

---

**Moss flora and vegetation of Saba and St. Eustatius (West Indies)<sup>1</sup>**

by Paulien Wiersma

*Institute of Systematic Botany, Heidelberglaan 2, Utrecht, the Netherlands*

---

Communicated by Prof. F.A. Stafleu at the meeting of October 31, 1983

**ABSTRACT**

The known mossflora of the small West Indian island Saba (870 m in altitude) consists to date of 48 species, while the neighbouring island St. Eustatius (600 m) has 40 species. The two islands have 27 species in common.

Widely distributed neotropical species dominate at all elevations, while wide-tropical (i.e. pan-tropical) species are found mainly at middle elevations (300–600 m). Species with smaller geographical distributions (southern neotropical, Caribbean) are restricted to higher elevations (above 600 m).

An attempt has been made to determine the relation between mosses and the plant communities, encountered along the altitudinal gradient, by calculating "association values", based on the results of random collecting. Four classes of association values have been distinguished: class A: very characteristic; class B: characteristic; class C: moderately characteristic; and class D: non-characteristic species. It appears that eight plant communities on both islands harbour one or more moderately to very characteristic species. *Neckeropsis undulata* is the only very characteristic species. It occurs in the evergreen seasonal forest on St. Eustatius. The results are compared with Guadeloupe, Martinique, Puerto Rico, Guyana and Suriname.

Finally, a key to the species is included.

**1. INTRODUCTION**

Saba (17°38'N, 63°14'W) and St. Eustatius (17°30'N, 62°58'W), two islands of the Netherlands Antilles, are located approximately 300 km southeast of Puerto Rico, 800 km north of the South American mainland and 2000 km southeast of Florida, North America. Saba lies about 30 km northwest of St.

<sup>1</sup> Results of the Geobotanical Exploration of Saba and St. Eustatius Part 1.

Eustatius from which it is separated by a channel of more than 500 m deep. Both islands are of volcanic origin and belong to an inner island arc of the Lesser Antilles, which is characterized by the presence of Tertiary and Quaternary volcanoes. Saba (12 km<sup>2</sup>) is up to 870 m altitude, with very steep cliffs and narrow valleys running down to sealevel (Plate 1A). St. Eustatius (21 km<sup>2</sup>) consists of a low volcanic complex in the northwest (up to 300 m) and a main volcano, The Quill (up to 600 m), in the southeast of the island (Plate 2A), which is of Holocenic origin and also has narrow valleys running down to sealevel. These two volcanic complexes are separated by a slightly sloping plane, the Cultuurvlakte (Plate 2A).

The climate of Saba and St. Eustatius is tropical and is characterized by a day temperature of 25–30°C, a precipitation of 1000 mm to over 2000 mm in the summit areas and an air humidity of 70–100% in the highest regions during rainfall. Climatic conditions are even throughout the year, but precipitation can be very erratic from year to year and month to month. Trade winds are predominantly easterly (mean wind velocity St. Eustatius 1910–1919: 4.6 m/s). During July–September, hurricanes may pass over the islands. A typical feature of the mountain peaks in the Caribbean is the presence of a great billowy mass of “trade wind cloud”, permanently masking summits unless dissipated in very dry or very still weather (Beard, 1949). Of the islands investigated, this is especially true for Saba (Plate 1A). On lower elevations cloudless, sunny conditions prevail for almost the entire year.

Stoffers (1956) described in detail physiographical and climatological features of Saba and St. Eustatius, as well as the altitudinal vegetation zones and plant communities, which are primarily correlated with climatic factors. The major vegetations zones, as related to altitude, are given in Fig. 1.

It should be noted that present vegetation in rather large areas on both islands is clearly of a secondary nature as a result of present or former cultivation or grazing by goats.

Little has been published on the mosses of Saba and St. Eustatius. Florschütz (1967) listed 17 moss species for Saba and 13 species for St. Eustatius; only 3 species were reported for both islands. During bryological fieldwork in July and August 1980 by M.W. van Slageren and in June and July 1981 by M.W. van Slageren and P.H. Wiersma, in the framework of the project “Geobotanical Investigations on the Netherlands Antilles of the Windward Group”, supported by the Netherlands Foundation for the Advancement of Tropical Research (WOTRO, grant 85–150), 176 moss collections were made on Saba (belonging to 48 species) and 147 moss collections on St. Eustatius (belonging to 40 species). The collections are deposited in the herbarium of Utrecht (U). Based on these collections, the geographical distribution patterns and habitats of the species were determined as well as their syntaxonomical importance for the characterization of the plant communities of the islands.

Since identification works for the mosses of the Antilles are scarce and mostly imperfect, a comprehensive key to the species, currently recognised on the two islands, has also been prepared.

2. LIST OF THE MOSSES OF SABA AND ST. EUSTATIUS

Column 1: *Locations* - S = Saba; E = St. Eustatius.

Column 2: *Vegetation types* (see fig. 1) - C.A. = Cultivated Area (Saba and St. Eustatius); II = Secondary rainforest (Saba, 500–600 m); III = Tree fern brake (Saba, 575–650 m); VIII = Palm brake (Saba, 775–825 m); IXa = Elfin woodland (Saba, 825–860 m, St. Eustatius, 550–600 m); IXb = Summit vegetation (Saba, 860–870 m); X = Evergreen seasonal forest (St. Eustatius 270–300 m); XI = Semi-evergreen seasonal forest (St. Eustatius 250–350 m); XII =

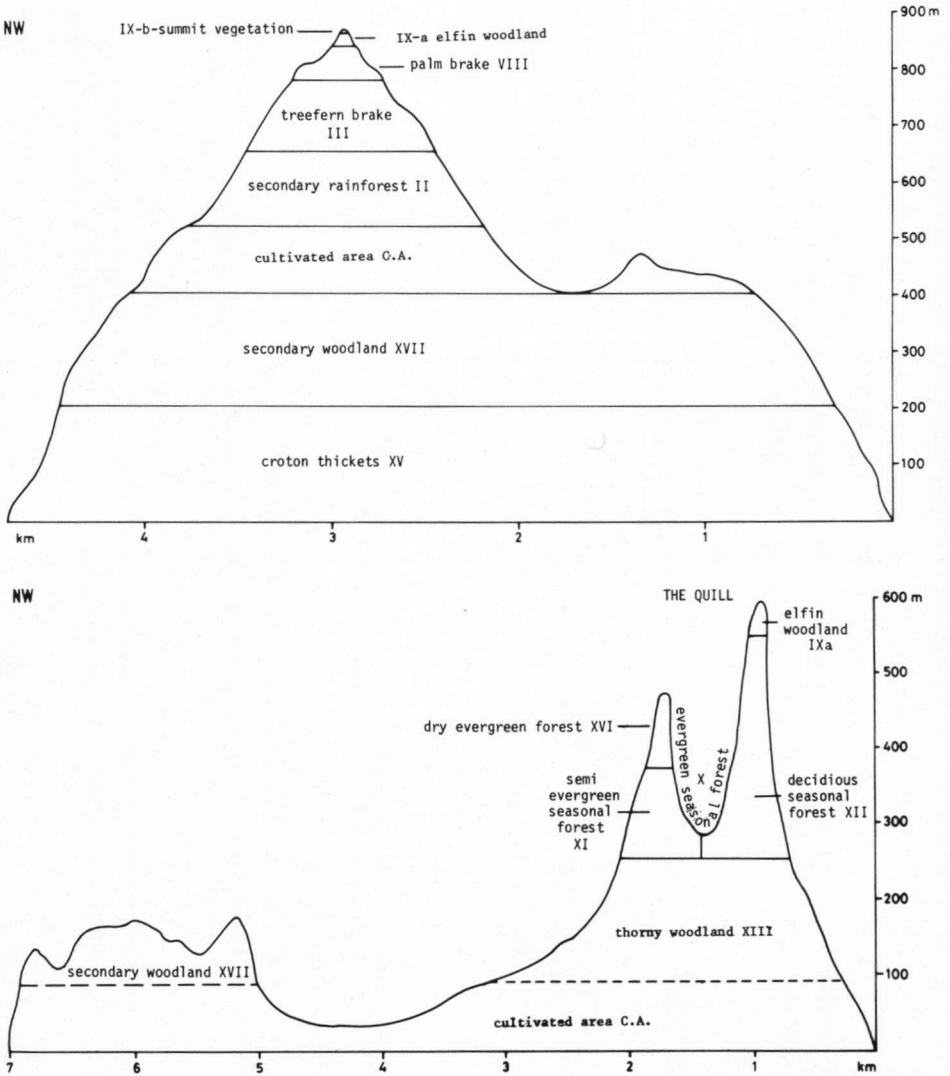


Fig. 1. Vegetation zones in relation to altitude of Saba (above) and St. Eustatius (below) (modified after Stoffers, 1956).



PLATE 1a

- A. Saba as seen from St. Eustatius. Note the trade wind clouds, a typical feature of Caribbean islands (photograph A.L. Stoffers).
- C. Leaf of *Euterpe globosa* covered with several liverwort spp. and *Lepidopilum scabrisetum* in palm brake vegetation at 800 m, Saba (photograph P.H. Wiersma).



**PLATE 1b**

- B.** Humid elfin woodland or mossy forest with luxuriant epiphytic liverwort vegetation at 850 m, Saba (photograph A.L. Stoffers).
- D.** Tree fern brake vegetation at southeastern slope of Mount Scenery at 650 m as seen from the summit of Saba. Notice the dry, scanty covered slopes in the background at a distance of ca.



PLATE 2a

- A. The Cultuurvlakte and The Quill as seen from northern hills of St. Eustatius (photograph P.H. Wiersma).
- C. *Orthostichopsis tetragona* hanging in great masses from trees in elfin woodland at 575 m, St. Eustatius (photograph P.H. Wiersma).



PLATE 2b

- B. Inner slopes and the rim of The Quill near highest part: Mazinga at 600 m, St. Eustatius (photograph P.H. Wiersma).
- D. Dry evergreen forest near the, top of The Quill at the lowest part of the rim at 400 m, St. Eustatius (photograph A.L. Stoffers).
-

Deciduous seasonal forest (St. Eustatius, 250–350 m); XIII = Thorny woodland (St. Eustatius, 100–250 m); XV = Croton thickets (Saba, 0–200 m); XVI = Dry evergreen forest (St. Eustatius, 390–550 m); XVII = Secondary woodland (Saba, 200–400 m, St. Eustatius, 0–200 m). (S), (E) = occurring on Saba, St. Eustatius resp.

Colum 3: *Substrates* - p = epiphytic; s = saxicolous; t = terrestrial.

Colum 4: *Provenance* - E = Endemic; TC = Caribbean; STN = Southern neotropical; TN = Neotropical; T = Wide tropical; C = Cosmopolitan.

species (63)*	1	2	3	4
<b>BARTRAMIACEAE</b>				
<i>Breutelia tomentosa</i> (Brid.) Jaeg.	S	IXb	p,s,t	TN
<i>Philonotis uncinata</i> (Schwaegr.) Brid. var. <i>glaucescens</i> (Hornsch.) Florsch.	S	C.A.,II,IXb	s,t	TN
<b>BRACHYTHECIACEAE</b>				
<i>Lepyrodontopsis trichophylla</i> (Hedw.) Broth.	S,E	II,III,VIII,IXa(E),XVI	p,s	TN
<b>BRYACEAE (det. H. Ochi)</b>				
<i>Bryum apiculatum</i> Schwaegr.	E	C.A.	s,t	T
<i>Bryum argenteum</i> (Hedw.)	S	C.A.,IXb	s,t	C
<i>Bryum leptocladon</i> Sull.	S,E	C.A.(S),II,IXb,XVII(S)	s,t	TN
<i>Bryum cf. pseudocapillare</i> Besch.	E	XVI,XVII	p,t	TN
<i>Bryum sp.</i>	E	IXa	s,t	-
<i>Bryum sp.</i> ("Erythrocarpa")	S	C.A.	s	-
<b>CALYMPERACEAE</b>				
<i>Calymperes donnellii</i> Austin	S,E	C.A.(S),II,VIII,IXa(E),XI, XII,XVI,XVII(S)	p,s,t	TN
<i>Calymperes erosum</i> C.M.	S	VIII	p	TN
<i>Calymperes lonchophyllum</i> Schwaegr.	E	IXa,XVI	p,s,t	TN

\*A few species, for which identifications are still incomplete, have been omitted. For species marked by an asterisk, see note added in proof (p. 364).



species (63)	1	2	3	4
<i>Calymperes richardii</i> C.M.	S,E	C.A.(S),X,XI,XVI,XVII	p,s,t	TN
<i>Syrrhopodon incompletus</i> var. <i>incompletus</i> Schwaegr.	S,E	C.A.(S),II,III,VIII,IXa(E), X,XVI	p,s,t	TN
<i>Syrrhopodon incompletus</i> var. <i>luridus</i> (Par. & Broth.) Florsch.	S,E	III,XVI	p,t	STN
<b>DICRANACEAE</b>				
<i>Campylopus atratus</i> var. <i>sabaensis</i> (Broth.) Florsch.*	S	IXb	s	E
<i>Campylopus trachylepharon</i> (C.M.) Mitt.*	S,E	IXb,XVI	p,s	STN
<i>Dicranella</i> cf. <i>longirostris</i> (Schwaegr.) Mitt.	S	II	s	TC
<i>Leucoloma albulum</i> (Sull.) Jaeg.	S	III,VIII,IXa	p	TC
<b>FABRONIACEAE</b>				
<i>Helicodontium capillare</i> (Hedw.) Jaeg. ( <i>Clasmatodon parvulus</i> (Hampe) Sull., cf. Florschütz, 1967)	S	C.A.,XVII	s	TN
<b>FISSIDENTACEAE</b>				
<i>Fissidens elegans</i> Brid. (syn. <i>F. guianensis</i> (Mont.))	S,E	II,X,XII,XIII,XVII(E)	p,s,t	TN
<i>Fissidens kegelianus</i> C.M.	S,E	C.A.,II,XI,XIII,XVI,XVII	p,s,t	TN
<i>Fissidens mollis</i> Mitt.	S	C.A.,II,III,XVII	s,t	TN
<i>Fissidens radicans</i> Mont.	E	XVI	t	TN
<b>HEDWIGIACEAE</b>				
<i>Rhacocarpus purpurascens</i> (Brid.) Par.	S	IXb	s,t	T
<b>HOOKERIACEAE</b>				
<i>Crossomitrium orbiculatum</i> C.M.	S	II,III	p,s	TC

species (63)	1	2	3	4
<i>Hemiragis aurea</i> (Brid.) Ren. & Card.	S	IXb	p	TN
<i>Lepidopilum scabrisetum</i> (Schwaegr.) Steere	S	VIII, IXa, IXb	p, s	TN
<i>Leskeodon andicola</i> (Mitt.) Broth.	S	VIII, IXa, IXb	p, s	TN
<i>Schizomitrium pallidum</i> Hornsch.	S, E	II, IXa(E), X, XI	p, s	TN
<b>HYPNACEAE</b>				
<i>Isopterigium</i> sp.	S	II, III, VIII	p	-
<i>Mittenothamnium diminutivum</i> (Hampe) Britt.	S, E	C.A.(S), II, VIII, IXa(E), XII, XVI	p, s, t	TN
<i>Vesicularia amphibola</i> (Mitt.) Broth.	S, E	C.A.(S), II, III, XI, XVII(S)	p, s	TN
<b>LEUCOBRYACEAE</b>				
<i>Leucobryum albidum</i> (Brid.) Lindb.	E	IXa, XVI	p, s, t	T
<i>Octoblepharum albidum</i> Hedw.	E	IXa, X, XI, XVI	p, s, t	T
<i>Octoblepharum pulvinatum</i> (Doz. & Molck.) Mitt.	S, E	II, III, VIII, IXa(E), XVI	p, s, t	TN
<b>LEUCODONTACEAE</b>				
<i>Leucodontopsis geniculata</i> (Mitt.) Crum & Steere*	E	XVI	p	TN
<b>METEORACEAE</b>				
<i>Meteoridium remotifolium</i> (C.M.) Manuel	S, E	C.A.(S), III, VIII, IXa, IXb, XVI	p, s, t	TN
<i>Papillaria nigrescens</i> (Hedw.) Jaeg.	E	IXa, XVI	p, s	T
<i>Squamidium nigricans</i> (Hook.) Broth.	S	VIII	p	TN
<i>Zelometeorium patulum</i> (Hedw.) Manuel	S, E	XVI, XVII(S)	p, s	T
<b>NECKERACEAE</b>				
<i>Neckeropsis undulata</i> (Hedw.) Reich.	S, E	II, IXa(E), X, XI, XVI, XVII(S)	p, s, t	TN

species (63)	1	2	3	4
<i>Porotrichum insularum</i> Mitt.	S	II,III,VIII,IXa,IXb	p,s	TC
<b>ORTHOTRICHACEAE</b>				
<i>Groutiella mucronifolia</i> (Hook. & Grev.) Crum & Steere	S,E	C.A.,II,III,VIII,IXa(E) XVI	p,s,t	TN
<i>Macromitrium cirrosum</i> (Hedw.) Bird.	S	VIII,IXa,IXb	p,s,t	TN
<i>Macromitrium scoparium</i> Mitt. (fide Florschütz, 1967)	S	-	-	TN
<b>PILOTTRICHACEAE</b>				
<i>Callicosta evanescens</i> (C.M.) Crosby	S	II	p	TN
<b>PLAGIOTHECIACEAE</b>				
<i>Stereophyllum cultelliforme</i> (Sull.) Mitt.	S,E	C.A.(S),II,X,XI,XVII(S)	p,s,t	TN
<i>Stereophyllum leucostegum</i> (Brid.) Mitt.	E	XI	p	TN
<b>POTTIACEAE</b>				
<i>Barbula agraria</i> Hedw.	E	XII	s	TN
<i>Hymenostomum breutelii</i> (C.M.) Kindb.	S,E	II,XIII	t	TN
<i>Hyophila microcarpa</i> (Schimp.) Broth.	S,E	C.A.,II,XVII(E)	p,s,t	TN
<i>Hyophila tortula</i> (Schwaegr.) Hampe	S,E	C.A.(S),II,III,XII	s,t	TN
<i>Weissia jamaicensis</i> (Mitt.) Grout	S,E	C.A.,II,IXa(E),XII,XIII	s,t	TN
<b>PTEROBRYACEAE</b>				
<i>Pireella pohlii</i> (Schwaegr.) Card.	S,E	C.A.(S),X,XI,XII,XVI, XVII(S)	p,s,t	TN
<i>Orthostichopsis tetragona</i> (Hedw.) Broth.	E	IXa,XVI	p,s,t	TN

species (63)	1	2	3	4
<b>SEMATOPHYLLACEAE</b>				
<i>Acroporium pungens</i> (Hedw.) Broth.	S,E	IXa,IXb,X,XI,XVI	p,s,t	TN
<i>Sematophyllum caespitosum</i> (Hedw.) Mitt.	S,E	C.A.(S),II,IXa(E),IXb,XII, XVI,XVII(S)	p,s,t	T
<i>Taxithelium planum</i> (Brid.) Mitt.	S,E	C.A.(S),VIII,XI,XII,XVI	p,s,t	TN
<b>SPLACHNACEAE</b>				
<i>Splachnobryum obtusum</i> (Brid.) C.M.	E	-	-	TC
<b>THUIDIACEAE</b>				
<i>Bryohaplocladium microphyllum</i> (Hedw.) Watanabe & Iwatsuki	S	C.A.,II	s,t	T
<i>Thuidium involvens</i> (Hedw.) Mitt.	E	IXa,X,XI,XVI	p,s,t	TN
<i>Thuidium recognitum</i> (Hedw.) Lindb. var. <i>delicatulum</i> (Hedw.) Warnst.	S,E	IXa,IXb,XVI	p,s,t	T

### 3. BRYOGEOGRAPHICAL ELEMENTS

The moss flora of Saba and St. Eustatius is characterized by a high percentage of neotropical species and an extremely low endemism. Based on species ranges taken from the most recent taxonomic revisions, the representation of bryogeographical elements is as follows (classification largely according to Gradstein & Weber, 1982):

Endemics	2%	
Southern neotropical	3%	(tropical Southern America)
Caribbean	7%	(West Indies and adjacent coasts of Central and South America)
Neotropical	71%	(widespread in tropical America)
Wide tropical	15%	(known also from palaeotropics and sometimes entering warm temperate regions)
Cosmopolitan	2%	

#### *Endemics*

The representation of bryogeographical elements corresponds very well to that of the Lesser Antilles as a whole (Crosby, 1969), except for endemism,

which on the Lesser Antilles is 12%. According to Crosby, endemism in the Lesser Antilles only occurs on the larger and older islands, like Guadeloupe and Martinique. The very young and small islands Saba and St. Eustatius harbour no endemic species. There is only a single endemic variety, *Campylopus atratus* var. *sabaensis*, described from the summit of Saba (see note, p. 364).

*Southern neotropical*

The southern neotropical element comprises only two mosses (3%): *Campylopus trachyblepharon*, known from Guyana and Suriname (Florschütz,

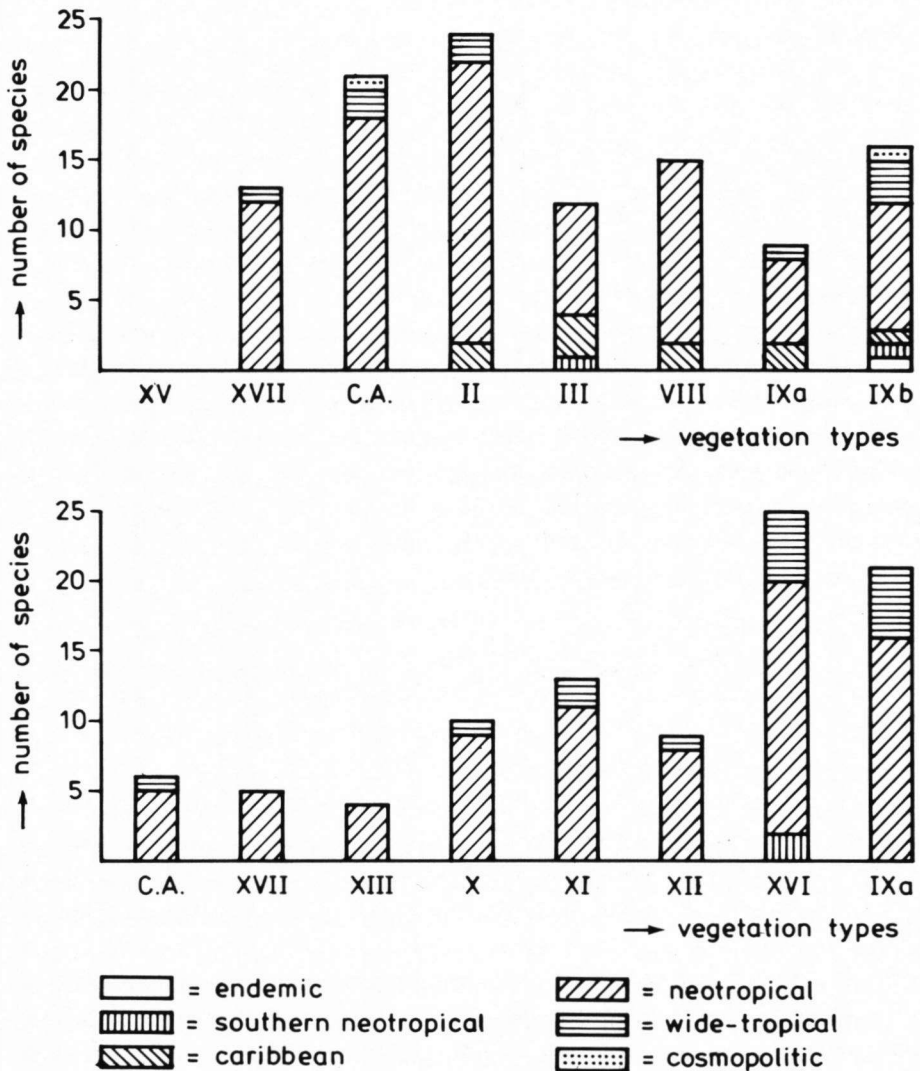


Fig. 2. Species richness and geographical elements of mosses in vegetation types along the altitudinal gradient on Saba (above) and St. Eustatius (below). For explanation of vegetation type numbers see Fig. 1 and Table 1.

1964) and *Syrrhopodon incompletus* var. *luridus* also known from northern Brazil (Reese, 1977). Both species occur at high elevations, and have not been reported from other West Indian islands.

### *Caribbean*

Typical caribbean species are few. On Saba this element comprises *Leucoloma albulum*, *Crossomitrium orbiculatum* and *Porotrichum insularum*, both growing at an altitude of 500 m or more (Fig. 2). On St. Eustatius it is represented by *Splachnobryum obtusum*, collected only once in 1973 (leg. Wagenaar Hummelinck s.n.).

### *Neotropical*

As is shown in Fig. 2, mosses with a neotropical distribution are represented at all altitudes, occurring in very small populations in the dry and hot lowland zones and attaining their maximal representation at middle elevations (400–600 m). Above 600 m they are still the dominating element, but they decrease in number. The high total percentage of neotropical species (71%) is also characteristic for other young and small islands of the Lesser Antilles (Crosby, 1969).

### *Wide tropical*

Species of this element can be found on both islands, roughly at middle and high elevations (15%). *Rhacocarpus purpurascens*, with its restricted occurrence on the summit of Saba, belongs to this group. It is also known from Africa and Australasia. Other wide-tropical species are: *Octoblepharum albidum*, *Papillaria nigrescens*, *Zelometeorium patulum* and *Sematophyllum caespitosum*. The following species are also known from more temperate areas (Europe): *Leucobryum albidum*, *Bryohaplocladium microphyllum* and *Thuidium recognitum* var. *delicatum*.

### *Cosmopolitan*

This element is represented by *Bryum argenteum*, occurring in the cultivated area of Saba.

## 4. MOSSES AND PLANT COMMUNITIES

### 4.1. *Saba*

Mosses apparently lack the physiological tolerance for the dry, hot atmospheric conditions and the intense light, characteristic of the lower steep slopes of Saba, up to 200 m (XV, Croton thickets), and are therefore absent in this vegetation zone.

They first appear in very small quantities in the secondary woodlands (XVII) at 200–400 m, e.g. *Calymperes donnellii*, *C. richardii*, *Fissidens kegelianus*, *Neckeropsis undulata*, *Pirella pohlii*, *Sematophyllum caespitosum* and *Stereophyllum cultelliforme*, which were all collected only once or twice, always growing on rock together with herbs and ferns.

Terrestrial mosses first appear in the cultivated area (C.A. 400–500 m) and

include certain common Neotropical Pottiaceae, such as *Hyophila microcarpa*, *H. tortula* and *Weissia jamaicensis* as well as the neotropical *Helicodontium capillare*. The wide-tropical *Sematophyllum caespitosum* grows on rock but may also colonize the soil.

The secondary rainforest (II), made up of gnarled trees up to 5 m high, occurs at an altitude of 500–600 m. It is the richest vegetation type for mosses (24 species), which grow in small quantities on the bases of tree trunks, on rock and on soil. Typical Caribbean mosses such as *Crossomitrium orbiculatum*, *Leucoloma albulum* and *Porotrichum insularum* have been collected here, as well as in plant communities of higher elevations.

In the tree fern brake (III Plate 1D), species richness decreases rather abruptly, probably as a result of a low light intensity. The tree fern brake forms a dense grove of 4 m high and is usually covered by clouds (Plate 1A). Mosses of lower as well as of higher altitudes are present. They grow mainly on the lower tree trunks. Terrestrial mosses are absent.

The palm brake (VIII), at an altitude of 775–825 m, has montane climatic conditions with high, constant rainfall and air humidity. Dripping-wet leaves of evergreens harbour epiphyllous mosses such as *Crossomitrium orbiculatum*, *Lepidopilum scabrisetum* (Plate 1C), *Zelometeorium patulum*, *Meteoridium remotifolium* and various species of liverworts.

The climatological conditions in the elfin woodland (IXa) at an altitude of 825–860 m (Plate 1B), are like those mentioned for the palm brake. Liverworts grow in large quantities on tree trunks, branches, twigs, aerial roots and leaves and share their sites with orchids and ferns. The moss flora of the elfin woodland, in contrast to the liverwort flora, is remarkably poor and can be characterized mainly by the occurrence of *Thuidium recognitum* var. *delicatulum*. Epiphyllous mosses are also present.

The summit vegetation of Mount Scenery (IXb, 860–870 m) has recently been cut for the installation of a transmitting aerial. Therefore, moss species such as *Bryum argenteum* and *Sematophyllum caespitosum* occur. Here, the strong, moist trade winds and the open nature of the present summit vegetation, have resulted in a high species richness for mosses. On exposed rocks, dense mats of the black-coloured *Campylopus atratus* var. *sabaensis*, *Breutelia tomentosa*, *Rhacocarpus purpurascens* and the South American *Campylopus trachyblepharon* occur. On shrubs, small colonies of *Hemiragis aurea*, *Lepidopilum scabrisetum*, *Leskeodon andicola*, *Meteoridium remotifolium* and *Porotrichum insularum* can be found.

#### 4.2. *St. Eustatius*

The cultivated area (C.A.), the secondary (XVII) and thorny (XIII) woodland, at low altitude, are dry and hot as on Saba. In former days, man destroyed large parts of the original vegetation for agricultural purposes. The moss flora is very scanty with low species diversity. Epiphytic and saxicolous species are practically absent. The wide-tropical *Bryum apiculatum* and neotropical mosses such as *Calymperes richardii*, *Fissidens elegans*, *F.*

kegelianus, *Groutiella mucronifolia*, *Hyophila microcarpa* and *Weissia jamaicensis* grow in very small quantities on shaded soil.

The seasonal forests, including remnants of an evergreen seasonal forest (X) in the crater of The Quill, the semi-evergreen seasonal forest (XI) and the deciduous seasonal forest (XII) on the northwestern and southwestern slope of The Quill, are characterized by the presence of deciduous trees in one or more tree layers. Species richness of mosses is somewhat higher than at low altitudes, caused by more favourable climatological conditions. Apart from the neotropical *Schizomitrium pallidum*, *Calymperes donnelli*, *C. richardii*, *Fissidens elegans*, *Neckeropsis undulata*, *Pirella pohlii*, *Stereophyllum cultelliforme* and *Thuidium involvens*, the wide-tropical *Octoblepharum albidum* and *Sematophyllum caespitosum* occur. Species are usually saxicolous or epiphytic. Due to the presence of a layer of dead leaves on the soil, terrestrial mosses are only sparingly present in these forests.

On the inaccessible northern and eastern slope of The Quill, where a secondary woodland and a montane thicket occur, no bryophyte collections have been made.

It is not clear to what extent the flora of lower slopes of The Quill have been modified by human interference. Traces of cultivation are still present.

In the dry evergreen forest (XVI, Plate 2B), situated at the narrow rim of The Quill at an altitude of 350–550 m, the moss flora is rich and varied in numbers of species. The high rainfall in combination with the absence of deciduous trees creates many suitable habitats for mosses. Apart from many epiphytic and saxicolous stands, mosses also grow on soil. Remarkable terrestrial mosses are *Leucobryum albidum*, *Octoblepharum albidum* and *Syrrophodon incompletus* var. *incompletus*. These species form thick cushions on the soil. In contrast with the number of neotropical species in the dry evergreen forest, the number of wide-tropical species such as *Zelometeorium patulum*, *Octoblepharum albidum*, *Papillaria nigrescens*, *Sematophyllum caespitosum* and *Thuidium recognitum* var. *delicatulum* has increased. One South-american species, *Campylopus trachyblepharon*, is found on an exposed rock at the northern part of the rim.

At the highest southeastern part of the rim (550–600 m), where rainfall and air humidity attain their maximum value, an elfin woodland is found (Plate 2B), which is floristically different from the elfin woodland on Saba (Stoffers, 1956). Liverworts are much less abundant than on Saba and only grow on the leaves of evergreens. *Orthostichopsis tetragona* with the occasional admixture of *Meteoridium remotifolium* hangs in long strings from the branches, forming a dense rain-absorbing system (Plate 2C). Since the luxuriant vegetation creates a dense shading of the forest floor, most mosses grow on trees and rock. As on Saba, species richness of mosses is lower than in the dry evergreen forest. Apart from the neotropical species of the dry evergreen forest, the wide-tropical *Thuidium recognitum* var. *delicatulum* (also known from the elfin woodland of Saba), occurs here.



#### 4.3. Bryosociological characterization of plant communities

In the Appendix the mosses of Saba and St. Eustatius are arranged according to the plant communities in which they were found. An attempt has been made to determine, on the basis of the results of random collecting, the degree of association of moss species with individual plant communities, with the aid of the following formula:

$$A_{sc} = \frac{n_m}{n_c} \times n_{sc}$$

$A_{sc}$  = species - plant community association value,

$n_m$  = maximum number of moss collections made in a plant community in the area of investigation (= 70, relating to the dry evergreen forest of St. Eustatius),

$n_c$  = total number of moss collections made in plant community c,

$n_{sc}$  = total number of collections of species s in plant community c.

Based on their  $A_{sc}$  values (see Appendix) I have subsequently classified the species in four classes as follows:

- A: "Very characteristic species" = occurring in one plant community with  $A_{sc}$  of at least 15, or occurring in two plant communities with differences in  $A_{sc}$  value of at least 32 (75% of the maximum  $A_{sc}$ : 42).
- B: "Characteristic species" = occurring in one plant community with  $A_{sc}$  of at least 10, or occurring in two plant communities with difference in  $A_{sc}$  value of at least 21 (50% of the maximum  $A_{sc}$ ).
- C: "Moderately characteristic species" = occurring in one plant community with  $A_{sc}$  of at least 5, or occurring in two plant communities with difference in  $A_{sc}$  value of at least 11 (25% of the maximum  $A_{sc}$ ).
- D: "Non-characteristic species" = occurring in one plant community with  $A_{sc}$  of less than 5, or occurring in two plant communities with difference in  $A_{sc}$  value less than 11 or occurring in more than two plant communities.

The definitions of the classes are rather arbitrarily, but they are designed to show as clearly as possible the differentiating properties of the species in relation to the plant communities. The preference of moss species for the plant communities is shown in the Appendix and in Table 1.

From Table 1 it appears that only eight plant communities have one or more "characteristic" mosses (classes A-C); the other plant communities show a more indifferent bryoflora. The characteristic species may be compared with the "elective" species recognised for Guadeloupe and Martinique by Stehlé (1943), and with data for Puerto Rico (Crum and Steere, 1957), Guyana (Richards, 1954) and Suriname (Florschütz, 1964). Except for the work of Stehlé, descriptions of plant communities in the consulted literature are very generalized. Therefore, detailed comparisons cannot be made.

It appears that *Campylopus trachyblepharon* is also known from Guyana (Richards, 1934). Besides, it is common in Brazil (Frahm, 1975).

*Rhacocarpus purpurascens*, characteristic for the summit vegetation of Saba, is known from the *Sphagnetum guadeloupense* at volcanic slopes or summits of Guadeloupe and Martinique, but it is also collected at the summit of Mount Roraima (2200 m), Guyana. It is a typical mountain species (Barthlott & Schultze-Motel, 1981).

*Breutelia tomentosa* is also reported from the summit of Mount Roraima, as well as from high mountain peaks on Puerto Rico and swamps on volcanic summits and *Sphagnum* basins in Guadeloupe and Martinique. Besides, it is a common species in Andean regions.

*Porotrichum insularum*, a moderately characteristic species of the elfin

Table 1. Distinctiveness of mosses for the main plant communities of Saba and St. Eustatius. For explanation of plant communities see text. For *Callicostella pallida* read *Schizomitrium pallidum*.

- : very characteristic (class A)
- : characteristic (class B)
- : moderately characteristic (class C)

Non-characteristic species (Class D) are omitted.

plant community	IXb	IXaS	VIII	XVI	IXaE	C.A.	X	XI
<i>Campylopus trachyblepharon</i>	•							
<i>Rhacocarpus purpurascens</i>	○							
<i>Breutelia tomentosa</i>	○							
<i>Campylopus atratus</i> var. <i>sabaensis</i>	•							
<i>Porotrichum insularum</i>		•						
<i>Macromitrium cirrosum</i>			○					
<i>Taxithelium planum</i>					○			
<i>Acroporium pungens</i>					•			
<i>Groutiella mucronifolia</i>					•			
<i>Octoblepharum albidum</i>					•			
<i>Orthostichopsis tetragona</i>							•	
<i>Hyophila tortula</i>								○
<i>Bryum leptocladon</i>								•
<i>Helicodontium capillare</i>								•
<i>Neckeropsis undulata</i>								●
<i>Thuidium involvens</i>								○
<i>Callicostella pallida</i>								•
<i>Pireella pohlii</i>								○

woodland on Saba, occurs in hygrophytic forests on Guadeloupe and Martinique. On Puerto Rico this moss occurs near summits of major ranges (600–900 m).

*Macromitrium cirrosum*, characteristic for the palm brake on Saba, occurs in hygrophytic forests on Guadeloupe and Martinique, but it is also reported there from cultivated areas, growing on fruit trees. On Puerto Rico it occurs in mountain forests above 300 m. The species is also reported from French Guyana.

*Taxithelium planum* (characteristic of the dry evergreen forest on St. Eustatius) as well as *Groutiella mucronifolia* (moderately characteristic of the dry evergreen forest on St. Eustatius), are both somewhat weedy species, growing on fruit trees in cultivated areas of Guadeloupe and Martinique. They also occur in wet habitats and in lowland rainforest of Guyana.

*Acroporium pungens* is known from the swamps on volcanic summits of Guadeloupe and Martinique, savanna forests in Suriname and wet mountain forests of Puerto Rico (usually near or at cloud-shrouded summits at high altitudes. On St. Eustatius the species reaches its highest abundance in the dry evergreen forests, but it is not as large and well-developed as in the elfin woodland (twice collected) and summit vegetation (once collected) of Saba.

*Octoblepharum albidum* is characteristic for relicts of the natural mesophytic forests of the French Antilles. It is reported from cultivated areas and xerophytic forests, lowland rainforests and from coastal plain and lower mountain slopes.

*Hyophila tortula*, characteristic for the cultivated area of Saba, is a weedy species in calcareous areas in the coastal plain and mountain lowermost slopes of Puerto Rico.

*Bryum leptocladon* is common on banks along mountain trails and roads (300 m and more) in Puerto Rico.

*Helicodontium capillare*, a moderately characteristic species in the cultivated area of Saba, occurs in wet mountain forests at middle altitudes in Puerto Rico.

The very characteristic *Neckeropsis undulata* is a wet-rock dwelling species in hygrophytic forests at middle altitudes in Guadeloupe and Martinique. It is also known as a light-shade epiphyte in lowland rainforests of Guyana and occurs in moist forests up to 900 m in Puerto Rico.

*Thuidium involvens*, characteristic for the evergreen seasonal forest of St. Eustatius, occurs in several West-Indian plant communities. It occurs on wet rocks in hygrophytic forests as well as on fruit trees in cultivated areas of Guadeloupe and Martinique. Furthermore, it is a calcareous soil-inhabiting species in Puerto Rico, widespread in the coastal plain.

Finally *Schizomitrium pallidum*, a common moss in lowland rainforests in South America, and *Pirella pohlii* are reported from hygrophytic forests at middle altitudes of Puerto Rico as well as Guadeloupe and Martinique.

In conclusion, it appears that most of the above-mentioned mosses of Saba and St. Eustatius appear to occur outside these areas in comparable environments. Since the cited literature lacks more detailed information about

presence and abundance of mosses and the vegetation in which they occur, a more detailed comparison cannot be made at present.

## 5. KEY TO THE MOSSES OF SABA AND ST. EUSTATIUS

### Abbreviations:

A = Arzeni, 1954; B = Bartram, 1949; CS = Crum and Steere, 1957; E = St. Eustatius; Fa = Florschütz, 1964; Fb = Florschütz, 1967; G = Grout, 1945; O = Ochi, 1980; Ra = Reese, 1961; Rb = Reese, 1977; S = Saba; Wa = Welch, 1962; Wb = Welch, 1966; Wc = Welch, 1969; Wd = Welch, 1971; We = Welch, 1972.

Elevations: low = 0-300 m; middle = 300-600 m; high = 600-900 m.

- |   |   |
|---|---|
| 1. Moss acrocarpous .....   | 2 |
| 1. Moss pleurocarpous .....   | 5 |
| 2. Leaves distichous, clasping the stem by a double lamina ( <i>Fissidentaceae</i> ) ... Group A  |   |
| 2. Leaves not distichous, without double lamina .....   | 3 |
| 3. Leaves consisting mainly of costa, in cross section with several layers of large hyaline leucocysts and median row of small 3 to 4-angled chlorocysts ( <i>Leucobryaceae</i> ) .....   |   |
| ..... Group B   |   |
| 3. Leaves different .....   | 4 |
| 4. Leaves with large hyaline cells in leaf base, sharply separated from much smaller, green lamina cells ( <i>Calymperaceae</i> ) .....   |   |
| ..... Group C   |   |
| 4. Leaves without characteristics of group A, B and C ( <i>Bartramiaceae</i> , <i>Bryaceae</i> , <i>Dicranaceae</i> , <i>Pottiaceae</i> , <i>Splachnaceae</i> ) .....   |   |
| ..... Group D   |   |
| 5. Costa double, reaching midleaf or beyond ( <i>Hookeriaceae</i> , <i>Pilotrichaceae</i> ) .. Group E  |   |
| 5. Costa absent, single or if double not reaching midleaf .....   | 6 |
| 6. Costa single ( <i>Fabroniaceae</i> , <i>Hookeriaceae</i> , <i>Leucodontaceae</i> , <i>Meteoriaceae</i> , <i>Neckeraceae</i> , <i>Orthotrichaceae</i> , <i>Plagiotheciaceae</i> , <i>Pterobryaceae</i> , <i>Thuidiaceae</i> ) ..... |   |
| ..... Group F   |   |
| 6. Costa absent, or if double not reaching midleaf ( <i>Brachytheciaceae</i> , <i>Hedwigiaceae</i> , <i>Hookeriaceae</i> , <i>Hypnaceae</i> , <i>Sematophyllaceae</i> ) .....   |   |
| ..... Group G   |   |

### GROUP A

*Moss acrocarpous. Leaves distichous, clasping the stem by a double lamina.*

- |   |   |
|---|---|
| 1. Upper leaf cells lax, 40 $\mu$ long; on rock; middle elevations of S; B 10, CS 409, Fa 35 .....  |   |
| ..... <i>Fissidens mollis</i>   |   |
| 1. Upper leaf cells smaller .....   | 2 |
| 2. Leaves entirely bordered by elongated cells; on clay, occasionally on rock or tree-bases; low and middle elevations of S and E; CS 411, Fa 43 .....                        |   |
| ..... <i>Fissidens kegelianus</i>   |   |
| 2. Leaves not bordered or border confined to base of double lamina of upper leaves or of perichaetial leaves only .....   | 3 |
| 3. Cells in double lamina finely pluripapillose, up to 13 $\mu$ in diameter; on rock, occasionally on soil and trees; middle elevations of S and E; B 16, CS 412, Fa 47 ..... |   |
| ..... <i>Fissidens elegans</i>  |   |
| 3. Cells in the double lamina smooth or bulging, 4-8 $\mu$ in diameter; one collection in dry evergreen forest of E; B 18, CS 419, Fa 67 .....                                |   |
| ..... <i>Fissidens radicans</i>   |   |

GROUP B

*Moss acrocarpous. Leaves consisting mainly of costa, in cross section with several layers of large hyaline leucocysts and median row of small 3 to 4-angled chlorocysts.*

- 1. Leaves subtubulose at apex; chlorocysts quadrate; abundantly growing on humus, also on rock and trees; middle elevations of E; B 71, Fb 526 ..... *Leucobryum albidum*
- 1. Leaves flattened at apex; chlorocysts triangular ..... 2
- 2. Leaves suberect, slender and very fragile; cells in upper half of lamina irregular in outline, 20–45  $\mu$  long; on all substrates; middle (E) and high (S) altituded; B 69, CS 445, Fa 110 ..... *Octoblepharum pulvinatum*
- 2. Leaves wide-spreading, fleshy, not fragile; cells in upper half of lamina rectangular in outline, 50–80  $\mu$  long; on all substrates; middle elevations of E; B 69, CS 445, Fa 112 ..... *Octoblepharum albidum*

GROUP C

*Moss acrocarpous. Leaves with large hyaline cells in leaf base, sharply separated from much smaller, green lamina cells.*

- 1. Leaves with narrow intramarginal bands (*teniolae*) of elongated cells, most conspicuous at shoulders (i.e. transition base-lamina) and frequently well extending up lamina ... 2
- 1. Leaves without intramarginal bands of elongated cells at shoulders ..... 4
- 2. Leaf cells smooth, sometimes slightly mammillose at ventral side; upper part of lamina often wider than leaf base; *cancellinae* (large hyaline cells in leaf base) rounded above; all substrates; low and middle elevations of S and E; B 79, CS 451, Fa 132, Ra 110 ..... *Calymperes richardii*
- 2. Leaf cells papillose to strongly mammillose at ventral side, at least in upper half of leaf; upper half of lamina always narrower than leaf base; *cancellinae* acute above ..... 3
- 3. Leaf cells 4–6  $\mu$  in diameter; upper *cancellinae* smooth at ventral side; trunks of trees, decaying wood, rocks and occasionally on soil; middle and high elevations of S and E; B 78, CS 450, Fa 38, Ra 122 ..... *Calymperes donnellii*
- 3. Leaf cells 6–10  $\mu$  in diameter; upper *cancellinae* ventrally mammillose; one collection in palm brake on S; high elevation; Fa 134, Ra 126 ..... *Calymperes erosum*
- 4. Leaves 15–18 mm long, long linear; cells in upper part of leaves transversely elongated; trees and rocks, in dry evergreen forest and elfin woodland of E; middle elevations; B 81, CS 448, Fa 119, Ra 96 ..... *Calymperes lonchophyllum*
- 4. Leaves up to 7 mm long, abruptly narrowed from obovate base to linear-lanceolate lamina; cells in upper part of leaf rounded-quadrate to rectangular ..... 5
- 5. Cells in upper part of leaf (except a few rows along costa and margin) elongate, at least 2 times as long as wide; Apex sharply acute; leaf base very broad with flaring, clasping shoulders; upper part of leaf subtubulose even when moist; two collections in tree fern brake on S; 700 m, and dry evergreen forest on E; 500 m; Fa 163, Rb 8 ..... *Syrhodon incompletus* var. *luridus*
- 5. Cells in upper part of leaf for the greater part rounded-square; leaf apex acuminate or broadly acute (sometimes subobtuse); upper part of leaf usually flat when moist; abundant on all substrates; middle and high elevations of S and E; Fa 162, Rb 5 ..... *Syrhodon incompletus* var. *incompletus*

GROUP D

*Moss acrocarpous. Leaves without the characteristics of group A, B and C.*

- |  |                                   |
|--|-----------------------------------|
| 1. Leaves conspicuously bordered by several rows of hyaline cells (3/4 down); border narrowed toward base; leaves entire; cells rounded-oblong 5 $\mu$ long, 4 $\mu$ wide, densely papillose, especially on back of upper half of leaf; corticulous species of high elevations on S; CS 440.....                               |                                   |
|  | <i>Leucoloma album</i>            |
| 1. Leaves inconspicuously bordered or border absent.....   | 2                                 |
| 2. Leaves colorless above, becoming whitish; rare species of cultivated area on S; B 172, CS 448, O 110 .....  |                                   |
|  | <i>Bryum argenteum</i>            |
| 2. Leaf greenish-yellowish (sometimes reddish) throughout .....  | 3                                 |
| 3. Leaf cells (elongate) rhomboidal-hexagonal, thinwalled, smooth .....  | 4                                 |
| 3. Leaf cells not as above, very often with thick (pitted) walls or papillose .....  | 6                                 |
| 4. Plants minute, 1–1.5 mm high; leaves rounded; costa ending 2–5 cells below apex; one collection of Hummelinck s.n. 1973, the species has not been recollected in 1980 or 1981; calcareous soil; low elevations of E; B 152, CS 481, Fa 180 <i>Splachnobryum obtusum</i>   |                                   |
| 4. Plants larger, more than 1.5 mm high; leaf apex not as above; costa percurrent to (long) excurrent .....  | 5                                 |
| 5. Plants small, up to 3 mm, leaves closely imbricate on main stem, ca. 0.7–0.9 $\times$ 0.3–0.45 mm, short acuminate; rocks in cultivated area of S and E; B 164, CS 488, O 117 .....   |                                   |
|  | <i>Bryum leptocladon</i>          |
| 5. Plants medium-sized, up to 2 cm high; leaves 1.5–2 mm long, broadly acute to slightly apiculate; rare moss of cultivated area on E; B 170, CS 491, Fa 188, O 128 .....  |                                   |
|  | <i>Bryum apiculatum</i>           |
| 6. Small plants growing in dense mats on soil or rock; upper leaf cells subquadrate, incrassate, papillose (rarely mammillose); basal cells rectangular usually thinner-walled and pellucid ( <i>Pottiaceae</i> ) .....  | 7                                 |
| 6. Plants lacking above characteristics .....  | 11                                |
| 7. Upper leaf cells oblong-subquadrate, mammillose .....   | 8                                 |
| 7. Upper leaf cells rounded and densely papillose .....  | 9                                 |
| 8. Plants very small, nearly stemless; leaves ovate-lanceolate, acute; upper leaf cells subquadrate, ventrally mammillose, more than 10 $\mu$ in largest diameter; leaf margins entire; once collected in deciduous seasonal forest on E; B 128, CS 475, Fa 170 .....  |                                   |
|  | <i>Barbula agraria</i>            |
| 8. Plants up to 3 cm high; leaves oblong to spatulate, obtuse; upper leaf cells quadrate, not more than 10 $\mu$ in largest diameter, bulging mammillose on both surfaces; leaf margin subentire to coarsely and irregularly dentate above; stones and soil; low and middle elevations of S and E; B 112, CS 473, Fa 173 ..... |                                   |
|  | <i>Hyophila tortula</i>           |
| 9. Plants coarse, to 1 cm high; leaves 2.5–3.5 mm long; costa 65–80 $\mu$ wide near base; terrestrial moss of S and E; CS 468 .....  |                                   |
|  | <i>Weissia jamaicensis</i>        |
| 9. Plants to 5 mm high; leaves 1.5–2 mm long; costa usually narrower at base .....   | 10                                |
| 10. Leaves lingulate or oblong-lanceolate, broadly acute or obtuse; upper leaf cells hexagonal or subquadrate; papillae often C-shaped; rocks, occasionally terrestrial; moss of cultivated area on S and E; B 113, CS 473 .....   |                                   |
|  | <i>Hyophila microcarpa</i>        |
| 10. Leaves narrowly lanceolate, acuminate and apiculate at apex; upper leaf cells irregularly subquadrate; papillae not C-shaped; two terrestrial stands in secondary rainforest on S and thorny woodland on E; CS 461 .....   |                                   |
|  | <i>Hymenostomum breutelii</i>     |
| 11. Leaf cells thickened throughout, smooth; costa at least 1/3 width of the leaf base ( <i>Campylopus</i> ) .....   | 12                                |
| 11. Leaf cells not thickened, papillose at upper ends; costa narrower ( <i>Bartramiaceae</i> ) ...   | 13                                |
| 12. Cells in the leaf base, just above the auricles, thinwalled; leaves 4–8 mm long; costa with prominent lamellae (3–5 cells high) on back; rocks, known from summit of S as well as a single locality on the Quill-rim on E; Fa 82 (p. 364).....   |                                   |
|  | <i>Campylopus trachyblepharon</i> |

12. Cells in leaf base, just above the auricles, incrassate and pitted; leaves up to 4 mm long; costa smooth at back; summit of S, on rock; Fb 526 (p. 364) ..... *Campylopus atratus* var. *sabaensis*
13. Large moss, 10 cm high or more, tomentose below; leaves 3–5 mm long, narrowly lanceolate from short ovate, lightly plicate base, slenderly acuminate; rock and soil; summit of S; B 200, CS 493 Fa 206.....*Breutelia tomentosa*
13. Plant 2–3 cm high, not tomentose; leaves 1–1.5 mm long, oblong lanceolate, acuminate; on rock in cultivated area of S.....*Philonotis uncinata* var. *glaucescens*

GROUP E

*Moss pleurocarpous. Costa double, reaching midleaf or beyond.*

1. Leaves complanate, leaves dimorphic, lateral leaves larger, asymmetric, truncate or rounded-obtuse at apex, often minutely and bluntly apiculate; cells oblong-hexagonal, unipapillate, thinwalled; on trees at middle elevations of S and E; B 303, CS 538, Wa 11 ..... *Schizomitrium pallidum*
1. Leaves not complanate, leaves not dimorphic, symmetric; leaf apex acute ..... 2
2. Leaves ovate, up to 1.5 mm long, not plicate; leaf cells narrowly oblong, faintly papillose at tips; one epiphytic stand in secondary rainforest on S; B 291, CS 530... ..... (*Pilotrichum cryphaeoides* =) *Callicosta evanescens*
2. Leaves elliptic-lanceolate, longer than 3 mm, plicate; leaf cells linear, smooth; one epiphytic stand at summit of S; B 321, CS 552, Wd 101 ..... *Hemiragis aurea*

GROUP F

*Moss pleurocarpous. Costa single.*

1. Leaf cells clearly papillose ..... 2
1. Leaf cells smooth ..... 6
2. Alar cells differentiated ..... 3
2. Alar cells not differentiated ..... 4
3. Leaf cells pluripapillose, in a row over lumen; one epiphytic and one saxicolous stand; middle elevations of E; B 265, CS 519, Fa 255.....*Papillaria nigrescens*
3. Leaf cells with only one or two papillae over lumen; one epiphytic stand in dry evergreen forest on E; CS 511, Fa 242 (p. 364) ..... *Leucodontopsis geniculata*
4. Apical cells of branch leaves bearing single sharp papillae; rocks in cultivated area of S; B 335, CS 559 ..... *Bryohaplocladium microphyllum*
4. Apical cells of branch leaves bearing two or more papillae ..... 5
5. Small plants, pinnately or bipinnately branched; paraphyllia few, unbranched; mainly on trees at middle elevations of E; B 339, CS 558 ..... *Thuidium involvens*
5. Robust plants, bipinnately or tripinnately branched; paraphyllia numerous, branched; all substrates in elfin woodland of S and E; B 339 ..... *Thuidium recognitum* var. *delicatulum*
6. Leaves, at least in the leaf base, conspicuously bordered by one or more rows of linear cells ..... 7
6. Leaves not bordered ..... 8
7. Several rows of linear cells at leaf base only; widespread on all substrates; all elevations of S and E; Fa 213 ..... *Groutiella mucronifolia*
7. Leaves bordered all around by one row of linear cells; on trees and rock, high elevations of S; B 297, CS 535, Wc 131, We 447 ..... *Leskeodon andicola*
8. Leaves complanate; leaves often asymmetric ..... 9

8. Leaves not complanate, leaves symmetric.....	12
9. Plants with conspicuous dendroid habit, regularly branched; trees, high elevations of S; CS 528 .....	<i>Porotrichum insularum</i>
9. Plants irregularly branched, habit not dendroid .....	10
10. Leaves undulate, broadly truncate and erose-denticulate at apex; alar cells not differentiated; all substrates, middle elevations of S and E; B 279, CS 525, Fa 269 .....	<i>Neckeropsis undulata</i>
10. Leaves not as above .....	11
11. Leaf apex acute to obtuse-apiculate, serrulate above; on all substrates, cultivated area of S and (semi)-evergreen seasonal forest of E; CS 565, G 62.....	<i>Stereophyllum cultelliforme</i>
11. Leaf apex acuminate, entire or nearly so; one epiphytic stand in evergreen seasonal forest on E; B 373, CS 565, G 62 .....	<i>Stereophyllum leucostegum</i>
12. Plants minute; leaves less than 1 mm long; leaf cells rhomboidal, elongated near costa at base and quadrate in 4 to 6 rows at basal angles; on rock in cultivated area of S; B 327, CS 555 .....	<i>Helicodontium capillare</i>
12. Robust plants; leaves more than 1 mm long; upper leaf cells isodiametric to oval gradually becoming linear towards leaf base .....	13
13. Basal leaf cells with "tuberculae" (wart-like papillae), rectangular and with pitted, very incrassate cell walls .....	14
13. Basal leaf cells not tuberculate, not rectangular, usually without pitted, very incrassate cell walls .....	15
14. Upper leaf cells oval-linear, 2-4: 1, usually longer at margins; on trees; high elevations of S, (the species has not been recollected in 1980-1981); CS 501, Fb 527 .....	<i>Macromitrium scoparium</i>
14. Upper leaf cells shorter; leaf cells at margins not differing from those at midleaf; mainly on trees, high elevations of S; CS 502, Fa 224 .....	<i>(Macromitrium schwaneckeanum =) Macromitrium cirrosum</i>
15. Alar cells distinctly separated from other leaf cells .....	16
15. Alar cells not distinctly separated from other leaf cells .....	17
16. Alar cells in more or less conspicuous rows, forming a triangular group; stem leaves up to 3.5 mm long, rather abruptly narrowed to a long slender, flexuous acumen, plants yellowish-green; branch leaves in 5 distinct spiral rows; abundantly growing epiphyte, occasionally on rocks, middle elevations of E; A 16, B 254, F 248 .....	<i>Orthostichopsis tetragona</i>
16. Alar cells forming a roundish group; stem leaves abruptly apiculate, 1-1.5 mm long; plants often tinged with brown or black; branch leaves only sometimes in spiral rows; only twice collected on trees in palmbrake (high elevation) of S; B 261, CS 517.....	<i>Squamidium nigricans</i>
17. Primary stems creeping and practically leafless; secondary stems short, dendroid; branch leaves often arranged in spiral rows; cells 45 $\mu$ long; mainly on rocks, low and middle elevations of S and E; A 34, F 250 .....	<i>Pirella pohlii</i>
17. Primary stems leafy, long and pendant, irregularly pinnate, branch leaves not arranged in spiral rows; leaf cells 80-100 $\mu$ long .....	18
18. Stem leaves appressed with clasping base and long piliferous acumen; apex of branch leaves usually not twisted; branch leaves finely denticulate; on stones, trees occasionally on leaves in woodland derived from dry evergreen forest on S (middle elevation) and dry evergreen forest on E; B 272, CS 522, Fa 259.....	<i>Zelometeorium patulum</i>
18. Stem leaves wide-spreading from insertion, usually without piliferous acumen; apex of branch leaves once or twice twisted; branch leaves sharply serrate; mostly on trees, middle and high elevation of S and E; B 271, CS 522, Fa 262	<i>Meteoridium remotifolium</i>



GROUP G

*Moss Pleurocarpous. Costa absent or if double, not reaching midleaf.*

- |  |   |
|--|---|
| 1. Leaf cells papillose .....  | 2 |
| 1. Leaf cells smooth .....   | 4 |
| 2. Costa short and double; leaf cells conspicuously papillose at back by projecting apical angles; all substrates, middle elevations of S and E; B 409, CS 583.....  |   |
| ..... <i>Mittenothamnium diminutivum</i>   |   |
| 2. Leaves ecostate; leaf cells pluripapillose .....  | 3 |
| 3. Plants creeping, complanate; leaves short acuminate; leaf cells bearing 5-7 papillae in single row over lumen; epiphyte occasionally on rock in dry evergreen forest on E; few collections from low and high elevations of S and E; B 395, CS 575 ..... |   |
| ..... <i>Taxithelium planum</i>  |   |
| 3. Plants not complanate; leaves long piliferous; leaf cells finely pluripapillose (i.e. papilla-like structures are spread over the lumen); rocks; summit of S; B 235, Fa 241 .....   |   |
| ..... ( <i>Rhacocarpus humboldtii</i> =) <i>Rhacocarpus purpurascens</i>   |   |
| 4. Alar cells distinctly differentiated, oval, inflated .....  | 5 |
| 4. Alar cells not or only slightly differentiated .....  | 6 |
| 5. Leaves lanceolate, 2-2.5 mm long; leaf margin inflexed above; leaf cells linear; peristome teeth with median furrow, transversely striolate below; trees, middle and high elevations of S and E; B 393, CS 573 .....                                    |   |
| ..... <i>Acroporium pungens</i>  |   |
| 5. Leaves oval-elliptic, 1-1.5 mm long; leaf margins plane; leaf cells rhomboid, shorter at extreme apex; peristome teeth with zig-zag median line; trees and rocks; all elevations of S and E; 389, CS 570 .....  |   |
| ..... <i>Sematophyllum caespitosum</i>   |   |
| 6. Stems and branches not complanate-foliate; leaves plicate, symmetric, 3-4.5 mm long; leaf cells with incrassate, pitted walls; trees and rocks at middle (E) and high (S) elevations; CS 560 .....  |   |
| ..... <i>Lepyrodontopsis trichophylla</i>  |   |
| 6. Stems and branches complanate-foliate; lateral leaves often asymmetric, less than 3 mm long; leaf cells thinwalled .....  | 7 |
| 7. Costa double, slender and inconspicuous (except in older leaves), seldom exceeding 1/4 leaf length; lateral leaves 2.5-3 mm long, asymmetric; on trees and leaves at high elevations of S; B 312, Wb 57 .....   |   |
| ..... <i>Lepidopilum scabrisetum</i>   |   |
| 7. Costa double, very short or absent; lateral leaves up to 1.5 mm long; leaves more or less symmetric .....   | 8 |
| 8. Leaves suborbicular; leaf apex obtuse, often keeled or folded; leaves serrulate in upper half; teeth often bifid; on trees and rocks, occasionally on leaves; high elevations of S; B 317, CS 547, Wd 90.....   |   |
| ..... <i>Crossomitrium orbiculatum</i>   |   |
| 8. Leaves ovate-lanceolate; leaf apex acute, not plicate; teeth (if present), not bifid; on trees and rock; middle elevations of S and E; B 405, CS 582..  |   |
| ..... <i>Vesicularia amphibola</i>   |   |

6. ACKNOWLEDGEMENTS

I am much indebted to Dr. S.R. Gradstein for his guidance and for his revision of the English text and to Prof A.L. Stoffers for enabling me to participate in the project and for providing photographs. I also wish to thank Dr. Dana Griffin (Gainesville) and Dr. F.J.A. Daniels for comments on the manuscript, Mrs. J. Florschütz for her help in constructing the key, Dr. Harumi Ochi for identifying some sterile Bryaceae and T. Schipper and P. Wartena for inking the drawings. Financial support from the "Studiekring voor Suriname en de Nederlandse Antillen", the Catharina van Tussenbroeck Fund, the van Eeden Fund and the Utrecht University Fund, making possible the trip to Saba and St. Eustatius, is gratefully acknowledged.

## REFERENCES

- Arzeni, C.B. - The Pterobryaceae of the Southern United States, Mexico, Central America and the West Indies. *Am. Midl. Nat.* **52**, 1-67 (1954).
- Barthlott, W. & W. Schultze-Motel. - Zur Feinstruktur der Blattoberflächen und systematischen Stellung der Laubmossattung *Rhacocarpus* and anderer Hedwigiaceae. *Willdenowia* **11**, 3-11 (1981).
- Beard, J.S. - The natural Vegetation of the Windward and Leeward Islands. *Oxford Forest. Mem.* **21**. (1949).
- Crosby, M.R. - Distribution patterns of West Indian Mosses. *Ann. Missouri Bot. Gard.* **56**, 409-416 (1969).
- Crum, H. & L.E. Anderson. - Mosses of Eastern North America. New York, 1328 p. (1981).
- Crum, H. & W.C. Steere. - The mosses of Puerto Rico and the Virgin Islands. In: *Scientific Survey of Puerto Rico and the Virgin Islands* **7**, 395-599 (1957).
- Florschütz, P.A. - Mosses of Suriname. In: *Flora of Suriname* (J. Lanjouw, ed.) **VI**. Leiden, 271 p. (1964).
- Florschütz, P.A. - Mosses from the Netherlands Antilles. *Acta Bot. Neerl.* **15**, 524-529 (1967).
- Frahm, J.P. - Conspectus der mittel- und südamerikanischen *Campylopus*-arten (Dicranaceae). *Bryophyt. Biblioth. 5. Vaduz*, 143 p. (1975).
- Gradstein, S.R. & W.A. Weber. - Bryogeography of the Galapagos Islands. *J. Hattori Bot. Lab.* **52**, 127-152 (1982).
- Grout, A.J. - A revision of the North American species of *Stereophyllum* and *Pilosum* with descriptions of some South American species. *Bryologist* **48**, 60-70 (1945).
- Manuel, M.G. - The genus *Meteoridium* (C. Müll.) Manuel, stat. nov. *Lindbergia* **4**, 45-55 (1977).
- Ochi, H. - A revision of the Neotropical Bryoideae, Musci (First Part). *J. Fac. Educ. Tottori Univ. Nat. Sc.* **29**, 49-154 (1980).
- Reese, W.D. - The genus *Calymperes* in the Americas. *Bryologist* **64**, 89-140 (1961).
- Reese, W.D. - The genus *Syrrophodon* in the Americas 1: the elimbate species. *Bryologist* **80**, 2-31 (1977).
- Richards, P.W. - Musci collected by the Oxford expedition to British Guyana in 1929. *Kew Bull. S.N.*, 317-338 (1934).
- Richards, P.W. - Notes on the bryophyte communities of lowland tropical rainforests, with special reference to Moraballi creek, British Guyana. *Vegetatio*. **5-6**, 319-328 (1954).
- Stehlé, H. - La végétation muscinale des Antilles Françaises et son intérêt dans la valorisation muscinale. *Caribbean Forest.* **4**, 164-182; *ibid.* **5**, 20-43 (1943).
- Stoffers, A.L. - The vegetation of the Netherlands Antilles. *Utrecht*, 142 p. (1956).
- Watanabe, R. & Z. Iwatsuki. - New name for *Haplocladium* (C.M.) C.M. (*Musci*) *Journ. Jap. Bot.* **56**, 259-261 (1981).
- Welch, W.H. - The Hookeriaceae of the United States and Canada. *Bryologist* **65**, 1-24 (1962).
- Welch, W.H. - The Hookeriaceae of Mexico. *Bryologist* **69**, 1-68 (1966).
- Welch, W.H. - The Hookeriaceae of Cuba. *Bryologist* **72**, 93-136 (1969).
- Welch, W.H. - The Hookeriaceae of Jamaica, Hispaniola and Puerto Rico. *Bryologist* **74**, 77-130 (1971).
- Welch, W.H. - The Hookeriaceae of the Lesser Antilles. *Bryologist* **75**, 404-455 (1972).

## APPENDIX

Association values of the mosses in the main plant communities of Saba and St. Eustatius (for explanation see text). Species collected only once or twice have been omitted.

Plant community	IXb	IXaS	VIII	XVI	IXaE	II	C.A.	XVII	X	XI
<i>Campylopus trachyblepharon</i>	14				3					
<i>Rhacocarpus purpurascens</i>	10									
<i>Breutelia tomentosa</i>	10									
<i>Campylopus atratus</i> var. <i>sabaensis</i>	8									
<i>Porotrichum insularum</i>	6	23								
<i>Thuidium recognitum</i> var. <i>delicatulum</i>	6	14			11					
<i>Lepidopilum scabrisetum</i>		23	11							
<i>Meteoridium remotifolium</i>	14	23	11	5			6			
<i>Leucoloma albulum</i>		14	11							
<i>Macromitrium cirrosum</i>			11							
<i>Lepyrodontopsis trichophylla</i>			11	5						
<i>Taxithelium planum</i>				10						
<i>Acroporium pungens</i>				9						
<i>Groutiella mucronifolia</i>				6						
<i>Octoblepharum albidum</i>				6						
<i>Leucobryum albidum</i>				9	7					
<i>Octoblepharum pulvinatum</i>				5	9					
<i>Calymperes lonchophyllum</i>				6	11					
<i>Orthostichopsis tetragona</i>				8	23					
<i>Syrhobodon incompletus</i> var. <i>incompletus</i>				18	7	12				
<i>Calymperes donnellii</i>				9	11	9				30
<i>Sematophyllum caespitosum</i>				5		9	14			
<i>Stereophyllum cultelliforme</i>						9	3	21	30	
<i>Fissidens kegelianus</i>						12	3	16		
<i>Weissia jamaicensis</i>						9	8			
<i>Philonotis uncinata</i> var. <i>glaucescens</i>	6						4			
<i>Vesicularia amphibola</i>							3			
<i>Hyophila tortula</i>							14			
<i>Bryum leptocladon</i>							8			
<i>Helicodontium capillare</i>							8			
<i>Hyophila microcarpa</i>							8	16		
<i>Calymperes richardii</i>				4			6	37		30
<i>Neckeropsis undulata</i>				3					42	
<i>Thuidium involvens</i>				8					35	
<i>Schizomitrium pallidum</i>						9			28	
<i>Fissidens elegans</i>								12	21	
<i>Pirella pohlii</i>				9						30

**Note added in proof:**

*Campylopus trachyblepharon*: According to Dr. J.P. Frahm (in litt.) the material of *C. trachyblepharon* from St. Eustatius (zone XVI) represents an epilose form of the wide-tropical *Campylopus savannarum* (C.M.) Mitt. The identity of *C. trachyblepharon* from Saba (zone IX<sub>b</sub>) is still unknown; the material does not belong to *C. trachyblepharon* according to Dr. Frahm.

*Campylopus atratus* var. *sabaensis*: This variety is reduced by Dr. Frahm (in litt.) to synonymy under the common neotropical *C. richardii* Brid. .

*Leucodontopsis geniculata*: According to J. Florschütz-de Waard (oral comm.) the specimen from St. Eustatius identified here as *Leucodontopsis geniculata* represents a form of *Papillaria nigrescens* with relatively few papillae.