

## Bryophytes from the Cape Verde Islands

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**Abstract:** Almost 450 specimens of bryophytes, so far the largest collection of bryophytes ever made on the Cape Verde Islands, were collected in 1995 by the second author on the major islands of the archipelago. Twenty seven species (3 hepatics, 24 mosses) are reported as new to the Cape Verde Islands: *Lejeunea ulicina* (Tayl.) Gottsche et al., *Riccia cavernosa* Hoffm. emend. Raddi, *Targionia hypophylla* L., *Barbula* cf. *consanguinea* (Thwait. & Mitt.) Jaeg., *Barbula unguiculata* Hedw., *Brachymenium exile* (Dozy & Molk.) Bosch. & Lac., *Bryoerythrophyllum ferruginascens* (Stirt.) Giac., *Bryoerythrophyllum inaequalifolium* (Tayl.) Zander, *Bryum cellulare* Hook., *Chenia leptophylla* (C. Müll.) Zander, *Desmatodon bogosicus* C. Müll., *Didymodon australasiae* (Hook. & Grev.) Zander, *Didymodon maschalogena* (Ren. & Card.) Broth. (*Didymodon michiganensis* [Steere] K. Saito), *Didymodon vinealis* (Brid.) Zander var. *flaccidus* (B.S.G.) Zander, *Eurhynchium meridionale* (B.S.G.) De Not., *Eurhynchium speciosum* (Brid.) Jur., *Fissidens sciophyllus* Mitt., *F. bogosicus* C. Müll., *F. flaccidus* Mitt., *F. helictocaulos* C. Müll., *Gymnostomiella* cf. *vernica* (Hook.) Fleisch., *Gymnostomum calcareum* Nees & Hornsch., *Hyophila involuta* (Hook.) Jaeg., *Orthotrichum diaphanum* Brid., *Tortula cuneifolia* (With.) Turn., *Tortula laevipila* (Brid.) Schwaegr. and *Weissiamicrostoma* (Hedw.) C. Müll. The doubtful record of *Marchantia paleacea* Bertol. could be confirmed. Numerous species are recorded as new to single islands.

*Tortula pierrotii* Biz. described from Tanzania has proved to be synonymous with *Bryoerythrophyllum inaequalifolium*. *Didymodon maschalogena* (Ren. & Card.) Broth. is an older name for *Didymodon michiganensis* (Steere) K. Saito. A study of types of species described as endemic to the Cape Verde Islands revealed that *Barbula bolleana* (C. Müll.) Broth. is an earlier name for *Hydrogonium bolleanum* (C. Müll.) Jaeg., *Barbula elliottii* Broth., *Barbula kivuensis* Leroy & P. de la Varde and *Barbula madagassa* Ren. & Card. are synonymous with the latter, *Hyophila crenulata* C. Müll. ex Dus. var. *brevifolia* Bizot is synonymous with *Hyophila involuta* (Hook.), *Barbula sulcata* Geh. is synonymous with *B. convoluta* Hedw. and *Tortula subcaroliniana* Bizot is synonymous with *Tortula amphidiacea* (C. Müll.) Broth.

In addition to the so far unpublished results of recent collections, a complete survey of the bryophyte flora of the Cape Verde Islands is given. A hundred and sixty two species (2 species of hornworts, 36 species of hepatics and 124 species of mosses) are so far known from this archipelago.

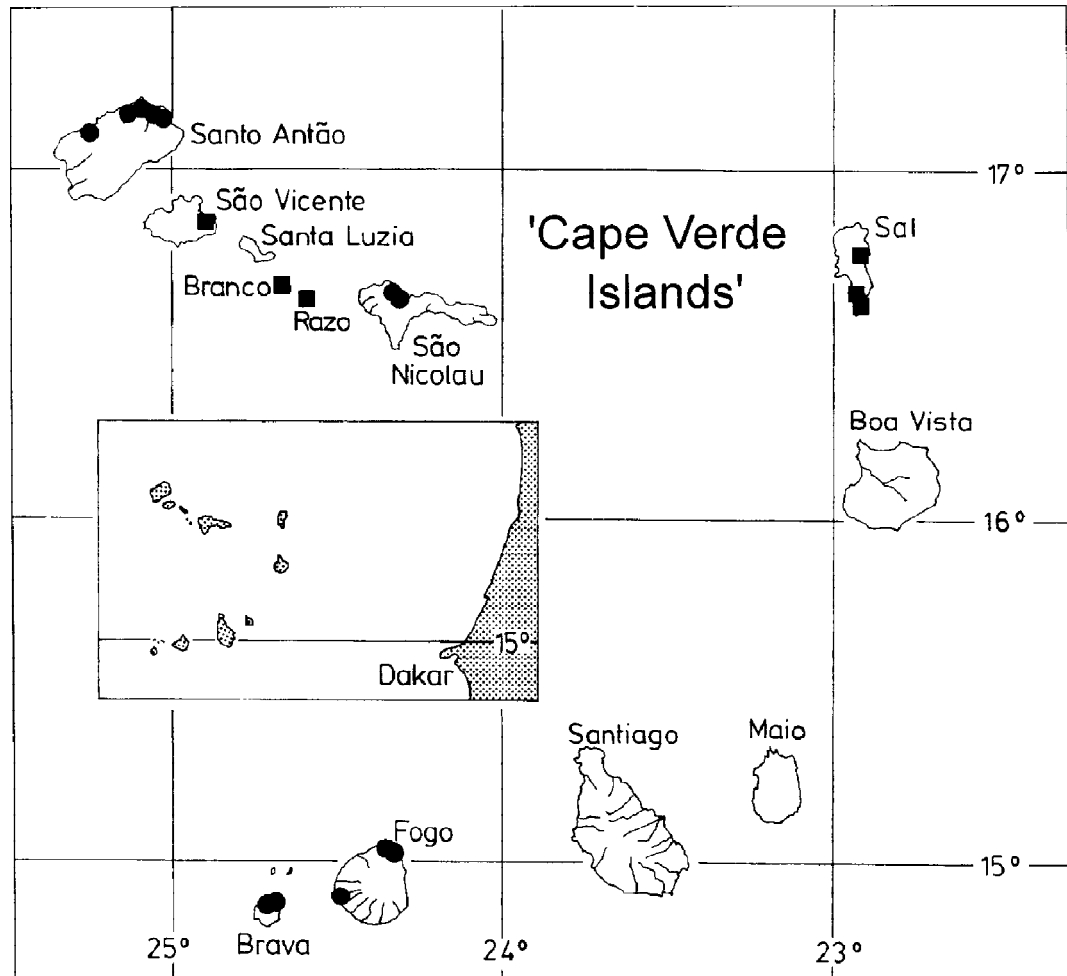


Fig. 1: Geographical Situation of the Cape Verde Islands.

### Introduction

The Cape Verde Islands are situated ca. 500 km W of the Cape Verde near Dakar in Senegal. The archipelago consists of nine larger, inhabit islands and six smaller, uninhabit islands. Two groups are distinguished: the islands above the wind (Ilhas de Barlavento) extending NW to SE and the islands below the wind (Ilhas de Sotavento) extending from WSW to ENE (fig. 1).

The six uninhabit islands as well as the islands of Sal, Boavista and Maio are low, Sal is 406 m, Boavista 387 m and Maio is 436 m high. In contrast the geologically younger, western islands reach

higher altitudes: Santo Antão 1979 m, São Vicente 725 m, São Nicolau 1304 m, Santiago 1392 m, Fogo 2829 m and Brava 976 m.

Santo Antao is the second largest and the second highest island. It is the island with the highest precipitation and has small streams with water running all year. Especially the valleys in the humid northeastern part carry the highest number of bryophytes.

São Vicente is one of the driest islands. Only its highest elevation, the 725 m high Monte Verde reaches into the cloud zone providing more humid conditions. Water is in part imported from Santo Antao. The island was once important because of

its natural harbour in Mindelo. It reaches well into the cloud belt and therefore the species number of bryophytes is similar as on Santo Antao. Even drier are the eastern islands of Sal, Boavista and Maio.

Sal is one of the lowest islands. Nevertheless Sal has gained importance in former times because of the salt works, and nowadays because of the international airport. On Sal, Boavista and Maio, being similarly low and dry, no bryophytes have been found so far. As a conclusion, all islands with an elevation of less than 500 m are devoid of bryophytes.

Santiago is the largest of the Cape Verde islands and due to its elevation suitable for agriculture. With almost 3000 m, Fogo is the highest island. Brava is the most densely populated island and due to its elevation of almost 1000 m also suitable for agriculture.

Like all middle-atlantic islands, the Cape Verde islands are of volcanic origin; there was never a land connection and thus the islands must have been colonized from other parts of the world.

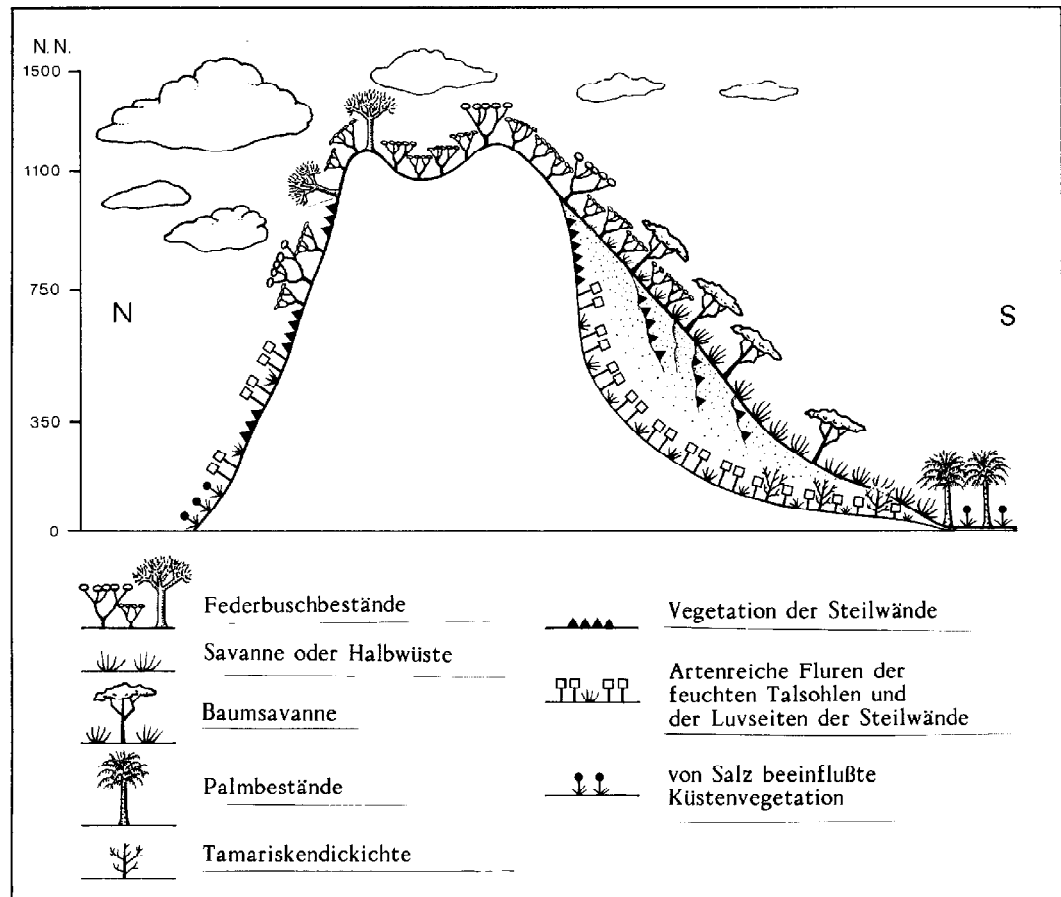
The climate is in general similar to the Sahelian climate on the African continent, being influenced by the location at the northern limit of the Inner Tropical Convergence with its depressions and the southern limits of the NE-trade winds zone with its high air pressure. It is also influenced by the Atlantic Ocean. Thus the mean temperature in the hottest month (September) is about 26° at sea level, that of the coldest month (January) 21° with an average of 23-24°C. The temperatures at higher elevations are accordingly lower, e.g. 18° at 1100 m. More important for the bryophytes is the precipitation. Due to the geographical situation the rain season is very short only between August and October. In many years even this short season stays absent. Droughts of many years are not unusual and have led to several (23 between 1719 and 1904) enormous disasters, during which many thousands of inhabitants died of starvation. In Mindelo, an average of 95 mm falls within 13 days, Praia gets 245 mm in 19 days. The precipitation is caused by the ITC reaching the islands from S (or also not) and therefore the southern islands (Ilhas de Sotavento) get more precipitation than the northern ones (Ilhas de Barlavento). With increasing elevation the importance of the NE-Trade Wind system raises because it creates a

cloud zone from ca. 500 m on. Thus the mountainous western islands can get a quite large and regular amount of fog precipitation whereas the lower islands depend totally on the rainfalls.

### Vegetation

The natural vegetation of the Cape Verde Islands has been almost completely destroyed because of agriculture, overgrazing, mainly by goats, wood cutting, depletion of all other natural resources and in recent years partly by afforestations. Relicts of natural vegetation are restricted to inaccessible areas. It is certain, that there never existed any closed woodland on Cape Verde.

Following an altitudinal transect from the coast to the summit the potential vegetation consists of different units of vegetation (Fig. 2). The coastal vegetation is dominated by halophytic species mainly from the *Zygophyllaceae*, *Portulacaceae* and *Chenopodiaceae*, which are joined by *Phoenix atlantidis*- and *Tamarix senegalensis*-shrublands within the dunes and estuaries. The only periodically water-carrying streams of the broader valleys (Ribeiras) naturally were bordered by *Tamarix senegalensis* and further inland also by *Ficus sycomorus* ssp. *gnaphalocarpa*. The dry plains up to 300 m of some islands were once covered by a loose savanna forest of *Acacia albida* or open grasslands. These have totally disappeared and are today replaced by afforestations with *Prosopis juliflora* and *Parkinsonia aculeata*. The higher regions of the NE-exposed slopes from approximately 400 m on carried a dense shrub vegetation dominated by the endemic species *Euphorbia tuckeyana*, *Echium* spp., *Conyza* spp. or *Artemisia gorgonum*. The vegetation of several islands is characterized by local endemic species e.g. *Nauplius smithii* on São Nicolau or *Echium vulcanorum* on Fogo. *Dracaena draco*, which was a typical species surmounting the formations, is today mostly missing. Large parts of the shrub vegetation have been replaced by agricultural sites or afforestations. The main crops are corn and beans and as soon as enough water is available sugar cane is planted. Especially the densely populated and more humid islands of Santiago and Brava have been heavily devastated by agricultural activities. The only places where an almost intact and species-rich



**Fig. 2:** Vegetation profile of the Cape Verde Islands

vegetation is found, are the steep inaccessible escarpments of the mountainous islands. Here, too, typical combinations of species for each island are growing, e.g. *Limonium lobinii* which is only occurring in the Serra da Malagueta on Santiago or *Conyza schlechtendalii* which is only found in the Alto das Cabaças-area on São Nicolau. The steep faces are important retreats for species missing today in the remaining areas of the islands. Especially the tree species like *Dracaena draco*, *Ficus sycomorus* spp. *gnaphalocarpa* or the endemic *Sideroxylon marginata* are today restricted to the steep faces where they occur in relictual numbers.

The result of the destruction of the vegetation cover are severe erosion problems. In many places

*Furcraea foetida* was planted to prevent further erosion with the consequence that the species is now spreading into the remaining intact zones due to its aggressive dispersal strategy and thus suppressing the natural species. Comparable dangers come from introduced species like *Opuntia ficus-indica* and *Lantana camara*, that have already destroyed the natural vegetation of large areas on many islands. The higher, humid areas of São Nicolau, Santo Antão, Santiago, Fogo and Brava are used for afforestations. Unfortunately no indigenous species are planted but only exotic species as *Pinus sp.*, *Cupressus sp.* or *Eucalyptus sp.* Those tree species cause further irreversible changes of the habitats.

With regard to the bryophyte flora of the islands

the structure of the phanerogamic vegetation is of less concern. A very large number of species is found in the damp, periodically water-running small valleys (Ribeirinhas) or in the mountainous regions, which receive a high precipitation because of the cloud-zone created by the NE-trade wind system, e.g. the upper part of the Ribeira do Paúl on Santo Antão. Few species occur in the open and exposed habitats most of them being xerophytic. Epiphytes are quite rare. Thus the bryophyte habitats are only indirectly threatened by human activities such as changes of the microclimate, e.g. through diversion of the water for irrigation purposes.

### History of bryological exploration

In spite of its phytogeographical peculiarity, the bryophyte flora of the Cape Verde Islands has remained poorly known.

In 1851, C. Bolle collected on the Cape Verde Islands. His collections were studied by C. Müller, who described several species as endemic to the Cape Verde Islands (*Zygodon bolleanus*, *Cryphaea bollei*, *Neckera bolleana*, *Neckera pseudoseductrix* (= *Entodon* p.), *Meesea bolleana* (= *Hydrogonium* b.), *Bryum anomodon*. The hepatics collected by Bolle were published almost 65 years later by Cardoso (1915) together with some mosses collected by himself in 1900 on Santo Antão. At that time, Cardoso (l.c.) listed 7 species of hepatics and 17 species of mosses. Also Montagne (1860) treated Bolle-collections

In 1910, Th. Herzog edited Adalbert Geheeb's "Bryologia atlantica" after his death. At that time, Geheeb (1910) listed only 20 (!) species of mosses, still mainly the Bolle-collections, but also a few specimens collected by R.T. Lowe from the Kew herbarium. For almost eighty years, the relatively small collection of Bolle remained the only source of knowledge of bryophytes from the Cape Verde Islands.

In 1934, the French botanist Auguste Chevalier collected bryophytes on the islands of Cape Verde stimulated by P. Allorge. A short note (Chevalier 1946) describes the results. Chevalier collected on Santo Antão, São Tiago and Fogo. The other islands of the archipelago were bryologically

unexplored at that time. His collections were handed over to Potier de la Varde. He published (Potier de la Varde 1943) 55 species of mosses. Based on this collection, Potier de la Varde described four species as new endemic from these islands (*Fissidens alatus*, *F. allorgei*, *Weissia cucullata* [W. vardei Biz. nom. nov.], *Funaria chevalieri*). Thirty four species were reported for the first time for the archipelago. A phytogeographical evaluation of these records was published by Portier de la Varde (1946). The hepatics collected by Chevalier remained first unidentified but were given to Mme. Jove-Ast after the death of P. Varde and were later published by her (Jovet-Ast 1946). The hepatic collection consisted of 10 species.

In 1958, Knut Byström from the Naturhistoriska Riksmuseet in Stockholm made 233 collections of bryophytes on the Cape Verde islands, of which the mosses were published by Bizot (1969) and the hepatics by Arnell (1961). Byström visited the islands of Santo Antão, São Vicente, São Nicolau, Santiago, Fogo and Brava. Based on his collection, Bizot described *Tortula subcaroliniana*, *Pinnatella revoluta* and the genus *Perssonia* (Bryaceae) as new. The Natural History Museum in Stockholm keeps a poorly labelled collection of unnamed bryophytes made by Byström. It is, however, not clear whether these are duplicates of the published specimens, specimens which were not published by Bizot or Arnell or even not seen by them.

In 1972, Dr. Per Sunding from the University of Oslo collected bryophytes on Santo Antão, São Nicolau, São Vicente, Santiago and Fogo, from which 45 species of mosses were published by Bizot & Dury (1978), 8 of them new records.

In 1980, H. Muhle collected ca. 400 specimens mainly on Santo Antão and São Vicente, of which the results are not yet published.

Additional records of bryophytes of the Cape Verde Islands are included in floristic contributions (Montagne 1861, Cardoso 1915, Arnell 1963) as well as in taxonomic treatments on hepatics by Schiffner (1909), Arnell (1956), Bischler (1978), Bischler-Causse (1989, 1993), Gradstein (1975) and Vanden Berghen (1976) and on mosses, e.g. in monographs of the *Bryum capillare* complex (Syed 1973) or the African species of *Bryum* (Ochi 1972).

The present state of knowledge was presented in

a checklist of the mosses of the Cape Verde Islands by Muhle (1982). At the same time, the hepatic and moss floras of the Cape Verde Islands were included in the checklist of the bryophytes of Macaronesia (Eggers 1982).

In 1995, the second author collected almost 450 specimens on the islands of Santiago, São Nicolau, São Vicente, Santo Antão, Brava and Fogo in connection with a project carried out by Dr. W. Lobin and T. Leyens (Botanical Institute, University of Bonn) and supported by the Gesellschaft für Technische Zusammenarbeit (GTZ). Although thoroughly searched for, no bryophytes were found on Sal and Boavista. However, since the climatic conditions during the collecting period were quite dry, no ephemeral species could be found. In addition, a small collection of bryophytes made by Teresa Leyens in December 1995 is included in this study.

In total, 444 specimens were collected, 78 specimens of liverworts and 366 specimens of mosses. This is the largest collection of bryophytes ever made on the Cape Verde Islands. The liverworts were identified by E. Fischer (Bonn), the mosses by Ph. Sollman (Pottiaceae, 180 specimens), H. Greven (*Grimmia*, 19 specimens), M.A. Bruggeman-Nannenga (*Fissiden*, 15 specimens), W.R. Buck (some critical mosses), J. Lewinsky (*Orthotrichum*) and all other taxonomic groups by the first author (151 specimens). About 13 specimens of Bryaceae (with 3 species) remained so far unidentified.

So far there has been no complete survey of bryophyte flora of the Cape Verde Islands. There exists no list of the hepatics from Cape Verde Islands and only a checklist for the mosses by Muhle (1982), which is, however, not complete, in some cases erroneous and is based on the nomenclature of the primary literature without any consideration of recent revisions. Therefore a first complete survey of the bryophytes of Cape Verde Islands is given here, completed by the recent collections of A. Lindlar. All previous records are mainly compiled from Eggers (1982) and supplemented by recent monographs and revisions.

Abbreviations used:

Bo	Boavista
Br	Brava
CV	unspecified records from the Cape Verde Islands
F	Fogo
M	Maio
S	Sal
SA	Santo Antão
SL	Santa Luzia
SN	São Nicolau
ST	Santiago
SV	São Vicente

An asterisk (\*) preceding a species name indicates a new record for the Cape Verde Islands.

An asterisk (\*) preceding an island abbreviation indicates new record for this island.

The specimens were mostly collected by Anja Lindlar in January and February 1995, a few also by Teresa Leyens during the same fieldtrip. Collection numbers without collectors name refer to collections by A. Lindlar, collections made by T. Leyens are indicated.

#### Hepaticae and Anthocerotae

*Acrolejeunea emergens* (Mitt.) Steph.  
Cardoso 1897 cited after Gradstein (1975).

*Anthoceros punctatus* L.  
ST (Jovet-Ast 1946).

*Cololejeunea minutissima* (Sm.) Schiffn.  
F, SN, ST (Arnell 1961).

*Cyathodium africanum* Mitt. (*C. cavernarum* Kunze)  
SN (Cardoso 1915), SA. (Arnell 1961).

*Exormotheca pustulosa* Mitt.  
SN, SA (Arnell 1961).

*Fossombronia angulosa* (Dicks.) Raddi  
F, SA (Arnell 1961, Jovet-Ast 1946). SA: Ribeira das Pombas, on wet sand, NE-exposed, 200 m

(293).

*Fossombronia pusilla* (L.) Nees

F (Arnell 1961). **SA:** Ribeirada Torre, on loam, N-NE-exposed, 1360 m (196, 206, 211); Ribeira do Paúl, on NE-exposed loamy slope, 1040 m (388, 390); Cova, on N-exposed rocks along the road 1200m (239).

*Frullania dilatata* (L.) Dum.

F, SA, SV (Jovet-Ast 1946).

*Frullania ericoides* (Nees) Mont.

F, SN, ST, SA, SV (Vanden Berghen 1976, Arnell 1961). **SN:** Alto das Cabaças, on NE-exposed rocks, 670 m (40). **ST:** Serra da Malagueta, E-NE-exposed cliffs W of Châ de Figueiras, 770-800 m (103, 106).

*Frullania socotrana* Mitt.

F, SN, ST, SV (Arnell 1961, Vanden Berghen 1976). **SN:** Alto das Cabaças, on NE-exposed rocks 670 m (41). **ST:** Serra da Malagueta, Châ de Figueiras, on *Eucalpytus*, E-exposed, 910-930 m (119); Serra da Malagueta, E-NE-exposed cliffs W of Châ de Figueiras, 770-800 m (111). **SV:** Monte Verde, top plateau, on NW-NE-facing cliff, 720 m (50). **\*BR:** Plateau between Mato and Vila Nova Sintra, on NW-exposed cliff, 750-820 m (461).

*Frullania spongiosa* Steph.

SN, ST, SV (Arnell 1961, Vanden Berghen 1976). **SN:** Alto das Cabaças, on NE-exposed rocks, 670 m (39). **SV:** Monte Verde, top plateau, on NW-NE-facing cliff, 720 m (53, 55, 56).

*Frullania tamarisci* (L.) Dum.

F, SN, ST, SV (Cardoso 1915, Vanden Berghen 1976, Arnell 1961 sub *F. nervosa*). **SA:** Ribeira da Torre, blockstream in pine forest, on N-exposed blocks, 1450 m (173). **SN:** Alto das Cabaças, on NE-exposed rocks, 670 m (49).

[*Jungermannia subtilissima* (Schiffn.) Grolle] M (Muhle 1982) is based on a misidentification (fide Grolle comm. J. Eggers).

*Lejeunea caespitosa* Lindb.

ST (Arnell 1956, 1961).

*Lejeunea eckloniana* Lindenb.

F (Arnell 1961, 1963).

*Lejeunea flava* (Sw.) Nees

ST (Arnell 1961).

*Lejeunea lamacerina* (Steph.) Schiffn.

ST (Arnell 1961).

*\*Lejeunea ulicina* (Tayl.) Gottsche et al.

**SV:** Monte Verde, top plateau, NE-NE extending cliff, on rotten wood, 720 m (52).

*Lophocolea cuspidata* (Nees) Limpr.

F (Arnell 1961).

*Lunularia cruciata* (L.) Dum.

SN, SA (Arnell 1961). **SA:** Ribeira da Torre, on NE-exposed humid rocks 1360 m (212); Ribeira de Janela, upper part, on NE-exposed rocks, 1050 m (Leyens 412). **SN:** Monte Gordo, Ribeirinha in NE-part, on NE-exposed loamy slope, 1060-1070 m (31).

*Mannia androgyna* (L. emend. Lindbg.) Evans

F, SN, ST, SA (Jovet-Ast 1946, Arnell 1961 sub *M. dichotoma*). **SA:** Tope de Coroa, Ribeirinha in NE-slope, on NE-exposed rocks, 1600 m (278); Ribeira do Paúl, on NE-exposed rocks, 1060 m (379); Morossos, on NE-exposed rocks, 1560-1570 m (126, 150); **F:** Monte Velha, on NE-exposed slope along the trail, 1550-1560 m (438). **SN:** Monto Gordo, Ribeirinha in NE-part, on NE-exposed loamy slope, 1030-1070 m (20, 21).

*Marchantia paleacea* Bertol.

CV (Montagne 1860 fide Bischler-Causse 1989). "Needs confirmation". F: leg. Chevalier (PC fide Bischler-Causse 1993). **SA:** Ribeira das Pombas, upper part, on N-exposed wet rocks, 200 m (318); Morossos, W exposed flushed rocks along the trail to Figueiras, 1460 m (131).

*Marchantia pappeana* Lehm.

CV: Bolle s.n. 1853, Cardoso (1915 as *M. papillata* Raddi) fide Bischler-Causse (1993).

*Marchantia polymorpha* L.

F. (Jovet-Ast 1946, Arnell 1961).

*Marchesinia mackaii* (Hook.) S.F. Gray  
CV (Jovet-Ast 1946).

*Noteroclada porphyrorhiza* (Nees) Mitt.  
CV (Schiffner 1909, Cardoso 1915, Jovet-Ast  
1946 “semble mal déterminée”).

*Phaeoceros carolinianus* (Michx.) Prosk.  
F, SN, SA (Arnell 1961).

*Plagiochasma eximium* (Schiffn.) Steph.  
F, SN, ST (Arnell 1961, Bischler 1978).

*Plagiochasma rupestre* (Frst.) Steph.  
F, SN, ST, SA, SV (Cardoso 1915, Jovet-Ast 1946,  
Arnell 1961, Bischler 1978). \***BR**: between Mato  
and Vila Nova Sintra, on NW-exposed rocks, 750  
-820m (82). **F**: trail near Ribeira Marmulano, on NE-  
exposed rocky slope 1220-1250 m (451, 452); Monte  
Velha, NE-exposed rocky slope, 1550-1600 m (439);  
Galinheiros, Ribeira Tania, N-exposed soil covered  
rocks of dry waterfall, 180 m (419). **SA**: Morossos,  
NW-part, W-exposed flushed rocks along the trail  
to Figueiras, 1460 m (132); Ribeira da Torre, N-NE-  
exposed humid rocks, 1360 m (198); Road from Vila  
de Ribeira Grande to Porto Novo, 3-4 km above Vila  
da Ribeira Grande, on SE-exposed rocks 810 m  
(158); Serra da Malagueta, Châ da Figueiras, NW-  
exposed rocks above the school, 810-830 m (113);  
NW-exposed rocks along road below the pass, 840  
m (115, 117). **SA**: Ribeira Fria, E-exposed humid  
rocks along the trail 580 m (275). **SN**: Monte Gordo,  
Ribeirinha in NE-part, NE-exposed loamy slope,  
1030-1070 m (17, 30, 32, 33); Ribeira do Paúl, on NE-  
exposed rocks, 1060 m (378), 1170-1180 m (357).  
**ST**: Road from Tarrafal to Praia, humid E-exposed  
slope, 530 m (417).

*Porella arboris-vitae* (With.) Grolle  
SN (Arnell 1961). **SN**: Monte Caldeirinha, on NE-  
exposed rocks, 1040 m (11). \***SV**: Monte Verde,  
top plateau, on N-exposed rocks, 760 m (57, 60).

*Radula lindenbergiana* Gott. ex Hartm.  
SN, ST, SA (Jovet-Ast 1946, Arnell 1961).

\*

*Reboulia hemisphaerica* (L.) Raddi  
F, SN, ST, SA (Jovet-Ast 1946, Arnell 1961).

\**Riccia cavernosa* Hoffm. emend. Raddi

**SA**: Morossos, NW-part, flushed rocks along the  
trail to Figueiras 1460 m (130). *Riccia crystallina*  
and *R. cavernosa* were not distinguished in the  
past. Therefore it can not be decided whether the  
record of *R. crystallina* belongs to this species or  
also to *R. cavernosa*.

*Riccia ciliata* Hoffm.  
F (Jovet-Ast 1946).

*Riccia crystallina* L. emend. Raddi  
F (Jovet-Ast 1946).

*Riccia gougetiana* Durieu & Mont.  
CV Potier de la Varde nach Jovet-Ast (1946).

*Riccia nigrella* DC.  
SN (Cardoso 1915, Montagne 1861 sub *R. minima*  
(L.) Raddi, Jovet-Ast 1946). **SA**: Ribeira de Janela,  
on N-exposed rocks, 1050 m (Leyens 413).

*Riccia sorocarpa* Bisch.  
SA (Arnell 1961).

\**Targionia hypophylla* L. (incl. *T. lorbeeriana* K.  
Müll.)

**F**: NE-part of Bordeira, on NE-exposed rocks, 1920  
m (463). **SA**: Ribeira da Torre, on NE-exposed  
rocks, 1360 m (195), 1400 m (187); Tope de Coroa,  
Ribeirinha in NE-slope, on NE-exposed rocks,  
1600 m (286).

## Mosses

*Aloina rigida* (Hedw.) Limpr.  
SA (Bizot 1969, Bizot & Dury 1978).

*Amblystegium riparium* (Hedw.) B.S.G.  
SA (Muhle 1982).

*Anacolia laevisphaera* (Tayl.) Flow.  
SN (Montagne 1860, Cardoso 1915, Bizot 1969 as  
*Bartramia stricta*), SA (Bizot & Dury 1978). \***F**:  
trail near Ribeira Marmulano, rocky slope 1220 -  
1250 m (459).

Records of *Bartramia stricta* Brid. from the Cape  
Verde Islands presumably refer to this species (De



Sloover 1975, Bizot & Dury 1978).

*Anoetangium aestivum* (Hedw.) Mitt. (*A. euchloron* [Schwaegr.] Mitt., *Zygodon bolleanus* C. Müll.)

SN (Geheeb & Herzog 1910 as *Zygodon bolleanus*), F, SA, ST (Bizot 1969, Bizot & Dury 1978 sub *A. euchloron*).

*Anomobryum filiforme* (Dicks.) Solms

SA, SN. (Bizot 1969, Bizot & Dury 1978 sub *A. juliforme* Solms).

*Barbula bolleana* (C. Müll.) Broth. Natürl. Pfl. 2(10), 280. 1924. Basionym: *Meesia bolleana* C. Müll., Bot. Zeit. 20: 338. 1862.

*Hydrogonium bolleanum* (C. Müll.) Jaeg., Ber. S. Gall. Naturw. Ges. 1877-78: 405. 1880.

*Trichostomum bolleanum* (C. Müll.) C. Muell., Gen. Musc. Fr. 416. 1900.

*Didymodon bolleanus* (C. Müll.) Broth., Natürl. Pfl. 1(3): 407. 1902. Type: (Cape Verde Islands), Insul. Capts., ...Sao Nicolao, Cascade de la Ribeira brava, 1851, C. Bolle (no. 6), herb. Brotherus (H, lectotypus nov.).

*Trichostomum ehrenbergii* Lorentz, Abh. Ak. Wiss. Berlin 1867: 25-28 + fig. 1-6; 7-19. 1868. *syn. nov.*

*Hydrogontum ehrenbergii* (Lor.) Jaeg., Ber. S. Gall. Naturw. Ges. 1877-78: 405. 1880.

*Didymodon ehrenbergii* (Lor.) Kindb., Eur. N. Am. Bryin. 2: 281. 1897.

*Barbula ehrenbergii* (Lor.) Fleisch., Musci Flora Buitenz. 1: 357. 1904.

*Hyophila ehrenbergii* (Lor.) Amann, Fl. Mouss. Suisse 2: 298. 1919. Type: (Egypt), Sinai, Wadi Esle, ad riv., leg. Ehrenberg, herb. Hampe (BM!), lectotypus nov.).

The protologue of *T. ehrenbergii* cites two collections. One collection (above) was traced and has been studied. This material agrees well with the data of the type literature. Formally, no type was indicated, therefore the collection above is selected here as lectotype.

*Barbula bolleana* (C. Muell.) Broth., replaces *Barbula ehrenbergii* (Lor.) Fleisch., because the former name is an older one (1862 versus 1867-1868). Both types were studied and compared. They agree well.

*Barbula elliottii* Broth., Bot. Jahrb. 24: 257. 1897.

*syn. nov.* Type: (Uganda), Africa or., Ruwenzori, Kasagamvao, 5200 ft, Scott Elliott 127, herb. Brotherus (H, holo). Note: Ann. R.H. Zander, 1986: "probably the same as *Barbula ehrenbergii*; only a few stems".

*Barbula kivuensis* Leroy & P. de la Varde, Inst. Pars Nat. Congo Belge, Expl. Parc. Nat. Alb. miss. Lebrun, fasc. 6: 15 + fig. 12-16. 1944. *syn. nov.* Type: (Zaire), Congo Belge, chutes de la Rutshuru, 1200 m., rochers dans les embruns en tapt, janv. 1938, J. Lebrun 9430, herb. V. Leroy (BR). Note: I. also studied: J. Lebrun 8433-C (BR, para). 2. This name was validly published, but for some reason not listed in the Index Muscorum.

*Barbula madagassa* Ren. & Card., Prodr. Fl. Bryol. Madag. 128. 1898. *syn. nov.* Type: Madagascar: sur les pentes occidentales du plateau central a Andriba, 1897, Comm. Dorr, herb. Motelay, in herb. F. Renaud 526 (PC). Note: Brotherus, Nat. Pfl. 1 (3): 403, 1902, as *Hyophila spec.*

**SA:** Ribeira das Pombas, upper part, on NE-exposed rocks, 200 m (313, 314, 316, 317), 280 m (394, 395, 397, 402); Ribeira Fria, upper part, 640-700 m, in wet N-exposed rocks (261, 264, 267); Tarrafal, on loamy soil along trail, N-exposed, 190 m (256, 257, 259). Ribeira da Torre, on E-exposed wet flushed vertical rocks in sugar cane plantation, 840 m (225). Ribeira Fria, im unteren Bereich, am Weg, on E-exposed rocks, 580 m (271). Ribeira do Paul, upper part, on NE-exposed wall, 1180-1170 m (364). **BR:** Ribeira da Faja de Agua, on W-exposed wet sandy trail-bank, 35-50 m (69, 71); vertical rocks along trail to the plantation, 160 m (77, 78, 79, 80, 81); on W-exposed wet rocks, 210 m (74, 75). **F:** Bordeira, spring at Domingos Santo, 2000 m (Leyens CV-95-15); Châ das Caldeiras, small ribeira at the foot of the volcano, 1800 m (Leyens CV-95-32). Monte Velha, on NE-exposed slope, 1550-1600 m (437). NE rim of Bordera, on N-exposed rocks, 1920 m (426). **ST:** Road from Tarrafal to Praia, on E-exposed humid slope, 530 m (415, 416).

\**Barbula cf. consanguinea* (Thwait. & Mitt.) Jaeg.

**BR:** Ribeira da Faja da Agua, on W-exposed humid, sandy slope 35 - 50 m (70).

*Barbula convoluta* Hedw. (*Barbula sulcata* Geh.)

*Barbula sulcata* Geheeb in Geheeb & Herzog, Bibl. Bot. 72: 46. 1910. *syn. nov.* Type: (Cape Verde Islands) Sao Nicolao: Mte Gordo, ad rupes, 4500

ft, steril, 1864, R.T. Lowe (BM, iso). Rhizoidal tubers as in *Barbula convoluta* Hedw. are scarcely present in the type material. D. Long already annotated the the BM-sheet “*Barbula convoluta*?” *Barbula sulcata* is according to the authors of the Index Muscorum a nomen nudum, but was legitimately published.

SN (Geheeb & Herzog 1910 as *B. sulcata*). \*F: Ribeira Filipe, 1600m (Leyens CV-95-25); Chadas Caldeiras, lava stream along previsory road, 1800m (Leyens CV-95-32). Galinheiros, Ribeira Tanha, NE-exposed soil covered rock at waterfall, 180 m (418, 420, 423). \*BV: Monte Gordo, Ribeirinha in northern part, on loam, 1030 - 1070 m (19). \*SV: Alto das Cabacas, on N-exposed rocks, 670 m (38, 45, 46, 47). \*SA: Descent from Rui Vaz to S. Jorge. On humid cliffs at ca. 850m (Leyens CV-95-36). Plateau between Mato und Vila Nova Sintra, 750 - 820 m (86). Serra da Malagueta, on NE exposed rocks and soil (102). Ribeira da Torre, 1400 m (180). Pass between Cova and Ribeira do Paul, 250 m (332, 338). Ribeira das Pombas, 260 m (409). SN: Monte Caldeirinha; E-slope, 1070 m (9). Plateau between Mato and Vila Nova Sintra, on NW-exposed rocks, 750-820m (85); Serra da Malagueta, Châ de Figueiras, on NW-exposed rocks above the school 810 - 830 m (114); Serra da Malagueta, Cha de Figueiras, on NW-exposed rocks below the pass, 840 m (116); Ribeira das Pombas, on wet sand, N-exposed, ca. 200 m (301); Ribeira do Paul, upper part, on NE-exposed wall, 1180 - 1170 m (354). Ribeira das Pombas, upper part, on NE-exposed wet rocks in plantation, 260 m (406).

*Barbula fallax* Hedw.

SA, SN (Bizot 1969, Bizot & Dury 1978).

*Barbula indica* (Hook.) Spreng. (*Semibarbula orientalis* [Web.] Wijk & Marg.)

SA, SN (Bizot 1969, Bizot & Dury 1978 sub *Semibarbula orientalis*). \*BR: along the road to the airport on N-exposed rock of old source, 520 m (97); on NE-exposed soil 540 m (94). Ribeira da Faja da Agua, on W-exposed humid sandy bank of trail 35-50 m (68). SA: Ribeira do Paul, upper part, on NE-exposed rocks and walls, 1060 m (380). Along the road from Ribeira Grande to Porto Novo, 3-4 km above Vila da Ribeira Grande, on SE-exposed rocks, 810 m (156, 157). Ribeira das Pombas, vertical rocks in southern part of the valley, on NE-exposed

wet rocks, 280 m (398, 401), Ribeira das Pombas, upper part, on N-exposed rocks, 200 m (289, 302). \*F: along the road from Galinheiros to S. Jorge, 290 m (Leyens CV-95-1, CV-95-2).

*Barbula lambarenensis* P. Varde (*Semibarbula* l. [P. Varde] Bizot)

SA (Bizot & Dury 1978 sub *Semibarbula* l.)

?*Barbula revoluta* Brid. in Schrad.

SA, SN (Bizot 1969). This species is reported by Bizot (1969: 445 based on 4 collections): “nous rapportons à cette espèce quelques brins, dont les feuilles sont fortement révolutes, trouvés entre d’autres mousses.” However, one collection studied (São Nicolau, between Cruzetinha and Mt. Gordo, ca. 1100 m, *Byström 124* [intermixed with *Hyophila crenulata*] PC-hb. Bizot) proved to be *Bryoerythrophyllum inaequalifolium*. This collection has the characteristic unicellular axillary gemmae. The other collections of *Barbula revoluta* from the Cape Verde Islands have not been studied. Thus the occurrence of *Barbula revoluta* in these islands is doubtful although possible.

\**Barbula unguiculata* Hedw.

SA: Ribeira das Pombas, upper part, ca. 200 m (302).

*Brachymenium acuminatum* Harv. (*B. borgeanum* Hampe)

SA “avec quelques doutes” as *B. borgeanum* (Bizot 1969). SA: Ribeira da Torre, on NE-exposed wall, 1180 m (217, 218 with *Bryum argenteum*, 356); on rocks, 1400 m (178), on loam, 1360 m (216, 204 with *Ditrichum sp.*). Cova, on N-exposed rocks along road, 1200 m (232). ST: Serra da Malagueta, E- and NE-slopes SW of Châ de Figueiras, on soil, 770-800 m (101); Châ de Figueiras, NW-exposed rocks above the school, 810-830 m (112); SE-exposed rocky slope, 930 m (123). BR: plain between Mato and Vila Nova Sintra, on NW-exposed rocks, 750-820 m (460). F: Monte Velha, NE-exposed slope along the trail, 1550-1600 m (440, 442).

\**Brachymenium exile* (Dozy & Molke.) Bosch. & Lac.

BR: along the road to the airport, on N-exposed rock, 520 m (99); plain between Mato and Vila Nova

Sintra, on NE-exposed terraces, 850 m (88). **SN:** Monte Gordo, Ribeirinha, on NE-exposed loamy slope, 1030-1070 m (28). **ST:** Serra da Malagueta, Chã de Figueiras, on *Eucalyptus*, NE-exposed, 910-930 m (118, 120); on E- and NE-exposed soil and rocks 770-800 m (110). **SA:** road from Vila da Ribeira Grande to Porto Novo, c. 3-4 km above Vila da Ribeira Grande, on SE-exposed rocks, 810 m (159). **F:** at the road N of Campanas, 490 m (Leyens CV-95-18); Ribeira Filipe, 1060 m (Leyens CV-95-24), CV-95-26 c. spor.); Bordeira, spring at Domingos Santo, 2000 m.

A species widespread in the drier parts of Africa (including the Sahara), SE- and E-Asia and Hawaii. It is differentiated from *B. acuminatum* by its wider laminal cells and the broader leaf apex with longer excurrent costa.

*Brachymenium philonotula* Broth.

SA, SN, ST (Bizot 1969, Bizot & Dury 1978). Ochi (1972) remarks under this species "close to *B. exile*, possibly even conspecific". Thus the records of this species by Bizot are probably identical with our records of *B. exile*. *Brachymenium philonotula* is recorded from tropical Africa (Zaire, Kenya, Madagascar, Tanzania), thus within the range of *B. exile*. Bizot mentions as typical for *B. philonotula* axillary gemmae as known for *Pohlia*-species, which are illustrated by Ochi (1972) for *B. exile*.

*Braunia alopecura* (Brid.) Limpr.

SA, SN (Potier de la Varde 1946 sub *Hedwigidium imberbe* rev. Bizot, Bizot 1969, Bizot & Dury 1978). **SA:** Ribeira da Torre, on NE-exposed rocks, 1180 m (223); 1200 m (340); 1400 m (184), 1450 m (170, 175); Cova, blockstream, on SW-exposed rocks, 1160 m (250); 1200 m (322). Collection number 175 has distinctly higher papillae.

The genera *Braunia* and *Hedwigidium* are usually distinguished by the immersed viz. exerted capsules, a problematical character if most of the material is sterile. As figured out by Frahm (1976, see also fig. 3), *Hedwigidium* can be recognized in sterile condition by its involute leaf margins and a leaf apex which is gradually contracted. *Braunia* has a leaf margin which is flat except for the most basal part of the leaf and has a leaf apex which is suddenly contracted (as a "dolphin nose"). Furthermore, the papillae on the leaf surface are different. *Braunia alopecura* occurs in a few

places in the southern Alps of Europe and was found in addition in one locality in the Apuan Alps (near Genova, Italy). For a distribution map see Frahm (1976). Records from the Pyrenees could not be confirmed and are probably also based on confusions with *Hedwigidium imberbe*. On the Macaronesian Islands, *Braunia alopecura* is only found on the Cape Verde Islands. This is a highly disjunct distribution pattern. However, there are 8 more species of *Braunia* described from tropical Africa and a revision of these species could reveal the identity of one or more of these species with *Braunia alopecura*.

\**Bryoerythrophyllum ferruginascens* (Stirt.)

Giac.

**SA:** Cova, Südrand, N-exposed rocks along the road, 1200 m (241).

\**Bryoerythrophyllum inaequalifolium* (Tayl.)

Zand.

*Tortula pierrotii* M. Bizot, Acta Bot. Acad. Scient. Hungar. 18: 21 + fig. 7, above. 1973. *syn. nov.* Type: Tanzania sud, Mbeya Mts., pres Mbeya, sur la terre, 2400 m., 7 II 1968, M.D. Balazs IO0/B, herb. Bizot (PC, holo). Notes: 1. the characteristic unicellular gemmae are present in the type collection. 2. Two additional collections could be studied: D. Balazs 100/E + IO0/G; they also belong to *Bryoerythrophyllum inaequalifolium*.

**SA:** Ribeira da Torre, humid side valley in the upper part, on N-NE-exposed rocks in cool and humid microclimate, 1360 m (202). Ribeira da Torre, on humid soil in pine forest, N-exposed, 1450 m (162, 165).

The species is found in northern South America, Panama, Mexico, North Carolina, the Canary Islands, India, Java and China. It propagates by unicellular gemmae born on branched stalks in upper leaf axils.

See also comment under *Barbula revoluta*.

*Bryosedgwickia densa* (Hook.) Biz. & P. Varde

ST (Bizot & Dury 1978).

*Bryum anomodon* Mont.

SA (Cardoso 1915). **SA:** Ribeira do Paúl, upper part, on NE-exposed wall, 1060 m (385). **\*F:** trail near Ribeira Marmulano, 1220-1250 m, on NE-

**Fig. 3:** SEM photographs of leaves of *Braunia alopecura* (left) and *Hedwigidium imberbe* (right).

exposed rocky slope (448). \***ST**: Serra da Malagueta, E- and NE-slopes SW of Châ da Figueiras, on E- and NE-exposed soil and rocks, 770-800 m (108).

This species is only known from the Cape Verde Islands, which does not necessarily mean that it is endemic to the Cape Verde Islands because of the insufficient knowledge of the species of this genus and also the insufficient bryological exploration of the tropics. The type was collected by Bolle "cum Rocellis in mont. insulae Sancti-Antonii". Illustration and description are found in Ochi (1972). The plants are low and imbricate, the costa is excurrent, the margins of the leaves are not bordered. Conspicuous are the laminal cells, which are elongated ("pohlioid") in the upper part of the leaves but lax in the lower part. In the peristome, the inner teeth (cilia) are longer than the outer ones.

*Bryum argenteum* Hedw.

SA, SN (Bizot 1969, Bizot & Dury 1978) incl. "Formes proches de var. *lanatum*". **SA**: Tope de Coroa, Ribeirinha, NE-slope, on rocks in former streambed, 1600 m (279); Morossos, NW-part, on N-exposed rocks, 1480 m (140); Ribeira do Paúl, upper part, on wall along the trail, NE-exposed, 1170 m (360); Ribeirada Torre, on NE-exposed wall, 1180 m (218) with *Brachymenium acuminatum*. **SN**: Monte Caldeirinha, on W-exposed slope, 1030 m (6). \***F**: Châ das Caldeiras, small ribeira at the foot of the volcano, 1800 m (Leyens CV-95-27); Ribeira Filipe, 1060 m (Leyens CV-95-22); N of Campanas, Ribeira Boga, 540 m, in road crevices (Leyens CV-95-20).

All plants belong to a special form which does not form cushions but consists of single plants intermingled with other mosses, and which is very small, has recurved hyaline leaf tips and densely foliate stem tips.

*Bryum canariense* Brid.

SA, SN (Bizot 1969, Bizot & Dury 1978). \***F**: Monte Velha, NE-exposed rocky slope along the trail 1550-1600 m (436). **SA**: Ribeira do Paúl, upper part, on NE-exposed rocks and walls, 1060-1200 m (342, 346, 347, 358, 359, 362, 363, 369, 370 c. spor. 371, 375, 376, 383, 386); Ribeira da Torre, on N-NE-exposed rocks, 1180-1400 m (189, 192, 200, 202, 203, 208, 209, 210, 214, 215, 215, 219, 220), in pine forest, 1450 m

(162, 165); Ribeira Fria, on E- and Ne-exposed wet rocks, 580 m (273), 640-700 m (260, 270); pass between Cova and Ribeira do Paúl, on NE-exposed rocks 1250 m (329); Cova, on rocks 1200 m (246, 325); Tope de Coroa, on rocks in former streambed, 1600 m (287); Ribeira das Pombas, on wet rocks, 200 m (307), 280 m (396); Ribeira de Janela, on NE-exposed rocks, 1050 m (Leyens 414); Morossos, on N-exposed rocks, 1460-1480 m (134, 135, 137, 138, 139, 142, 145, 146).

*Bryum capillare* Hedw.

SA, SN (Bizot 1969). **SA**: Ribeira da Torre, pine forest, on soil on NE-exposed slope, 1450 m (163).

\**Bryum cellulare* Hook.

**SA**: Morossos, seepage rock along the trail to Figueiras, 1460 m, Wexposed (133).

A tropical species recorded so far from Central Africa, Niger, some relictual localities in the Mediterranean, Australia, SE and E-Asia.

*Bryum nitens* Hook. (*B. alpinulum* Besch. var. *latinerve* P. Varde & Thér.)

SA (P. Varde 1943 with description of var. *latinerve*). A species widespread from tropical Africa to Australasia, SE-Asia to Japan.

?*Bryum rubicundum* C. Müll.

SN (Geheeb & Herzog 1910). According to Ochi (1972) probably a depauperate *Mielichhoferia*.

?*Bryum torquescens* Bruch

M (Syed 1973). Syed indicates this species from Maio, but this would be the only record of a bryophyte from this island, which seems to be very unlikely. It can be supposed, that "Maio" is the Latin herbarium information for the date of the collection.

*Campylopus pilifer* Brid.

F, SA, SN, ST, SV (Bizot 1969 sub *C. polytrichoides*, Bizot & Dury [1978] sub *C. introflexus* [Hedw.] Brid. var. *polytrichoides* [De Not.] Giac.). **F**: Ribeira Marmulano, NE-exposed rocky slope, 1220-1250 m (458). **SA**: Ribeira da Torre, on N-exposed rocks, 1180 m (222), 1400-1450 m (172, 186); Cova, on N-exposed rocks, 1200 m (237, 320); Ribeira do Paúl, on NE-exposed rocks 1180 m (349). **SN**: Alto das Cabaças, on N-exposed rocks, 670 m (44); Monte

Caldeirinha, on SE-exposed rocks, 1030-1070 m (8, 14, 16). **SV:** Monte Verde, top plateau, on N-exposed rocks, 760 m (63).

?*Campylopus pyriformis* (Schultz) Brid. CV (Bizot 1969). This species was indicated from the Cape Verde Islands as "Mousses indiquées des Iles du Cap Vert mais non recueillies par M. Byström". It could, however, not be found in the earlier literature. The occurrence of this species on the islands seems to be dubious.

\**Chenia leptophylla* (C. Müll.) Zander **SN:** Monte Gordo, Ribeirinha, on NE-exposed loamy slope, 1030-1070 m (25, 26). **SA:** Tope de Coroa, Ribeirinha in NE-slope 1600 m (283).

*Crossidium crassinerve* (De Not.) Jur. (*C. cloronotus* [Brid.] Limpr.) SA, SN (Bizot 1969). \***F:** Châ das Caldeiras, small ribeira at the foot of the volcano, 1800 m (Leyens CV-95-29).

?*Cryphaea bollei* Broth. & Geh. SA, SN, SV (Geheeb & Herzog 1910 with description and illustration, P. Varde 1943, Bizot 1969, Bizot & Dury 1978). According to Bizot (1969) a doubtful species only known in sterile condition, which might be synonymous with *Pseudoleskea pseudoattenuata*. Nevertheless, he lists both species in his publication based on subtle differences. A type is kept in Helsinki (H-BR) but presently loaned to H. Muhle, a fragmentary isotype is present in PC (see also P. Varde 1943). The synonymy of this species with *Pseudoleskea pseudoattenuata* can not be confirmed, since a type specimen of the latter can not be located. Although Broth. & Geh. made the new combination, there is no specimen of this species in his herbarium. However, the isotype of *Cryphaea bollei* and other material of the same species collected by Byström on SA as well as the material named as *Pseudoleskea pseudoattenuata* from the Cape Verde Islands and mainland Africa (e.g. Natal) seems to be identical.

\**Desmatodon bogosicus* C. Müll. **SA:** Morossos, steep rocks along the way to Figueiras, on N-exposed rocks, 1480 m (140, 143). Tarrafal, on humid soil below a wall, N-exposed,

300 m (254, 255). Cova, N-exposed rocks along the road, c. 1200 m (242). Tope de Coroa, Ribeirinha in NE-slope, 1600 m (283A, 288). Ribeira das Pombas, upper part, ca. 200 m (302). **SN:** Monte Gordo, Ribeirinha, loamy slope, NE-exposed, 1030-1070 m (24).

*Desmatodon convolutus* (Brid.) Brout (*Tortula atrovirens* [Sm.] Lindb.) SA (Bizot & Dury 1978). \***F:** NE-rim of Bordeira, on NE-exposed rocks, 1920 m (432); southern part of Bordeira, 2200 m (Leyens CV-95-4). **SA:** Morossos, NE-part, 1560 m (127). Ribeira do Paul, on NE-exposed walls along the road, 1180-1170 m (353A).

\**Didymodon australasiae* (Hook. & Grev.) Zander **F:** NE-rim of Bordera, on NE-exposed rocks, 1920 m (431, 433). Monte Velha, on trailbank, NE-exposed, 1550-1600 m (443, 446); Châ das Caldeiras, small ribeira at the foot of the volcano, 1800 m (Leyens CV-95-30). **SA:** Ribeira do Paul, upper part, on NE-exposed rocks and walls, 1060 m (367), 1170-1180 m (352). Tope de Coroa, on NE-exposed rocks, 1600 m (285). Cova, southern part, on N-exposed rocks along road, 1200 m (235, 243). Ribeira da Torre, humid side valley in upper part, on wet rocks, 1360 m (214). Tope de Coroa, Ribeirinha in NE-slope, 1600 m (288A). Ribeira do Paul, on NE-exposed walls along the road, 1180-1170 m (353). A species widely distributed in North, Central and South America, southern Europe, southern Africa and Australasia.

\**Didymodon maschalogenae* (Ren. & Card.) Broth. (*Didymodon michiganensis* [Steere] K. Saito) **F:** NE rim of Bordera, on NE-exposed rocks, 1920 m (428, 434). Monte Velha, on NE-exposed slope along trail, 1550-1600 m (444). **SN:** São Nicolau and Mt. Gordo 1100 m, *Byström 119* (intermixed with *Weissia cucullata*), *124* (intermixed with *Hyophila crenulata*) PC-hb. Bizot. See also comment under *Didymodon rigidulus*.

*Didymodon maschalogenae* replaces *Didymodon michiganensis*, because the former is an older name (1905 versus 1938). The holotypes of both taxa were studied and compared. They were found to be identical:

*Didymodon maschalogenae* (Ren. & Card.) Broth., Nat. Pfl. 1 (3): 1192. 1909.  
*Barbula maschalogenae* Ren. & Card., Bull. Soc. R.

Bot. Belg. 41 (1): 53. 1905.

Type: (India), Sikkim, Darjeeling, G.A. Miller, herb. Cardot (PC)

Gangulee (1972, p. 755) gives a good illustration of the type collection. Chopra (1975, p. 140) is not correct in listing this name under *Barbula rigidula* (Hedw.) Milde. *Didymodon rigidulus* (Hedw.) emend. Zander is clearly another concept (e.g. Zander 1981).

*Barbula michiganensis* Steere in Grout, Moss Fl. N. Am. 1: 180. 1938. *syn. nov.*

*Didymodon michiganensis* (Steere) K. Saito, J. Hattori Bot. Lab. 39: 517. 1975. Type: USA, Michigan, Alger Co., Pictured Rocks. 20 Aug. 1935, Nichols & Steere (MICH).

*Didymodon rigidulus* Hedw. emend. Zander (incl. *Barbula acuta* (Brid.) Brid.)

SA, SN (Bizot 1969, Bizot & Dury 1978 as *Barbula acuta*). \*F: Monte Velha, NE-exposed slope along trail, 1550-1600m (435). Châ de Caldeiras, small ribeira at foot of volcano, 1800m (Leyens CV-95-31).

Bizot (1969: 245) reports *Barbula acuta*: “semble un peu différent de la plante européenne par les feuilles moins révolutes.” A specimen of *Barbula acuta* from São Nicolau, however, proved to be *Didymodon maschalogenia*.

*Didymodon tophaceus* (Brid.) Lisa

SA, SN (Potier de la Varde 1946, Bizot 1969). \*F: Bordeira, spring at Finto Nobu, 1950 m (Leyens CV-95-13). SA: Ribeira da Cruz, 1050m (276A).

*Didymodon vinealis* (Brid.) Zander \*var. *vinealis* SA: Cova, on N-exposed rocks along the road, ca. 1200m (233, 236).

var. *flaccidus* (B.S.G.) Zander (*Barbula cylindrica* [Tayl.] Schimp. in Boul.)

SA, SN (Bizot 1969, Bizot & Dury 1978).

\**Ditrichum spec.*

SA: Ribeira da Torre, upper part, on loam over rocks, NE-exposed, 1360 m (204 with *Brachymenium acuminatum*, 205). The plants are sterile and thus the species cannot be identified, however, species of this genus have not yet been reported from the Cape Verde Islands.

*Entodon pseudoseductrix* (C. Müll.) Jaeg.

F, SA, SN (Bizot 1969, Bizot & Dury 1978). Described as endemic from the Cape Verde Islands. Is perhaps conspecific with *E. schleicheri*.

*Entodon schleicheri* (Schimp.) Dem. (*Neckera cladorrhizans* Hedw.)

SA (Cardoso 1915, Montagne 1860).

*Epipterygium tozeri* (Grev.) Lindb.

SA. SA: Ribeira das Pombas, on rocks and wet sand in streambed, N-exposed, 200 m (298), det. W.R. Buck. A very fragmentary collection consisting of 2 plants.

*Eriopodium perrottetii* (Mont.) Jaeg. (*E. grossirete* C. Müll.)

SA (Bizot 1969, P. Varde 1946).

*Eucladium verticillatum* (Brid.) B.S.G.

SA, SN (Bizot & Dury 1978). SA: Ribeira Fria, upper part, on flushed rocks, N-exposed, 640-700 m (262, 263, 265). Ribeira da Torre, E-exposed flushed rocks in sugar cane plantation, 840 m (227)

\**Eurhynchium meridionale* (B.S.G.) De Not.

SV: Monte Verde, top plateau, 760 m, below rocks, N-exposed (59).

*Eurhynchium praelongum* (Hedw.) B.S.G. (*Oxyrhynchium praelongum* [Hedw.] Warnst.

SA (Geheb & Herzog 1910).

\**Eurhynchium speciosum* (Brid.) Jur.

SA: Ribeira das Pombas, on wet rocks at waterfall in the southern part of the valley, 280 m (399), also as a fragment on moist sand in streambed, 200 m (310); Ribeira da Torre, seepage rocks in sugar cane plantation, 840m (226). A temperate species which is characteristic for wet rocks and springs.

*Fabronia leikipiae* C. Müll.

SA, SN (P. Varde 1946, Bizot 1969). SA: Morossos, on rock in streambed with *Pseudoleskea pseudoattenuata*, 1560-1570 m (155).

*Fissidens alatus* P. Varde

F (P. Varde 1943)

*Fissidens allorgei* P. Varde

SA, SN (P. Varde 1943, Bizot 1969).

*Fissidens bocarangensis* P. Varde  
SA (Bizot 1969).

\**Fissidens bogosicus* C. Müll.

**SA:** Ribeira das Pombas, upper part, on NE-exposed wet rocks, 200 m (297, 303, 309); Ribeira da Torre, on NE-exposed rocks covered with loam, 1360 m (197). **F:** trail near Ribeira Marmulano, on NE-exposed rocky slope, 1220-150 m (455).

*Fissidens danckelmannii* C. Müll.  
SA, SN (Bizot 1969, Bizot & Dury 1978).

\**Fissidens flaccidus* Mitt.

**BR:** on NE-exposed rocks at spring along the road to the airport, 520 m (95).

\**Fissidens helictocaulos* C. Müll.

**SN:** Monte Gordo, Ribeiringa at NE slope, on NE-exposed loamy slope, 1030-1070 m (23). **SA:** Cova, on NE-exposed rocks along the road, 1200 m (247). Ribeira da Torre, on NE-exposed rocks covered with loam, 1360 m (197). **F:** trail near Ribeira Marmulano, on NE-exposed rocky slope, 1220-150 m (455).

*Fissidens longipes* Welw. & Duby  
CV (P. Varde 1946, Bizot 1969).

*Fissidens minutulus* Sull.  
CV (Chevalier in Bruggeman-Nannenga 1978).

\**Fissidens sciophyllus* Mitt.

**BR:** on NW-exposed rocks along the road to the airport, 580 m (91, 92, 93); on NE-exposed rocks at spring along the road to the airport, 520 m (95). **SA:** Serra de Malagueta, NE-slope of Chã Figueiras, on NE-exposed rocks, 770-800 m (107). Ribeira das Pombas, upper part, on NE-exposed loamy rock in plantation, 280 m (392, 405, 410). **F:** trail near Ribeira Marmulano, on NE-exposed rocky slope, 1220-150 m (455).

*Funaria chevalieri* P. Varde  
F (P. Varde 1943). As indicated by P. Varde, the type (in PC) is similar to *F. pulchella* Philib. but shall differ by the length and colour of the peristome teeth and also the spore surface.

*Funaria hygrometrica* Hedw.

SA (Cardoso 1915, Montagne 1861). **SA:** Topede Coroa, Ribeirinha in NE-slope, 1600 m (288).  
var. *calvescens* Schwaegr.  
SN (Bizot 1969).

*Grimmia laevigata* (Brid.) Brid.

F, SA (Bizot 1969, Bizot & Dury 1978). **SA:** Ribeira da Torre, block stream in pine forest with *Braunia alopecura*, 1450 m (177), 1400 m (185, 191); Cova, rocks along road, 1200 m (245); on SW exposed rocks in block stream, 1200 m (320); Morossos, on NE-exposed rocks, 1560 m (124, 148). **F:** NE-rim of the Bordeira, on NE-exposed rocks, 1920 m (430); southern part of Bordeira, 2200 m (Leyens CV-95-3).

*Grimmia trichophylla* Grev.

CV (P. Varde 1946).

ssp. *lisa* (De Not.) Boul. SA, SN (Bizot 1969, Bizot & Dury 1978). **SA:** Pass between Cova and Ribeira do Paúl, on NE-exposed rocks, 1250 m (328, 339); Morossos, on NE-exposed rocks in stream bed, 1560 m (151, 153); Ribeira do Paúl, on NE-exposed wall along trail, 1200 m (343, 344); Ribeira da Torre, block stream in pine forest, 1450 m (166, 174, 176a), 1400 m (182, 183).

*Groutiella laxotorquata* (Besch.) Wijk & Marg.  
SN, ST, SV (Bizot & Dury 1978). **SN:** Alto das Cabaças, NE-exposed rocks, 670 m (42, 48). **ST:** Serra da Malagueta SW of Chã de Figueiras, E-NE exposed rocks, 770-800 m (104). **SV:** Monte Verde, top plateau, N-exposed rocks, 760 m (62, 64). Cardoso (1915) lists *Macromitrium* sp., which may belong to this or the next species.

*Groutiella sarcotricha* (Broth.) Wijk & Marg.  
CV (Brotherus 1925 as *Macromitrium sarcotrichum* [C. Müll.] Par.).

\**Gymnostomiella cf. vernicosa* (Hook.) Fleisch.  
**SA:** Ribeira das Pombas, ca. 200 m, on N exposed rocks (305, 306). **F:** Galinheiros, Ribeira Tanha, on soil covered rocks at waterfall, 180 m (418A, 425).

*Gymnostomum aeruginosum* Sm.  
SA, SN (Bizot 1969, P. Varde 1946).

\**Gymnostomum calcareum* Nees & Hornsch.  
**SA:** Ribeira da Cruz, Hang kurz unterhalb des



Passes, on N-exposed rocks, 1050 m (276); (366);  
Ribeira do Paul, upper part, 1060 m, on N-exposed  
rocks and walls (366, 368). Tope de Coroa,  
Ribeirinha in NE-part, on NE-exposed rocks, 1600  
m (281A, det Th. Arts).

*Haplodontium notarisii* (Mitt.) Broth.  
SA. (Bizot 1969).

*Hedwigia ciliata* (Hedw.) Ehrh ex P. Beauv.  
SA, SN (Bizot 1969, Bizot & Dury 1978). **SA:**  
Ribeira do Paúl, on NE-exposed rocks, 1170- 1180  
m (345).

*Herpetineuron toccoeae* (Sull. et Lesq.) Card.  
F (Eggers 1982).

*Homalothecium nilgheriense* (Mont.) Robins.  
(*Palamocladium n.* [Mont.] C. Müll.)  
SV (Bizot & Dury 1978). \***Br:** Monte Tina SE of Vila  
Nova Sintra, NE-exposed rocky slope, 800 m (89).  
\***SN:** Monte Caldeirinha, on soil and rocks along  
trail, E-exposed, 1020 m (3). **SA:** Pass between  
Cova and Ribeira do Paúl, on NE-exposed rocks,  
1250 m (336)

*Homalothecium sericeum* (Hedw.) B.S.G.  
SA, SN (Montagne 1860 sub *Leskea sericea*,  
Cardoso 1915).  
Var. *mandonii* (Mitt.) Ren. & Card. (*Homalothecium mandoni* [Mitt.] Geh.) SA, SN, ST, SV  
(Cardoso 1915, Bizot 1969, Bizot & Dury 1978). **SA:**  
Ribeira da Torre, on N-NE-exposed rocks, 1400 m  
(193); on N-exposed rocks in blockstream, 1450 m  
(171).

[*Hydrogonium bolleanum* (C. Müll.) Jaeg.]  
SA, SN, ST. (Cardoso 1915, Bizot 1969, Bizot &  
Dury 1978). Probably conspecific with *Barbula*  
*ehrenbergii*.

*Hymenostylium congoanum* Dix. et Nav.  
SA, SV (Bizot 1969, Bizot & Dury 1978).

*Hyophila machadoana* Sergio (*Hyophila crenulata* C. Müll. ex Par.)  
SN (Bizot 1969).

\**Hyophila involuta* (Hook.) Jaeg.  
*Hyophila crenulata* C. Muell. ex Dus. var. *brevi-*

*folia* Bizot, Svensk Bot. Tidskrift B. 63, H. 4:  
444. 1969. *syn. nov.* Type: Cape Verde Islands, Sao  
Nicolau: between Cruzetinha and Calderinha, ca.  
1000m., 19.11.1958. K. Byström 60, det. Bizot, 1966.  
(S, lectotypus nov.). Type material could not be  
traced in herb. PC. However, as stated in the  
original publication (Bizot, 1969) a set of the material  
was also placed in herb. S. Three of the five  
collections cited in the original literature were  
found in herb. S and have been studied. Formally,  
no type was indicated, therefore a lectotype is  
selected here.

**SA:** Ribeira da Torre, E-exposed flushed vertical  
rock in sugar cane plantation, 840 m (229). Ribeira  
do Paúl, on NE-exposed rocks and walls, 1060 m  
(384). Ribeira das Pombas, upper part, on wet rocks  
in upper part of plantations, NE-exposed, 260 m  
(406A, 408).

*Hypnum cupressiforme* Hedw.  
SA (Montagne 1860, Cardoso 1915, Bizot & Dury  
1978).

*Isothecium myosuroides* Brid.  
CV (Bizot 1969, P. Varde 1946).

*Leptobryum pyriforme* (Hedw.) Wils.  
F. **F:** Bordeira, spring at Fonti Nobu, 1950 m (Leyens  
CV-95-6, CV-95-10).

*Leptodon longisetus* Mont. (*Pinnatella revoluta*  
Biz. cf. Enroth, J. Hattori Bot. Lab. 71: 75-82, 1992)  
SN (Bizot 1969 with description of *Pinnatella*  
*revoluta*), ST (Bizot & Dury 1978).

?*Leptodon smithii* (Dicks.) Mohr  
SA (Bizot & Dury 1978). A questionable record.  
The authors write: "The sample resembles the  
above mentioned species (*L. longisetus*) in anatomy,  
leaves, costa and tissue but differs in the  
stems being twisted."

*Leucodon sciuroides* (Hedw.) Schwaegr. var. *morensis* (Schwaegr.) De Not.  
SA, SN (Bizot 1969, Bizot & Dury 1978). **SA:** Pass  
between Cova and Ribeira do Paúl, NE-exposed  
rocks, 1250 m (326). **SN:** Monte Gordo, N-slope, on  
*Euphorbia ruckeyana*, 1220 m (34).

*Neckera intermedia* Brid. (*N. bolleana* C. Müll.)

SN (Geheeb & Herzog 1910, Montagne 1860 sub *N. crispa*, Cardoso 1915 sub *N. crispa*). **SN:** Monte Caldeirinha, on NE-exposed rocks, 1040 m (12). The record of *Neckera sp.* from SN (Bizot & Dury 1978) may belong here.

\**Orthotrichum diaphanum* Brid. det. J. Lewinsky  
**SN:** Monte Caldeirinha, W-slope, on soil of slope (!), W-exposed, 1030 m (7). **ST:** Serra da Malaguetta, Chã de Figueiras, epiphytic on *Eucalyptus*, E-exposed, 910-930 m (121):

A species with a very scattered distribution in W-Europe, Near East, Iran, North Africa and Canary Islands, South Africa, Abyssinia, Hawaii, California, southern North America, Ecuador, Paraguay and adjacent Bolivia.

*Orthotrichum schimperi* Hammar (*O. pumilum* Sw.)  
SA (Muhle 1982).

*Oxystegus tenuirostris* (Hook. & Tayl.) A.J.E. Smith (*O. cylindricus* [Brid.] Hilp.)  
SA (Bizot 1969, Bizot & Dury 1978).

*Perssonia sanguinea* Biz.  
SA, SN, ST (Bizot 1969 with description, Bizot & Dury 1978).

?*Philonotis calcarea* (B.S.G.) Schimp.  
CV (Bizot 1969). This species was indicated from the Cape Verde Islands as "Mousses indiquées des Iles du Cap Vert mais non recueillies par M. Byström". It could, however, not be found in the earlier literature.

*Philonotis fontana* (Hedw.) Brid.  
SA (Montagne 1860, Cardoso 1915).

*Philonotis hastata* (Dub.) Wijk. & Marg. (*Ph. laxissima* Mitt., *Ph. obtusata* C. Müll.)  
SA, SN (Bizot 1969, Bizot & Dury 1978)

*Philonotis marchica* (Hedw.) Brid.  
F, SA (Bizot & Dury 1978).

*Philonotis nanothecioidea* Par. & Broth.  
SA (Bizot 1969).

*Philonotis rigida* Brid.

SV (Montagne 1860, Cardoso 1915). \***SA:** Ribeira das Pombas, on wet rocks at waterfall in the south of the valley, NE-exposed, 280 m (393). Ribeira da Torre, on wet inundated rocks, E-exposed, 840 m (224). \***F:** Trail near Ribeira Marmulano, on NE-exposed slope, 1220-1250 m (450); Bordeira, spring at Fonti Nobu, 1950 m (Leyens CV-95-9, CV-95-11).

\**Platyhypnidium rusciforme* (Hedw.) Dix.

**SA:** Ribeira da Torre, vertical rock in sugar cane plantation, 840 m (228.).

\**Pleuridium spec.*

**SA:** Ribeira da Torre, on moist soil on NE-exposed trailbank in pine forest, 1450 m (160).

The specimen resembles *P. acuminatum*, which is holarctic in its distribution, but has also been recorded from Madeira, the Azores and the Canary Islands. However, it resembles also the description and illustration of *P. pappeanum* (C. Müll.) Jaeg. from South Africa (Magill 1981). Both species differ in spore size, which is 24-28 µm in *P. acuminatum* but 17-20 µm in *P. pappeanum*. The capsules of the specimen from Santo Antão were not ripe when collected in February, but the unripe spores have a maximum diameter of only 13-15 µm. It can hardly be expected that the spores will get larger than 20 µm when ripe. Thus the identity with *P. pappeanum* is more probable.

*Pleurochaete squarrosa* (Brid.) Lindb.

SA, SN, ST (Cardoso 1915 as *Tortula s.*, Bizot 1969, Bizot & Dury 1978). **SA:** Ribeira da Torre, on gravel, NE-exposed, 1400 m (194), on blockstream in pine forest, N-exposed, 1450 m (176), on NE-exposed wall, 1180 m (222). Pass between Cova and Ribeira do Paúl, on NE-exposed rocks, 1250 m (330). Morossos, NE-part, on rocks in blockstream, NE-exposed, 1560 m (129)

*Pseudoleskea pseudoattenuata* (C. Müll.) Broth.  
SA (P. Varde 1946, Bizot 1969). **SA:** Morossos, on rocks in streambed, 1560-1570 m with *Fabronia leikipiae* (155); on NE-exposed rocks, 1560 m (125, 128); Ribeira do Paúl, on wall along the trail, N-exposed, 1200 m (341).

This species is characterized by broad and shortly pointed leaves with a strong costa, which is curved in the upper part, and short oval to rhomboid laminal cells. The plants are here referred to this

species, which was recorded earlier for the Cape Verde Islands. However, it may be identical with one of the several other species of *Pseudoleskea* from tropical Africa, which can only be confirmed by a revision.

*Pterogonium gracile* (Hedw.) Sm.

SA. (Bizot 1969). **SA:** Ribeira do Paúl, on NE-exposed rocks 1170-1180m(350); Ribeira da Torre, blockstream in pine forest, on N-exposed rocks, 1450 m with *Braunia alopecura* (170).

?*Pterigynandrum filiforme* Hedw.

CV (Bizot 1969). This species was indicated from the Cape Verde Islands as “Mousses indiquées des Iles du Cap Vert mais non recueillies par M. Byström”. It could, however, not found in the earlier literature. The occurrence of this boreal montane species on the islands seems to be dubious.

*Ptychomitrium nigrescens* (Kunze) Wijk & Marg. SA, SN, SV. **SA:** Pass between Cova and Ribeira do Paúl, NE-exposed rocks, 1250m (333); Ribeira do Paúl, upper part, on NE-exposed rocks, 1170-1180 m (348); Ribeira da Torre, on NE-exposed rocks, 1400m (181). **SN:** Monte Caldeirinha, eastern slope, on SE-exposed rocks, 1030 m (15). \***F:** trail near Ribeira Marmulano, NE-exposed trailside, 1220-1250m(456); NE-rim of Bordeira, NE-exposed rocks, 1920 m (429).

*Ptychomitrium subcrispatum* Thér. & P. Varde SA, SV, SN (Bizot 1969, Bizot & Dury 1978 sub var. *obscurum* Biz.). **SA:** trail above Ribeira da Torre, on NE-exposed rocks 1450m (168). Cardoso (1915) lists *Notarisia crispata* Mont. from SV and SN, which is a synonym of *Ptychomitrium crispatum* (Hedw.) Jaeg.

*Rhynchostegium megapolitanum* (Web. & Mohr) B.S.G.  
SA (Geheeb & Herzog 1910).

*Scleropodium touretii* (Brid.) L. Koch

SA (Bizot & Dury 1978). **SA:** Ribeira da Torre, on humid soil in pine forest, 1450 m (167).

*Scorpiurium circinatum* (Brid.) Fleisch. & Loeske SA, SN (Cardoso 1915, Bizot 1969). \***SV:** Monte

Verde, top plateau, under rocks, N-exposed, 760 m (58). **SN:** Monte Caldeirinha, trailbank, 1020 m (5). **ST:** Serra da Malagueta, Chã de Figueiras, on *Eucalyptus* (!), 910-930 m, E-exposed (122).

*Splachnobryum erosulum* C. Müll. ex Dus.  
SA, ST. (P. Varde 1946)

*Stereophyllum auriculatum* Gepp

SV (Cardoso 1915). A species which occurs also in Angola. The species was collected on S. Vicente by Welwitsch, who collected also in Angola during the same travel.

*Timmiella barbuloides* (Brid.) Mönk.

SA, SN (Cardoso 1915, Bizot 1969, Bizot & Dury 1978). **SA:** Ribeira do Paúl, upper part, on NE-exposed loamy slope, 1040 m (389), 1060 m (374, 377). Tope de Coroa, Ribeirinha in NE-slope, on NE-exposed rocks, 1600 m (282). Morossos, NE-part, on rocks, 1560-1570 m (154), rocks along the way to Figueiras, N-exposed, 1480 m (141). Ribeira da Torre, on NE-exposed walls, 1180 m (221), on humid soil on pine forest, NE-exposed, 1450 m (164, 169), humid side valley in upper part, 1360 m, on humid rocks (199, 213). Cova, N-exposed rocks along road, 1200 m (234, 238). **SN:** Monto Gordo, Ribeirinha in NE part, NE-exposed loamy slope, 1030-1070 m (19, 29). Ribeira de Janela, 1050 m, on NE-exposed rocks (411) \***F:** Monte Velha, NE-exposed trailbank, 1550-1600 m (Leyens 441). Trail near Ribeira Marmulana, on NE-exposed rocky slope, 1220-1250 m (449, 453)

*Tortella nitida* (Lindb.) Broth.

SA, SN (Bizot 1969, P. Varde 1946). **SA:** Pass between Cova and Ribeira do Paul, on N-exposed rocks, 1250 m (337).

*Tortula amphidiacea* (C. Müll.) Broth.

*Tortula subcaroliniana* Bizot, Svensk Bot. Tidskrift, Bd. 63, H. 4: 446. 1969. *syn. nov.* Type: Cape Verde Islands, Sao Nicolau, ca. 1000m., 20.11.1958, K. Byström 115, det. Bizot, 1966. (S, para).

The type collection cited in the original publication (Bizot, 1969) could not be traced in herb. PC, nor in herb. S. Bizot's paper clearly states that the material is present in both herbaria. Very recently, the first author searched himself in herb. PC (Bizot), but without success. Only a para-type collection

was located in herb. S and has been studied. This collection was compared with American collections of *Tortula caroliniana* Andrews (in Bizot's paper (1969) by mistake called "*T. carniolica*") and also with material called *Tortulatanganyikae* Dix. from Central Africa. Both taxa now belong to *Tortula amphidiacea* (C. Müll.) Broth.; see Zander (1993): p. 267 and p. 330.

SA, SN (Bizot 1969 with description).

?*Tortula canescens* Mont.

SN (Bizot 1969: 445). This species is reported by Bizot from the Cape Verde Islands from 2 collections. One (Byström 124 intermixed with *Hyophila crenulata*, PC-hb. Bizot) was studied. It proved, however, to be *Tortula solmsii*. There is also no other collection of this species in the herbarium of Bizot. Thus the occurrence of *T. canescens* on the Cape Verde Islands is questionable but may be possible.

\**Tortula cuneifolia* (With.) Turn.

SA: Morossos, NE part, on NE-exposed rocks, 1560-1570m (152).

*Tortula fragilis* Tayl. (*Tortula hildebrandtii* [C. Müll.] Broth., *T. erubescens* [C. Müll.] Broth.) SA (Bizot 1969 sub *T. erubescens*).

\**Tortula laevipila* (Brid.) Schwaegr.

F: Châ das Caldeiras, small ribeira at foot of the volcano, 1800 m (Leyens CV-95-28). SA: Tope de Coroa, Ribeirinha in NE-slope, on rocks, 1600 m (283B).

*Tortula marginata* (B.S.G.) Spruce ssp. *limbata* (Lindb.) Podp.

CV (Potier de la Varde 1946).

*Tortula solmsii* (Schimp.) Limpr.

SA, SN, F (P. Varde 1943, Bizot 1969, Bizot & Dury 1978) The earlier records by Bizot were named as var. *minor* Roth. SA: Ribeira do Paúl, upper part, on NE-exposed walls, 1060m (351, 354A, 365, 373, 381). Cova, N-exposed rocks along the road, 1200 m (230, 231, 233A, 240). Ribeira da Torre, humid side valley in upper part, on N-exposed wet rocks, 1360m (197, 207).

*Trichostomum brachydonium* Bruch (*Hyophila*

*excurrentinervis* Par. ex Broth.

SA, SN, ST, SV (Bizot 1969, Bizot & Dury 1978 sub *Hyophila excurrentinervis forma*). SA, SN. \*F: Galinheiros, Ribeira Tania, on NE exposed rock of dry waterfall, 180 m (421); Ribeira Filipe, 1060 m (Leyens CV-95-23). SA: Pass between Cova and Ribeira do Paúl, on NE-exposed rocks, 1250 m (334). Ribeira doas Pompas, upper part, on N-exposed rocks, 200m (312), 260m (403, 407). Ribeira da Torre, on N-exposed rocks, 1400 m (179). Serra da Malagueta, Cha de Figueiras, on NW-exposed rocks, 840m (116). Road from Tarrafal to Praia, 530 m (416). Ribeira do Paúl, on NE-exposed wall, 1060 m (372A). \*BR: steep slope NE of Mato, on NW-exposed rocks, 750-820 m (83). SN: Monte Caldeirinha, E-slope, NE facing rocks, 1070 m (10), NE rim, on NE-exposed rocks, 1040m (13, 323). Alto da Cabaças, NE-rim, in N-facing rocks, 670 m (36, 37). Road to the airport, on N-exposed rock beside source, 520 m (98) ST: Serra da Malagueta, E-slopes, on E-exposed rocks, 770-800 m (100, 105).

*Trichostomum crispulum* Bruch

*Weisia cucullata* P. de la Varde, Bull. du Mus. Hist. Nat. Paris, 2-e serie, t. XV, no. 1: 240 + fig. 3. 1943. *hom. illeg. syn. nov. Weisia vardei* Bizot, Norw. J. Bot. 25: 249. 1978. *nom. nov.* Type: Cape Verde Islands, San Antao, Cova, rochers, 18-2026 sept. 1934, Leg. M. Chevallier, det. P.d.V. 7995 (PC, S). The type collection is very scanty. It is the kind of material on which no new names should be described. Only a few young setae are present. Most gametophyte characters point to *Trichostomum crispulum* Br., notably the strong costa (at leaf base), the details of the leaf base, the cucullate leaf apex, the format of the plants, the general colour and the more or less interrupted way of growing of the plants. The sexual condition should differ (Varde, 1943: 240). The third author carefully studied the sexual condition of the collections present in herb. S (four K. Byström numbers and the type). The third author has only found commonly female plants and separate, more rarely, male individuals. Polyoicous or synoicous conditions (see: Varde, 1943) were not found on the material. See also Bizot's remarks (Bizot 1969, p. 442-443). Conspicuously, neither P. Varde nor Bizot recorded *T. crispulum* from the Cape Verde Islands, which proved to be quite common. Therefore, the third author considers it reasonable to

treat this name as a synonym of *Trichostomum crispulum*.

SN (Geheeb & Herzog 1910). SA, SN, SV (P. Varde 1943 as *Weisia cucullata* with description, Bizot 1969, Bizot & Dury 1978 as *W. vardei*): \*BR: ridge NE of Mato, on NE exposed soil in terraces, 850 m (462). \*F: trail near Ribeira Marmulano, NE-exposed rocky slope, 1220-1250 m (447, 454). Monte Velha, NE-exposed rocky slope, 1550-1600 m (445); Pedro Homen, pump station, 460 m (Leyens CV-95-17). \*SA: Pass between Cova and Ribeira do Paúl, on NE exposed rocks, 1250m (327, 331). Ribeira da Torre, humid side valley in upper part, on NE-exposed rocks, 1360m (201). Ribeira do Paúl, on NE exposed rocks and walls, 1060 m (372, 382), 1170-1180m (361, 362). Cova, SW-exposed blockstream above road, 1160 m (251). Ribeira das Pombas, on N-exposed rocks, 200 m (311). Tope de Coroa, Ribeirinha in NE-slope, on NE-exposed rocks, 1600m (281). SN: Alto das Cabacas, on N-exposed rocks, 670 m (35). \*ST: Serra da Malagueta, Chã de Figueiras, on *Eucalyptus* (!), E-exposed, 910-930 m (118). \*SV: Monte Verde, top plateau, on N-exposed rocks, 760 m (62).

*Weissia controversa* Hedw.

SA, SN, ST, SV (Bizot 1969, Bizot & Dury 1978). SN: Monte Caldeirinha; E-exposed slope along trail, 1020 m (4).

\**Weissia microstoma* (Hedw.) C. Müll.

SV: Monte Verde, top plateau, on SW-exposed rocks, 720-750 m (54).

? *Weissia tortilis* (Schwaegr.) C. Müll.

SA, SN (Bizot & Dury 1978 sub *Hymenostomum cf. tortile* [Schwaegr.] B.S.G. "The usual shape of the leaves is different from those of *H. tortile*").

*Zygodon conoideus* (Dicks.) Hook. & Tayl.

SA (Muhle 1982).

## Discussion

### a) Numbers of species

A total of 162 species of bryophytes (2 hornworts, 36 hepatics, 124 mosses) is reported from the Cape Verde Islands. The records of several species (e.g.

*Barbula revoluta*, *Bryum rubicundum*, *B. torquescens*, *Campylopus pyriformis*, *Cryphaea bollei*, *Leptodon smithii*, *Philonotis calcarea*, *Pterigynandrum filiforme*, *Stereophyllum auriculatum*, *Tortula canescens*, *Weissia tortilis*) are doubtful, see comments under these species. Other species (e.g. *Philonotis fontana*) were only recorded in the last century. Numerous species described as endemic from the Cape Verde Islands could not yet be revised. Therefore the bryophyte flora may consist of about 150 species at present. Additions are, however, to be expected, as shown by the 28 new records published in this contribution.

Table 1 gives a survey of the distribution of the bryophytes within the archipelago.

The evaluation for the hepatics (Hepaticae and Anthocerotae) shows that there are no records of hepatics from Santa Luzia, Sal, Boa Vista and Maio. Only one hepatic species is known from Brava, and only 8 species were collected so far on São Vicente. Santo Antão, São Nicolau, Santiago and Fogo have similar species numbers of 17, 16, 15 and 17 respectively.

The highest number of species of mosses (97) is found on Santo Antão, followed by São Nicolau (53), Fogo (31), Santiago (21), São Vicente (15) and Brava (9). A total of the mosses and hepatics reveals the same sequence: Santo Antão (114), followed by São Nicolau (69), Fogo (48), Santiago (36), São Vicente (23) and Brava (10). As mentioned above, the number of hepatics on the different islands of the archipelago is, however, different, showing about the same species numbers on Santo Antão, São Nicolau, Santiago and Fogo. Accordingly, the moss-hepatic index varies between 9 (Brava) and 1.4 (Santiago), cf. table 1.

### b) Phytogeographical Elements

The hepatic species can be attributed to the following phytogeographical elements:

1. Tropical elements, which are found else in tropical Africa or also in the Neotropics: *Acrolejeunea emergens*, *Cyathodium africanum*, *Frullania socotrana*, *F. spongiosa*, *Lejeunea caespitosa*, *Marchantia pappeana*, *Noterochlada phyrorrhiza*, *Plagiochasma eximium*. Included are species, which extend to the Canary Islands, Madeira or the Azores (*Frullania ericoides*, *Lejeunea eckloniana*), or even to Ireland (*Lejeunea*











**Fig. 4:** Phytogeographical elements of the hepatics from the Cape Verde Islands.

**Fig. 5:** Phytogeographical elements of the hepatics on the different islands of the Cape Verde archipelago.

*flava*), since this occurrence can be interpreted as a relict.

2. Mediterranean elements such as *Exormotheca pustulosa*, *Fossombronia angulosa*, *Lejeunea lamacerina*, *Lunularia cruciata*, *Mannia androgyna*, *Marchantia paleacea*, *Marchesinia mackii*, *Plagiochasma rupestre*, *Reboulia hemisphaerica*, *Riccia cavernosa*, *gougetiana*, *R. nigrella*, *Targionia hypophylla*.

3. Temperate elements: *Anthoceros puntatus*, *Cololejeunea minutissima*, *Fossombronia pusilla*, *Frullania dilatata*, *Lejeunea ulicina*, *Lophocolea cuspidata*, *Porella arboris-vitae*, *Radula lindenbergiana*, *Riccia sorocarpa*, *R. ciliata*. Many of these species are oceanic or also submediterranean-oceanic in distribution.

4. Holarctic is *Frullania tamarisci*.

5. Cosmopolitan are *Marchantia polymorpha*, *Riccia crystallina* and *Phaeoceros carolinianus*.

Table 2 lists all floristic elements in numbers of species and percentage of the total hepatic flora for the Cape Verde Islands in general as well as for all individual islands in which hepatics were found. Figs. 4 and 5 are illustrate these data. Except for the two cosmopolitan and one holarctic species, the

hepatic flora of the Cape Verde Islands is almost equally composed of tropical, mediterranean and temperate species with each 10 species. Approximately the same percentage of floristic elements is found on São Nicolau and Fogo. The mediterranean element dominates on Santo Antão, and the tropical one on Santiago, which may be, however, a result of an uncomplete floristic exploration. Also at the present state of knowledge, the tropical element dominates on São Vicente, if such interpretation is reasonable based on only 6 recorded species.

A first evaluation of the phytogeographical elements of mosses was made by P. Varde (1946), based, however, only on the 53 species collected by Chevalier. He distinguished between “Espèces cosmopolites (2), Espèces à large dispersion (18), Espèces méditerranéennes (7), Espèces Macaronésiennes (2), Espèces africaines” and “Espèces endémiques (9)”. His evaluation is no more up to date because of its restriction to the Chevalier collection and nomenclatural errors. An evaluation of the present floristic data shows that the mosses have a similar phytogeographical composition as the hepatics: 40 species are temperate (in part also tropical montane) in distribution,

30 mediterranean (including the macaronesian element), 41 are tropical, 5 are cosmopolitan, 8 endemic (at the present state of knowledge, including so far unrevised taxa).

### c) Dispersal

Young volcanic islands without ever existing land connection are ideal models for studying the dispersal of species. All species of an insel flora must be or must have been able for long distance dispersal, except for introductions by man. Thus all bryophyte species of the Cape Verde Islands must be considered as anemochorous, in part also as zoochorous. This might be a simple statement, however, with regard to frequent sterility of the species recorded here, it is hardly understandable that all species should have dispersed by long distance dispersal.

Furthermore, it has to be considered that long distance dispersal is a stochastic event and that chance plays a rôle in the colonization of islands. Thus the floristic differences between single islands can only in part be attributed to different ecological factors such as elevation, humidity, availability of habitats but also to chance.

Due to the climatic changes during the end of Tertiary, in the Pleistocene and Holocene, it can be assumed that the species of the different phytogeographical elements have colonized the islands in different periods. It has also to be considered that the global wind system was different in these periods and that different origins for aerial transport of spores are possible. The climate at the end of the Tertiary was tropical to subtropical at this latitude and thus tropical elements could have been the first to colonize the islands. During glacial periods in the Quaternary, this latitude had a mediterranean type climate, which could be the origin of the mediterranean species today, of which probably only a part survived. Since 8000 years, the Cape Verde Islands are subject to a more and more arid climate, in which probably part of the former flora became extinct or got confined to narrow ecological niches (e.g. in deep ravines, or on vertical cliffs in the cloud zone) in which the species survive today as relicts. The present source of dispersal is probably the African continent, which is in 500 km distance and spore dispersal from there is possible especially by trade winds, which can disperse bryophytes from semidesert habitats, perhaps

also the larger spores of Marchantiales. It can also be assumed that the colonization of the Cape Verde Islands (and probably also extinction of species) is still in progress.

### d) Propagation

A conspicuous feature of the bryophyte flora of the Cape Verde Island is the high sterility of species. Only 5 species out of all mosses collected by the third author (*Bryum canariense*, *Ptychomitrium nigrescens*, *P. subcrispatum*, *Orthotrichum diaphanum*, *Pleuridium acuminatum*) were found with sporophytes. All pleurocarpous mosses were sterile. No Pottiaceae, a family with usually high rates of sporophytes, were fertile. Only one of the 49 specimens of *Bryum canariense* was found with sporophytes. This applies at least to January and February 1995, and although the rainy season in which most bryophytes can be fertilized is in August and September and sporophytes could be expected during the collecting season, the precipitation was very low in 1994. It can be argued from the frequent sterility of species that these species were dispersed to the Cape Verde Islands by spores but stayed there sterile or propagated vegetatively.

### e) Endemism

Fifteen species bryophytes were described from the Cape Verde Island as endemic to the Archipelago, which were annotated by Muhle (1986). These are (except for infraspecific taxa described as endemic): *Frullania bystroemii*, *Fissidens alatus*, *F. allorgei*, *Barbula sulcata*, *Hydrogonium bolleanum*, *Tortula subcaroliniana*, *Weissia vardei*, *Funaria chevalieri*, *Bryum anomodon*, *Perssonia sanguinea*, *Zygodon bolleanus*, *Cryphaea bollei*, *Neckera bolleana*, *Pinnatella revoluta* and *Entodon pseudoseductrix*. Some species turned out, however, to be identical with species occurring elsewhere, e.g. *Frullania bystroemii* (= *F. spongiosa*), and *Pinnatella revoluta* (= *Leptodon longisetus*). Other species are doubtful and supposed to be identical with other species, e.g. *Neckera bolleana* (? *N. intermedia*), *Cryphaea bollei* (? *Pseudoleskea attenuata*), *Entodon pseudoseductrix* and *Zygodon bolleanus* (? *Anoetangium* sp.). Most of these doubtful species were described by C. Müller and can no more be revised, since the type material in the Botanical Museum in Berlin was destroyed.

**Fig. 6:** Correlation between elevation of the islands of the Cape Verdean archipelago and the number of hepatic species found on each island.

*Bryum anomodon* was accepted by Ochi (1972) in his revision of the African species of the genus. All other species (*Fissidens alatus*, *Fissidens allorgei*, *Barbula sulcata*, *Tortula subcaroliniana*, *Weissia vardei*, *Funaria chevalieri*, and the endemic genus *Perssonia*) were not yet revised. Therefore the attempt was made to locate the type specimens. The types of both *Fissidens* species (in PC) were on loan to Dr. Bruggeman-Nannenga. The type of *Funaria chevalieri* was present in PC and shows a distinct species. However, it cannot be excluded that it is either more widespread or identical with one of the about hundred other species within this genus. The position of *Perssonia sanguinea* could not be clarified. It was described based on a special structure of the peristome. The gametophyte resembles, however, *Bryum haematoneuron* C. Müll. described from Ethiopia and known as *B. sahyadrense* Card. & Dix. from India and the Philippines. *Barbula sulcata* proved to be synonymous with *B. convoluta*, *Tortula subcaroliniana* with *T. am-*

*phidiacea* and *Weisia vardei* with *Trichostomum crispulum*.

As usual, endemism in bryophytes is much lower than in flowering plants. Eighty-four species of the ca. 650 species of flowering plants of the Cape Verde Islands are endemic. The rate of endemism is much higher, if the introduced species are not taken into account.

Except for the species described as endemic for the Cape Verde Islands, quite a high number of species are not found on other macaronesian islands. These are:

*Anacolia laevisphaera*, *Barbula indica*, *Barbula lambarenensis*, *Brachymenium acuminatum*, *Braunia alopecura*, *Bryosedgwickia densa*, *Entodon schleicheri*, *Erpodium perrottetii*, *Fabronia leikipiae*, *Fissidens bocarangensis*, *F. dancelmannii*, *F. longipes*, *Groutiella laxotorquata*, *G. sarcotricha*, *Herpetineuron toccocae*, *Homalothecium nilghiriense*, *Hymenostylium congoanum*, *Oxystegus tenuirostris*, *Philonotis nantheoidea*, *Pseudoleskea pseudoattenuata*, *Pty-*

*chomitrium subcrispatum*, *Splachnobryum obtusulum*, and *Stereophyllum auriculatum*. With the exception of *Oxystegus tenuirostris*, which is a temperate species, all other species are tropical in distribution. This shows the stronger tropical affinities of the Cape Verde Islands caused by their location in more equatorial latitudes.

#### f) Diversity

As to be expected, the number of bryophyte species is correlated with the elevation of the islands, as shown for the hepatics (fig. 6). The higher the island, the more numerous is the bryophyte flora. This concerns especially the islands reaching into the cloud belt of the trade winds.

#### List of synonyms used in the earlier literature:

Anoetangium euchloron = *Anoetangium aestivum*  
 Anomobryum juliforme = *A. filiforme*  
 Barbula acuta = *Didymodon rigidulus*  
 Barbula cylindrica = *Didymodon vinealis* var. *flaccidus*  
 Barbula sulcata = *B. convoluta*  
 Bartramia stricta = see under *Anacolia laevisphaera*  
 Brachymenium borgeanum = *B. acuminatum*  
 Bryum alpinulum = *B. nitens*  
 Crossidium chloronotus = *C. crassinerve*  
 Cyathodium cavernarum = *C. africanum*  
 Erpodium grossirete = *E. perrotetii*  
 Frullania nervosa see under *F. tamarisci*  
 Hedwigidium imberbe see under *Braunia alopecura*  
 Homalothecium mandonii = *H. sericeum* var.  
 Hydrogonium bolleanum = *Barbula bolleana*  
 Hymnostomum tortile = *Weissia tortilis*  
 Hyophila crenulata = *H. machadoana*  
 Hyophila excurrentinervis = *Trichostomum brachydontium*  
 Leskea sericea = *Homalothecium sericeum*  
 Macromitrium sarcotrichum = *Groutiella s.*  
 Mannia dichotoma = *M. androgyna*  
 Marchantia papillata = *M. pappeana*  
 Neckera bolleana = *N. intermedia*  
 Neckera cladorrhizans = *Entodon schleicheri*  
 Notarisia crispata see under *Ptychomitrium subcrispatum*  
 Orthotrichum pumilum = *O. schimperi*  
 Oxyrhynchium praelongum = *Eurhynchium p.*

*Oxystegus cylindricus* = *O. tenuirostris*  
 Palamocladium nilgheriense = *Homalothecium n.*  
 Philonotis laxissima = *Ph. hastata*  
 Philonotis obtusata = *Ph. hastata*  
 Pinnatella revoluta = *Leptodon longisetus*  
 Riccia minima = *R. nigrella*  
 Semibarbula lambarenensis = *Barbula l.*  
 Semibarbula orientalis = *Barbula indica*  
 Targinia lorbeeriana = *T. hypophylla*  
 Tortula atrovirens = *Desmatodon convolutus*  
 Tortula erubescens = *T. fragilis*  
 Tortula hildebrandtii = *T. fragilis*  
 Tortula subcaroliniana = *T. amphidiacea*  
 Weissia cucullata = *Trichostomum crispulum*  
 Weissia vardei = *Trichostomum crispulum*  
 Zygodon bolleanus = *Anoetangium aestivum*

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