *S. giganteum* Broth., Fröhlich 1964; cf. Arts 2001]

#### **Timmiaceae**

*Timmia bavarica* Hessel. (Kürschner 1996)

### **ANTHOCEROTOPHYTA**

*Anthoceros* spec. (Griffith 1849)

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