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Taxonomic Results of the BRYOTROP Expedition to Zaire and Rwanda

17. Andreaeaceae, Bruchiaceae, Dicranaceae, Rhizogoniaceae, Bartramiaceae, Rhacocarpaceae, Hedwigiaceae, Cryphaeaceae, Leucodontaceae

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Abstract: Thirteen new records of species of *Andreaea, Trematodon, Campylopus* and *Rhabdoweisia* for Rwanda viz. Zaire are published. *Campylopus cerradensis* Vital and *Paraleucobryum longifolium* (Hedw.) Loeske ssp. *brasiliense* (Broth.) P. Müller & J.-P. Frahm, previously only known from Brazil, are reported for Africa for the first time. *Campylopus schmidii* C. Müll. is reported for the first time for the African continent. *Campylopus leucochlorus* is regarded as synonymous with *C. hildebrandtii* (C. Müll.) Jaeg. *Atractylocarpus capillifolius* Dix. is regarded as synonymous with *A. alticaulis* (Broth.) Williams. Based on a different spore size, spore ornamentation and growth form as well as cultivation experiments, *Antitrichia kilimandscharica* Broth. is regarded as separate species and not as synonymous with *A. curtipendula* (Hedw.) Brid. *Acrocryphaea robusta* Broth. in Mildbr. is combined new to the genus *Schoenobryum*.

Abbreviations::

* New record for Rwanda viz. Zaire
KB: Kahuzi-Biega (Zaire)
Ka: Karisimbi (Rwanda)
Ny: Nyungwe Forest (Rwanda)
Ak: Akagera region (Rwanda)
Ki: Kigali region (Rwanda)
100-171, number of collecting site.
For locality data and a description of the collecting sites see the contribution by E. Fischer on the vegetation of the study area in this volume (Tropical Bryology 8: 13-37, 1993). The specimens are deposited at the Botanical Museum Berlin as well as in the herbarium of the author (except for unicates).

ANDREAEACEAE

Andreaea Hedw.
For African species see De Sloover (1977).

**Andreaea firma* C. Müll.
So far recorded only from Mt. Kilimanjaro and Mt. Kahuzi (De Sloover 1977). Our specimens from Mt. Karisimbi match the description and illustrations given by De Sloover (1977), especially concerning the rounded, not distinctly pitted cells of the upper part of the leaf. De Sloover discussed whether this character might

be caused by the juvenile stage his plants, however, *Pócs 8193* has antheridia and *Frahm 8238* has sporophytes (which were not known so far in this species).
Ka: 164, *Frahm 8271, Pócs 8193;* 165: *Frahm 8238.*

Andreaea mildbraedii Broth.
Ka: 164, *Pócs 8115.*

Andreaea obovata Thed.
Ka: 164: *Frahm 8139.*

BRUCHIACEAE

Trematodon Michx.

**Trematodon intermedius* Welw. & Duby
KB: 128, *Frahm 7341, 7405, 7507*. **Ka:** 160, *Frahm 8126.*
Very small plants with the appearence of a species of *Bruchia* having a rudimentary peristome and spores of 25 µm in diameter. Previously recorded from Central Africa from Rutshuru, prov. Kivu, in Zaire (Demaret 1940).

**Trematodon longicollis* Michx.
Zaire prov. Kivu, volcan Nyragongo 2700 m, on warm soil around fumaroles, *Frahm 9022*. New to Zaire. The plants are large with sporophytes up to 25 mm long, probably because of the habitat. The specimen is referred to this species because the neck of the capsule is distinctly more than two times longer than the urn (Magill 1981). Nearest records are from Zimbabwe and Uganda (Kis 1985).

DICRANACEAE
Dicranoideae

Dicranelloideae

Dicranella (C.Müll.) Schimp.

Dicranella subsubulata (C. Müll.) Jaeg.
On open bare soil.
KB: 128, *Frahm 7406.*

Dicranella pertenella C. Müll. ex Dus.
KB: 128, *Pócs 7385*, det. Ochyra.

Dicranella sp.
Along roadside and on trail bank.
Ny: 111: *Frahm 6426;* 112, *Frahm 6446.*

Pseudephemerum (Lindb.) Hag.

Pseudephemerum nitidum (Hedw.) Reim.
On wet soil at the margin of ditches in a tea plantation with *Riccia.*
Ny: 153, *Frahm 8020a.* **KB:** 129, *Frahm 7339* det. Ochyra.

Dicranoideae

Dicranoloma (Ren.) Ren.

Dicranoloma billardieri (Brid.) Par.
A southern hemisphere species which goes up from South Africa to the mountains of Central Africa, where it is the only representative of the genus. In appearence it resembles a species of *Dicranum*, and often grows together with *Dicranum johnstonii*, from which it is difficult to distinguish without experience. Microscopically it differs from the latter by elongate pitted laminal cells, a narrow costa and especially by the narrow border of elongate hyaline cells along the leaf margin. This character seems to be the only differentiating *Dicranoloma* from *Dicranum.*
Dicranoloma billardieri is epiphytic found only, on stems and branches especially and in large quantity in the canopy, where it forms hugh mossballs. These mossballs are characteristic of very humid habitats, independent of the altitude. They are found in the Nyungwe Forest only in a small area in 2000 m elevation at the western border of the forest, where they are exposed to the humidity coming from Lake Kivu, and there especially on exposed ridges or in swamp forests. On Mt. Kahuzi, it is found only below the summit at 3200 m, and there only in an elfin-forest-like stand, which is exposed to frequent

fog.
Mossballs are also formed by liverwort species such as *Chandonanthus spp.*, *Herbertus spp.* and *Plagiochila spp.* (as in the wet parts of the Erica-belt of Mt. Kahuzi). At Mt. Karisimbi, liverworts and especially *Antitrichia curtipendula* form mossballs. *Dicranoloma*-mossballs can reach a diameter of two meters. When saturated with water, they can gain such enormous weight that they break the branches on which they are growing. Fallen down, they are so heavy that they cannot be carried by one person. In this way, mossballs play an important role for the ecology of this type of forest. The bryophytes forming the mossballs in the canopy retain nutrients mainly from the rainfall. In this way, they acquire nutrients, convert them into phytomass, and resupply these nutrients when falling from the canopy as organic fertilizer.
Ny: 106, *Frahm 6288;* 107, *Frahm 6295;* 108, *Frahm 6337.;* 155, *Frahm 7970, 7977.* **KB:** 147, *Frahm 7757.*
Recently Norris & Koponen (1989) introduced (unfortunately in a journal with not very wide distribution for such an important proposal) that the name *Dicranoloma* should be used for only six species, two of northern Australia and four of Caledonia. The other species comprised in the genus *Dicranoloma* should be combined under *Dicranum*. Accordingly, the same authors (Norris & Koponen 1990) combined the species of *Dicranoloma* from new Guinea to *Dicranum.*
In fact the terrestrial subantarctic species of the genus *Dicranoloma* cannot be distinguished clearly from species of the genus *Dicranum*, which was usually regarded as holarctic. Insofar it is a phytogeographically very important insight that *Dicranum* is not holarctic but bicentric and disjunct in the temperate to (ant)arctic regions. I personally have difficulties to include the tropical epiphytic representatives of *Dicranoloma* in *Dicranum*, too. These are adapted to this epiphytic lifeform by often pendant growth, longer leaves with border of narrow cells (limbidium), smaller sporophytes and the absence of a central stand in the stem. These are typical adaptations to epiphytism and one could argue that this is just an expression of species of *Dicranum* which climbed on trees during their evolution. The quantity and quality of characters, however, seem to me sufficient to keep such species in a separate genus, *Dicranoloma*. Noris & Koponen lectotypified the genus chosing *Dicranoloma serratum* (Broth.) Par.,
which is such an epiphytic species with limbidium and short seta. Insofar my opinion is in accordance with the lectotypification but not with the limitation of the genus *Dicranoloma* to six species in northern Australia and New Caledonia. I my opinion species such as *Dicranoloma billardieri* (as well as many other tropical epiphytic species) should also remain in this genus.

Dicranum Hedw.

Dicranum johnstonii Mitt.
Growing usually in subalpine forests, within the summit region of Mt. Biega at 2650 m elevation as relativly small plants, but on Mt. Kahuzi between 3000 and 3300 m elevation in large tufts on rotten wood, horizontal stems of trees and at base of trees. Smaller plants have also been found in wet parts of the Nyungwe forest, such as the Kamiranzovu swamp and the Rwasenoko valley. *Pócs 3136* is a form with hamate leaves which resembles the description of *D. affine* Broth described from the same area.
Ny: 103, *Pócs 6136.* 108, *Frahm 6344.* **KB:** 132, *Frahm 6938*; 135, *Frey & Kürschner 7008;* 149, *Frey & Kürschner 7452, Pócs 7806.*

Campylopodioideae

Key to the genera:

1	Leaves with very broad, clasping, sheathing base, abruptedly contracted to a long acumen. Plants *Anisothecium*-like	*Microcampylopus*
1*	Leaves not with sheathing base.	2
2	Seta cygneous.	3
2*	Seta straight.	4
3	Seta more than 1 cm long. Capsules curved, strumose. Peristome teeth smooth.	*Bryohumbertia*
3*	Seta less than 1 cm long. Capsules curved or straight. Peristome teeth papillose.	

Campylopus

4 Perichaetial leaves longly acuminate, covering most of the seta.

Pilopogon

4* Perichaetial leaves not much differentia ted, not sheathing the seta.

Atractylocarpus

Atractylocarpus Mitt.
for worldwide monograph see Padberg & Frahm (1985).

A. alticaulis (Broth.) Williams (*Metzleria alticaulis* Broth. in Mildbr., *Metzlerella alticaulis* (Broth.) Broth., *Atractylocaulis flexifolius* Dix., *Atractylocarpus capillifolius* Dix., J. Bot. 76: 225, *syn. nov*. Type: Mt. Kenya, *Allan s.n.* 1924, BM).

A species confined to Central and East Africa (Ruwenzori, Kahuzi, Karisimbi, Mt. Kenya and Kilimanjaro). It occurs in the subalpine belt from 3000 m elevation to the forest line. Although the habitat has been indicated on herbarium labels as soil and rocks, it was consistently found on rotten wood.
KB: 148, *Frahm 7706,* Campylopodioideae Exsiccatae 1. **Ka:** 159, *Frahm 8351, 8070*.

Bryohumbertia
For survey of the genus see Frahm (1982).

B. flavicoma (C. Müll. ex Broth.) J.-P. Frahm (*Campylopus flavicoma* C. Müll. ex Broth., *Campylopus metzlerelloides* (P. Varde & Thér.) Biz., *Bryohumbertia metzlerelloides* P. Varde & Thér.)
This species vegetatively resembles species of *Campylopus* with narrowly lanceolate leaves, distinct alar cells, long rectangular, pitted basal laminal cells and short rectangular upper laminal cells. As the genus *Pilopogon*, it can be distinguished only by the sporophyte. The setae are longer, c. 1.5 cm long, with a curved, strumose capsule and a longer operculum, which is as long as the capsule. Furthermore the peristome teeth are smooth and not papillose. Fortunately sporophytes are produced almost always.
Bryohumbertia flavicoma grows commonly on humic soil and rotten wood in montane forests between 1900 and 3000 m altitude. Usually short plants up to 1 cm tall are found. When well developed, the plants get taller and are interruptedly foliate.
KB: 128, *Frahm 7342;* 131: *Frey & Kürschner 6920, Frahm 7122*; 133, *Frey & Kürschner 6977;* 137, *Frahm 6960;* 139:, *Frahm 77288, 292*; 141, *Frahm 7054;* 142, *Frahm 7340;* 145, *Frey & Kürschner 7482;* 147, *Frahm 7551,* Campylopodioideae Exsiccatae 3, 133: *Frahm 6962; .152,* Frahm 7563 **Ny:** 103, *Pócs 6153;* 107, *Pócs 6325, 6326, Frahm 6292*; 111, *Frahm 6423, 6421, 6445.; 108,* Frahm 6327, 6329. Uwinka, along forest trail 2450 m, *Frahm 9014, 9015, 9016, 9017*. Zaire: prov. Kivu, volcan Nyragongo 2600 m, *Frahm 9016.* **Ka:** 159: *Frahm 8069; 8111*.

Campylopus Brid.
for a survey of the African species see Frahm (1985).

**Campylopus carolinae* Grout
A species hitherto known only from the Americas. It occurs on sandy soil of the coastal plains of SE-North America and has been described as *C. cerradensis* Vital from the Cerrado-regions of Brazil. The unusual disjunction between Brazil and SE-North America (which is also found in two other species of *Campyolopus*) has been subject of speculations. Since no land connection existed between Eastern North America and South America, dispersal of spores or fragments has been postulated. The disjunct occurrence of *C. carolinae* shows, however, that all three disjunct ranges are more probably a relict of a former wider range in the Mesozoic, when arid climatic conditions existed before the separation of South America and Africa. Long distance dispersal as explanation for the disjunction between South America and Africa is most unlikely, since this species is found very rarely with sporophytes (the two African collections known so far are sterile) and the sporophytes are immer-

sed between the upper comal leaves of thr plants. Interestingly, *C. carolinae* grows in Africa in absolutely the same habitats, loose sandy soil in which the plants are nearly buried, in regions of dry forests or degraded areas in which these forest were destroyed. In Rwanda, *C. carolinae* was found in two sites more than 100 km apart, both at 1500 m elevation. The locality near Kigali consists of rocky outcrops and is therefore a drier site within cultivated land. The locality in SE-Rwanda is situated in a degraded savannah woodland, in which forests are cut and remnants of natural forests are found only on steep cliffs. The American *Campylopus carolinae* was regarded as vicariant species of the African *C. perpusillus.* Both species are the only representatives of the small subgenus Campylopidulum in which each species was known from tropical America and tropical Africa respectively (Frahm 1986). This lead to the conclusion that both species have developed from a common ancestor after separation of South America and Africa. The recent discovery of *C. carolinae* in Africa shows, however, that both species were apparently sympatric species, at least in Africa. Both species are very closely related and differ mainly in the excurrent costa of the leaf, which is hyaline in *C. carolinae* but concolorous in *C. perpusillus.* The leaf apex is gradually narrowed into the hyaline excurrent costa in *C. carolinae,* but contracted with a short mucro in *C. perpusillus*.
Ak: 116: *Frahm 6515;* 170, *Frahm 8362.*

**Campylopus decaryii* Thér.
A species so far known only from Madagascar and South Africa. It resembles *C. nanophyllus* or *C. perpusillus,* but differs in the transverse section of the costa lacking any ventral stereids. It is recorded here as new to Zaire and Central Africa, where it was found on soil around the Irangi fieldstation at 850 m elevation.
KB: 127, *Frahm 7701.*

**Campylopus dicranoides* Thér. & Nav.
Easily recognized by its homomallous leaves, this species occurs on rotten wood in subalpine forests. It is known from Mt. Kenya, Mt. Elgon, Muhavura and Nyungwe-Forest and reported here as new to Zaire from Mt. Kahuzi. *Frahm 7705* shows abundant microphyllous branches as in *C. flexuosus,* which were not yet known from this species.
KB: 148, *Frahm 7705*, Campylopodes Centrali-Africanae Exsiccatae 1.

**Campylopus flaccidus* Ren. & Card.
An afro-montane species ranging from South Africa to southern Sudan. In Central Africa it was only recorded from Burundi and is reported here as new to Zaire and Rwanda.
KB: 146, *Frahm 7549*, Campylopodes Centrali-Africanae 14. **Ny:** Uwinka, on gravel along road 2450 msm, *Frahm 9012*..

**Campylopus flexuosus* (Hedw.) Brid.
A tropical montane species in South- and Central America and Africa with extension to the oceanic parts of the holarctic. Easily known by microphyllous branches for vegetative propagation. It grows on soil and rotten wood, rarely epiphytic, in montane forests from 2000 - 3000 m. It ranges from the East African islands to Tanzania and Uganda and is reported here as new to Rwanda.
Ny: 110, *Pócs 6402;* 155, *Frahm 7959, 7960*, Campylopodes Centrali-Africanae Exsiccatae 3, *Frahm 7963, 7980*.. Zaire prov. Kivu, volcan Nyragongo, around fumaroles in 2800 m alt., *Frahm 9008, 9011.*

Campylopus hensii Ren. & Card.
A species of preferably lower altitudes and found only near the Irangi fieldstation in 850 m elevation. on buttress.
KB: 119: *Frahm 6615.*

**Campylopus hildebrandtii* (C. Müll.) Jaeg.
C. leucochlorus (C. Müll.) Par., syn. nov.
See also comments under *C. perichaetialis*.. Reported here as new to Rwanda, although it has been previously collected there and distributed in exsiccates by De Sloover. It grows on soil, on rotten or living wood in altitudes from 2000 m to the forest line. Sporophytes have been found only in epiphytic habitats. The leaves are usually appressed and straight but can be homomallous in the same tuft (e.g. in *Frahm 6417, 6447)*, apparently in drier habitats.
KB: 128, *Frahm 7388;* 137, *Frahm 6952;* 138,

Frahm 7011, 7012, Campylopodes Centrali-Africanae 30, *Frahm 7013;*; 132, *Frey & Kürschner 6897; Frahm 6623, 9637, 6940, 6941; 6942;* 134, *Frahm 6963*, Campylopodes Centrali-Africanae Exsiccatae 19; 135, *Frey & Kürschner 6996;* 138, *Frahm 7013*, Campylopodes Centrali-Africanae 24;143, *Frey & Kürschner 7417;* 144, *Frahm 7667*; 145, *Frey & Kürschner 7484, Frahm 7548*, Campylopodes Centrali-Africanae 10. *Frahm 7555*; 7665; 148, *Frey & Kürschner 7477, Frahm 7707*, Campylopodes Centrali-Africanae Exsiccatae 9, *Frahm 7738*; 152, *Frahm 7562, 7560.* **Ny:** 106: *Frahm 6227;* 107, *Pócs 6328;* 108, *Frahm 6132, 6328*; 111: *Frahm 6417*, Campylopodes Centrali-Africanae 27**,** *Frahm 6418*, Campylopodes Exsiccatae 174, *Frahm 6419*. 112, *Frahm 6447;* 157, *Frahm 8007*.

Campylopus hildebrandtii has a broad geographical and ecological amplitude. It occurs from South Africa to Ethiopia and from the Comores to Cameroun in elevations between 1600 and 3000 m, terrestrial as well as epiphytic. Accordingly, it varies morphologically. In wet habitats, it is very robust, several cm high and very turgid foliate (leucobryoid). In appearence it is like *Paraleucobryum enerve* with swollen foliate stems. Such forms occur in wet forests such as *Philippia*-forests on soil below the forest line as well as as "mossballs" at lower altitudes in the canopy of wet rainforests. Medium sized forms are epiphytic in E-Zaire and Rwanda very characteristically found on *Agaurea salicifolia*, where sporophytes are produced regularly, and also on humic soil and rotten wood. Small forms are found on soil at lower elevations (1600 - 2000 m) in montane forests, where forms with curved leaves are observed mixed with normally foliate forms with straight leaves.

This species is morphologically very similar to *C. perichaetialis*. These species differ only in the upper laminal cells, which are oval (c. 4:1) in *C. perichaetialis* and subquadrate, short rectangular or oblique (c. 1.5:1) in *Campylopus hildebrandtii*. The transverse section of the costa shows no stereid groups in *C. perichaetialis*, but distinct dorsal stereid groups in *C. hildebrandtii*. Both species belong to a complex of species distributed in Africa and South America with the same appearence and differing only in the transverse section of the costa and the shape of the upper laminal cells. This complex consists of

(1) *C. subnitens* Kaal., a species of the Subantarctic known only from the Crozet, Marion, Prince Edward and Kergueles Islands. It has no stereids in transverse section of the costa and upper laminal cells 4-5 times longer than broad. It has a transverse section of the costa which shows substereids in the central part, but changes to *Paraleucobryum*-like relations in the marginal parts of the costa. This type of transverse section of costa is also typical for

(2) *C. pittieri* Williams and

(3) *C. albidovirens* Herz. distributed through the Andes from northern Argentina to Mexico, *C. pittieri* being a páramo species, *C. albidovirens* a high montane species. Both species seem to be directly derived from *C. subnitens* by spreading northwards after the uplift of the Andes. *Campylopus pittieri* differs from *C. subnitens* by having an even broader costa, filling 4/5 or more of the leaf, and the ventral hyalocysts being broader. In Africa, the next relative of *C. subnitens* is

(4) *C. bartramiaceus* (C. Müll.) Thér. from South Africa, which has laminal cells as in *C. subnitens* (4-5:1), but dorsal stereid groups in transverse section of the costa and the costa ridged at the back.

(5) *C. hildebrandtii* also has stereid groups, but distinctly shorter laminal cells (1.5:1), whereas

(6) *C. perichaetialis* has no stereids and the upper laminal cells 4 times as long as broad, similar to *C. subnitens*, but lacks the *Paraleucobryum*-like transition of the transverse section towards the margins. *Frahm 6963* and *7707* have upper longer laminal cells 2.5 times longer than broad, but are referred here to *C. hildebrandtii* because of distinct stereid groups in transverse section of the costa.

Campylopus jamesonii (Hook.) Jaeg. (*C. procerus* (C. Müll.) Par.)

A large *Dicranum*-like species, which is widely distributed in all African mountains and the Andes. It is mainly a subalpine species and characteristic for the forest floor in *Erica* forests, but is found also at lower altitudes in open habitats, such as rocky, open slopes.

Conspicuously it has not been found in Mt. Karisimbi. In the subalpine belt, it seems to be always associated with *Erica* forests, which are lacking on Mt. Karisimbi with the exception of a small spot.
KB: 132, *Frahm 6929, 6935, 6945*, Campylopodes Centrali-Africanae 16.;*Pócs 7101;* 147, *Frahm 7740;* 149, *Frahm 7581*, Campylopodes Exsiccatae 168; 150, *Frahm 7758.* **Ny:** 104, *Frahm 6208;* 106: *Frahm 6228, 6271.*, Campylopodes Centrali-Africanae 15; 107, *Frahm 6304.*.

**Campylopus johannis-meyeri* (C.Müll.) Kindb.
A species known from the higher elevations in Tanzania, Kenia, East Zaire and Cameroon is reported here as new for Mt. Kahuzi-Biega. It is a closely related to *C. pilifer*, but without dorsal lamellae at the costa. It has been found on soil at 2900 m altitude.
KB: 145, *Frahm 7556*, Campylopodes Centrali-Africanae 20.

Campylopus kivuensis P. Varde & Thér.
This species is known only from the type locality, Mt. Nyragongo in Zaire, and one very doubtful additional record, which cannot be located. At the type locality, it grows in large masses in the summit region above 3000 m, which is affected by the recent eruptions, and in smaller quantity below, even epiphytic.
Campylopus kivuensis is probably a modification of *C. johannis-meyeri*. The general structure of the leaves is the same. *Campylopus kivuensis* differs only by larger plants, longer leaves and longer upper laminal cells, all gradual differences which are interpreted as caused by the high humidity in the cloud region of Mt. Nyragongo. Zaire Prov. Kivu, volcan Nyragongo**:** *Frahm s.n.*, Campylopodes Centrali-Africanae 25; *Frahm 9007;* on tree 2800 m, *Frahm 9008*; around fumaroles in 2800 m, *Frahm 9009, 9010.*.

**Campylopus nanophyllus* C.Müll. ex Broth.
This species is widely distributed through tropical Africa, but not yet recorded from Central Africa. It grows in small tufts on soil covered rocks and soil in dry habitats.
Ak: 170, *Frahm 8361, 8368.*

Campylopus nivalis (Brid.) Brid.
A species of the subalpine and alpine belt of South and Central America and Africa is reported from all mountains in Central Africa. It grows on all kinds of substrates but has been found during the BRYOTROP expedition mainly epiphytic on trunks of giant Senecios, where it has been found often with sporophytes. On Mt. Karisimbi it reaches up to the summit in 4500 m. The specimens from the alpine belt have luxuriant growth in extensive tufts several cm high. These forms show conspicuously long leaf tips. On Mt. Biega and Mt. Kahuzi the plants are distinctly smaller and the species is less frequent. *Campylopus nivalis* shows considerable variation concerning the size of the plants (0.5 to 8 cm), length of the leaves and shape of the upper laminal cells. Apparently, the length-width ratio of the upper laminal cells is higher in plants with longer leaves. Rarely specimens with falcate leaves have been found (e.g. *Frahm 8272).*
KB: 131, *Frahm 6946;* 147, *Frahm 7739;* 148, *Frahm 7768, 7789, 7733;* 149, *Frey & Kürschner 7422., 7427., 7437.* **Ka:** 147, *Frahm 7708,* Campylopodes Centrali-Africanae 21; 148, *Frahm 7704*; 158, *Frahm 8116; 161*, Frahm 8143; 162, *Frahm 8100, 8162, 8255, 8357*, Campylopodes Centrali-Africanae 13; 163: *Frahm 8354*, 8356, *8359*; 164: *Frahm 8355*; 165, *Frahm 8353*, Campylopodes Centrali-Africanae Exsiccatae 12; 159: *Frahm 8072, 8272;* 160: *Frahm 7550*, Campylopodes Exsiccatae 171, 172; 167, *Frahm 8219., 8337.*

Campylopus obrutus Thér. & P. Varde
It is a member of the subgenus *Thysanomitrion* with low and evenly foliate stems and conspicuously broadly lanceolate, obtusely pointed leaves and narrow costa. The range is identical with the equatorial rainforest in Africa from Guinea to Nigeria, Cameroon, Gabon and Zaire and accordingly, it occurs at lower altitudes and has been found on the area of the Irangi field station at 850 m altitude, which is comparable low for this genus. *Frahm 7978* has sporophytes, which are found rarely but allow to recognize this species as a member of the subgenus *Thysanomitrion*. Whereas the leaves on sterile plants are broadly lanceolate and blunt with a short excurrent mucro, the perichaetial leaves

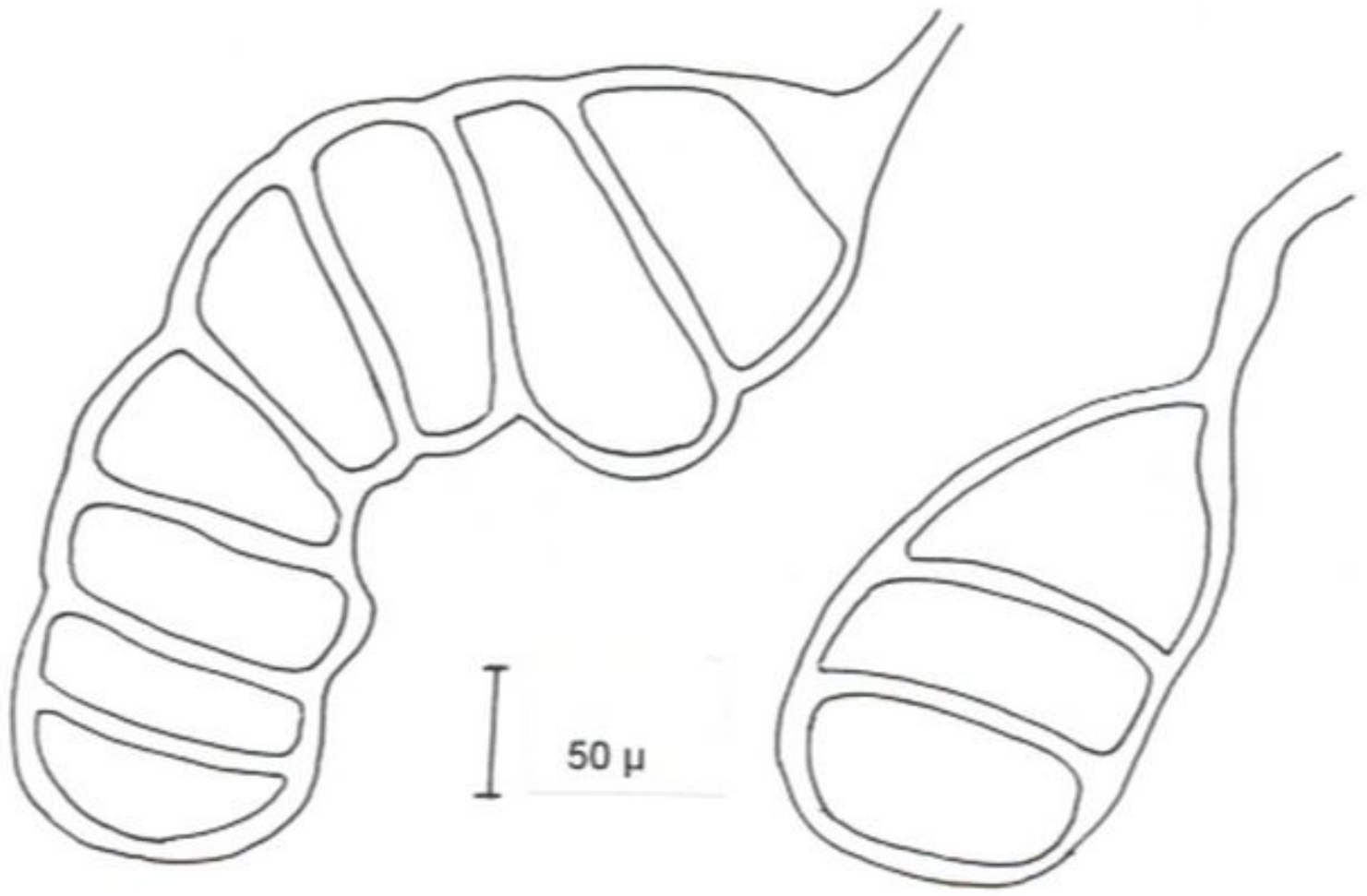

Fig. 1. Rhizoid gemmae of *Campylopus perichaetialis* P. Varde & Thér. (*De Sloover 892*, hb. Frahm)

perpusillus but have oval to elongate oval upper laminal cells and not subquadrate to shortly rectangular cells.
KB: 127, *Frahm 6649,* Campylopodes Centrali-Africanae Exsiccatae 8. **Ny:** 154: *Frahm 7978., 7979.*

Campylopus paludicola Broth. in Mildbr.
This species has longly pointed, serrate leaves and long rectangular upper laminal cells, typical for swamp habitats and known from Malawi, Tanzania, Kenya, Rwanda and Zaire. *Frahm 6281* has sporophytes, which were known previously once. The setae are 10-15 mm and conspicuously long for this genus. The species is typical of swamps, where it grows on peaty soil, but has also been found on wet soil covered rocks.
KB: 129, *Frahm 7056, 7344*, Campylopodes Centrali-Africanae Exsiccatae 6, *Frahm 7343*, Campylopodes Exsiccatae 169. **Ny:** 102, *Frahm 6095;* 106, *Frahm 66280, 281;* 107, *Frahm 6272,* Campylopodes Centrali-Africanae 23, 115: *Frahm 6510.* **Ka:** 164, *Pócs 8118* det. Ochyra.

Campylopus perichaetialis P. Varde & Thér.
I grows onn soil and trees. In the Kahuzi-Biega Park, it has been found typically and consistently on trunks of *Agaurea salicifolia* in large quantities. It ranges from 2-3000 m altitude.
KB: 131, *Frahm 6934;* 132, *Frahm 6936*, Campylopodes Exsiccatae 175, 155, *Frahm 7959*, Campylopodes Centrali-Africanae Exsiccatae 7. **Ny:** 103: *Pócs 6186;* 107, *Frahm 6270*, Campylopodes Centrali-Africanae 28; *Frahm 9018,9019,9020, 9021;* 111: *Frahm 7972.*; 112, *Frey & Kürschner 7945.*
During examination of herbarium material, rhizoid gemmae have been found in *de Sloover 892* (fig. 1), which is the first record of rhizoid gemmae in a *Campylopus* species from Africa. *Campylopus perichaetialis* is very similar to *C. hildebrandtii (C. leucochlorus)* and differs only-

During examination of herbarium material, rhizoid gemmae have been found in *de Sloover 892* (fig. 1), which is the first record of rhizoid gemmae in a *Campylopus* species from Africa. *Campylopus perichaetialis* is very similar to *C. hildebrandtii (C. leucochlorus)* and differs only by the smaller plants, longer upper laminal cells and the transverse section of the costa without dorsal stereid groups. These characters are very variable and intergradations seem to occur concerning intermediate transverse sections of the costa and combinations of short upper laminal cells with transverse sections of the costa without stereids. Therefore it may be that *C. perichaetialis* is conspecific with *C. hildebrandtii.* Also see comments under *C. hildebrandtii*. . Both species show conspicuous long sheathing perichaetial leaves. Potier de la Varde and Thériot in the type description compare it with the perichaetial leaves of the genus *Pilopogon* ("... , feuilles périchétiales ayant à peu près la disposoition de celles d´un *Pilopogon*"). Since *C. perichaetialis* corresponds with the subantarctic *C. subnitens* in all characters except for the marginal parts of the transverse section of the costa, it may have been derived from the latter by spreading northwards into the African mountains, where it occupied ecological niches on humid, humic or peaty soil in high montane to subalpine forests, similar to *C. subnitens* in subantarctic heathland. *Campylopus hildebrandtii* may have originated relatively recently by adapting to epiphytism, forming stereid groups in the costa, and developing shorter laminal cells.

Campylopus pilifer Brid.
This species grows on open rocks with a wide ecological and altitudinal amplitude. It is a pioneer on young lava flows and ash (e.g. around Mt. Kinamura in Zaire), where this is the only bryophyte species on the two year old ash from the eruption of 1989. It forms pure mats in enormous extension. It has also been found growing on asphalt of a roadside (*Frahm 7554*). The worldwide range includes tropical America and Africa, Sri Lanka, as well as southern parts of North America and Europe.
KB: 132, *Frahm 6939;* 144, *Frahm 7554*; Campylopodes Centrali-Africanae 17; 137: *Frahm 6950, 6957*. Campylopodes Exsiccatae 173. **Ka:** 159, *Frahm 8084;* 161, *Frahm 8352*, Campylopodes Centrali-Africanae 18; **Ny:** 101, *Frahm 6088;* 106: *Frahm 6269*, Campylopodes Centrali-Africanae 19; 155, *Frahm 7611*. **XX:** 170, *Frahm 8365, 8396.* Zaire prov. Kivu, volcan Kinamura 25 km N of Goma, *Frahm 9003*; Lavaflow between Tongo and Kalingera, *Frahm 9004*; on lava rocks 18 km N of Goma along road to Rutshuru, *Frahm 9005;* Rwanda: along road between Kibuye and Cyangugu, *Frahm 9006.*

***Campylopus praetermissus* J.-P. Frahm
This species is widely distributed, but very scattered so far in Gabun, Kenya, Tanzania and South Africa, and is recorded here as new to Zaire and Rwanda. It grew in both localities on wet open granitic rocks in 1300 m and 2000 m altitude. *Frahm 6283* and *6284* show very large, inflated red-brown alar cells probably as a result of the habitat, which consists of wet rocks in exposed situation.
KB: 125, *Frahm 6854*, Campylopodes Centrali-Africanae Exsiccatae 2. **Ny:** 106: *Frahm 6283, 6284, 6273*, Campylopodes Centrali-Africanae 26; 108: *Frahm 6334.*.

**Campylopus robillardei* Besch.
It is a species characteristic for dry habitats such as degraded forests or savannahs. It resembles much *C. savannarum* (C. Müll.) Mitt., but is differentiated from the latter by ventral hyalocysts in transverse section of the costa in the lower part of the leaf. It ranges from South Africa to Uganda and is reported here as new to Rwanda and Zaire.
KB: 152, *Frahm 7557, 7570a*. Zaire: prov. Kivu, volcan Kinamura, on lava rocks, *Frahm 9013.* **Ak:** 170, *Frahm 8394.*

Campylopus savannarum (C.Müll.) Mitt.
This species occurs in a wide range of habitats from savannahs to rainforest, but usually at lower altitudes. It has been found around the Irangi field station at 850 m on a grass roof and on rotten wood. The specimen from Nyungwe Forest at 2300 m elevation is depauperate. *Campylopus savannarum* varies considerably, especially in size, and has been described from

Africa under 22 different names. It forms a natural group of species with *C. hensii* and *C. robillardei*. The first is a larger species with longer leaves serrate down to the middle of the leaf and is confined to lowland and submontane rain forests. The latter differs only by ventral hyalocysts in transverse section of the costa and therefore seems to be an geographical and ecological vicariant species in southern latitudes and in higher elevations.
KB: 119, *Frahm 6605;* 127, *Frahm 6651*. **Ny:** 106, *Frahm 6229;* 116, *Frahm 6548*, Campylopodes Exsiccatae 170; 111, *Frahm 6427*; 154, *Frahm 7962*, Campylopodes Centrali-Africanae Exsiccatae 5;*7975*. **Ki:** 116, *Frahm 6518*.

**Campylopus schmidii (*C. Müll.) Jaeg. (*C. aureus* Bosch & Lac.)
This is a primarily SE-Asian species (from India to Hawaii), which is also known from all East African Islands. It has been found for the first time in continental Africa, which is a remarkable extension of its range.
Campylopus schmidii is regarded as vicariant species of *C. pilifer*. As *C. pilifer*, it occupies the same habitats and is a characteristic pioneer species on lava flows (e.g. in Hawaii, Reunion). It differs from the latter mainly only in the lack of dorsal lamellae on the costa. The ranges of both species previously overlapped only on the island of Reunion.
On Mt. Kahuzi, *C. schmidii* was found on soil in low heath vegetation on a ridge at 2800 m elevation. *Campylopus pilifer* occurs in the same area but is confined to rocks and does not compete with *C. schmidii*.
Campylopus schmidii has also been found in California, probably spread from the Hawaiian population, and seems to extend its range also in Africa.
KB: 145: *Frahm 7553*, Campylopodes Centrali-Africanae 22.

Microcampylopus (C. Müll.) Fleisch.
For worldwide monograph see Giese & Frahm (1985).

Microcampylopus laevigatus (Thér.) Giese & J.-P. Frahm (*Campylopodium laevigatum* Thér., *Campylopodium euphorocladum* var. *laevigatum* (Thér.) Luis., *Microcampylopus longifolius* Nog.)
This species is disjunct between Africa and SE-Asia. In the African region it has been described from Madagascar and has been additionally found in Central Africa in Burundi, Rwanda and Uganda. It grows on open acidic soil along roads, in disturbed sites like quarries, or on soil covered rocks along road cuts. The many records from Rwanda are all situated along the road Butare - Cyangugu, where the species is very frequent.
Ny: 105, *Frahm 6210;* 106: *Frahm 6230;* 111, *Frahm 6425;* 154, *Frahm 6365;* 156, *Frahm 7961*, Campylopodioideae Exsiccatae 2; *Frahm 7984*, *7987*, *7989*, *9000*.

Pilopogon Brid.
for worldwide monograph see Frahm (1983)

P. africanus Broth. in Mildbr. (figs. 2-3)
This is the only representative of this genus in Africa, which has been found so far in Central Africa (around Lake Kivu in Zaire, only on Mt. Kahuzi, in Rwanda and Burundi), in Tanzania and Kenya, and disjunct on Mt. Cameroon. It is typical for roadside cuts, where it can cover large areas, and disturbed, gravelly or sandy soil along roads, trails, and open slopes. Thus its frequency has been stimulated by human influence, especially road construction. It is frequently found with sporophytes and can be distinguished from species of *Campylopus*, which are vegetatively identical, by the long perichaetial leaves, the straight setae and the long cylindric, upright capsule.
Ny: 101, *Frahm 6086;* 102: *Frahm 6086*, Campylopodioideae Exsiccatae 4; *Frahm 9001*; *Frahm 6046;* 106, *Frahm 6287*; 105, *Frahm 6219;* 156, *Frahm 7973*, *7991*, *7992*. 157, *Frahm 8006*. **KB:** 138, *Frahm 7014*; 151: *Frahm 7702*.; 150, *Frahm 7774;* 151, *Frahm 7709*. **Ka:** 159, *Frahm 8269*; 161, *Frahm 8079*, *8350*. 163, *Frahm 8246*. Zaire, Volcan Nyragongo, *Frahm 9007*.

Paraleucobryoideae

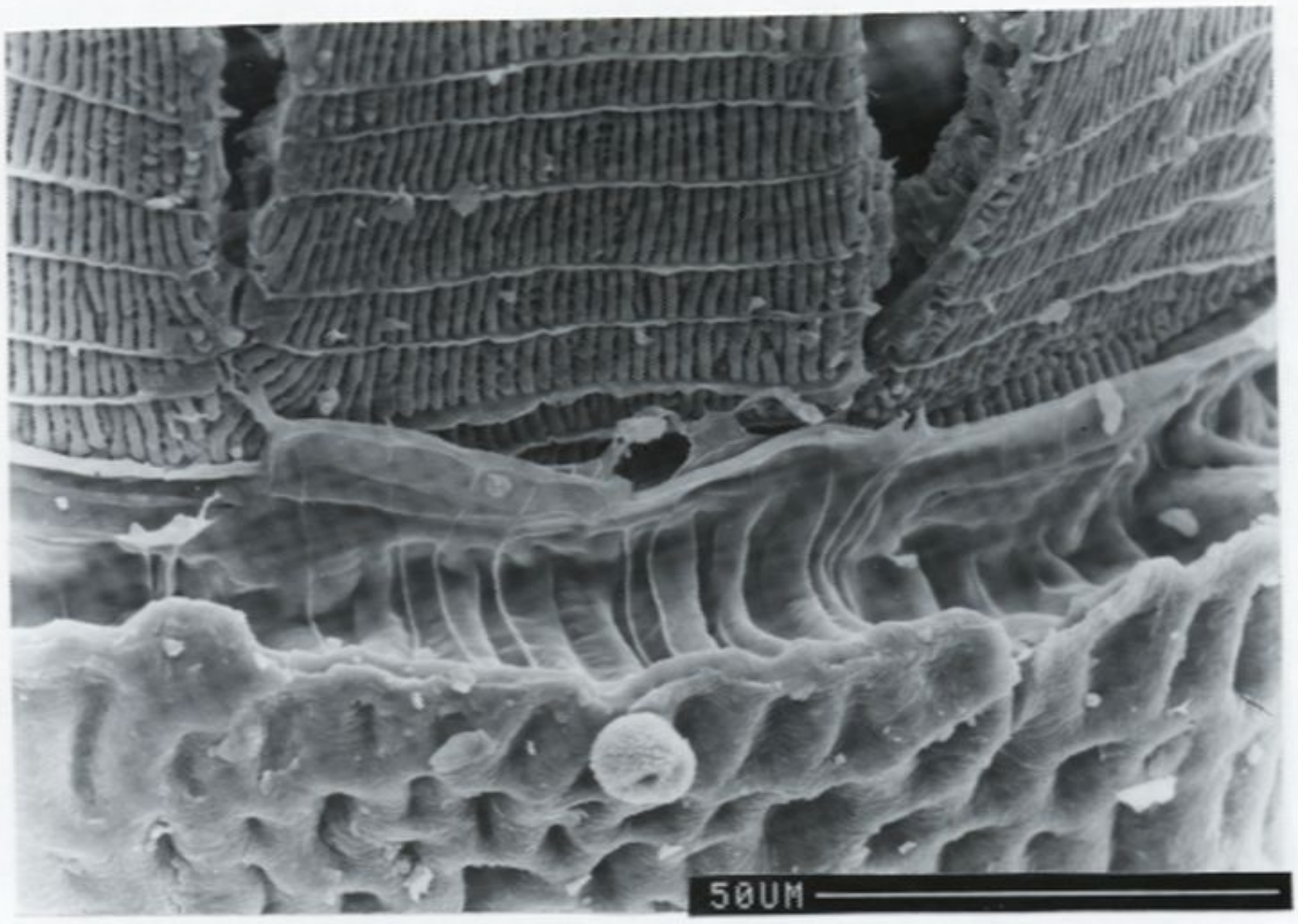

Fig. 2. *Pilopogon africanus*, SEM photograph of the upper part of capsule (*after Frahm 6086*).

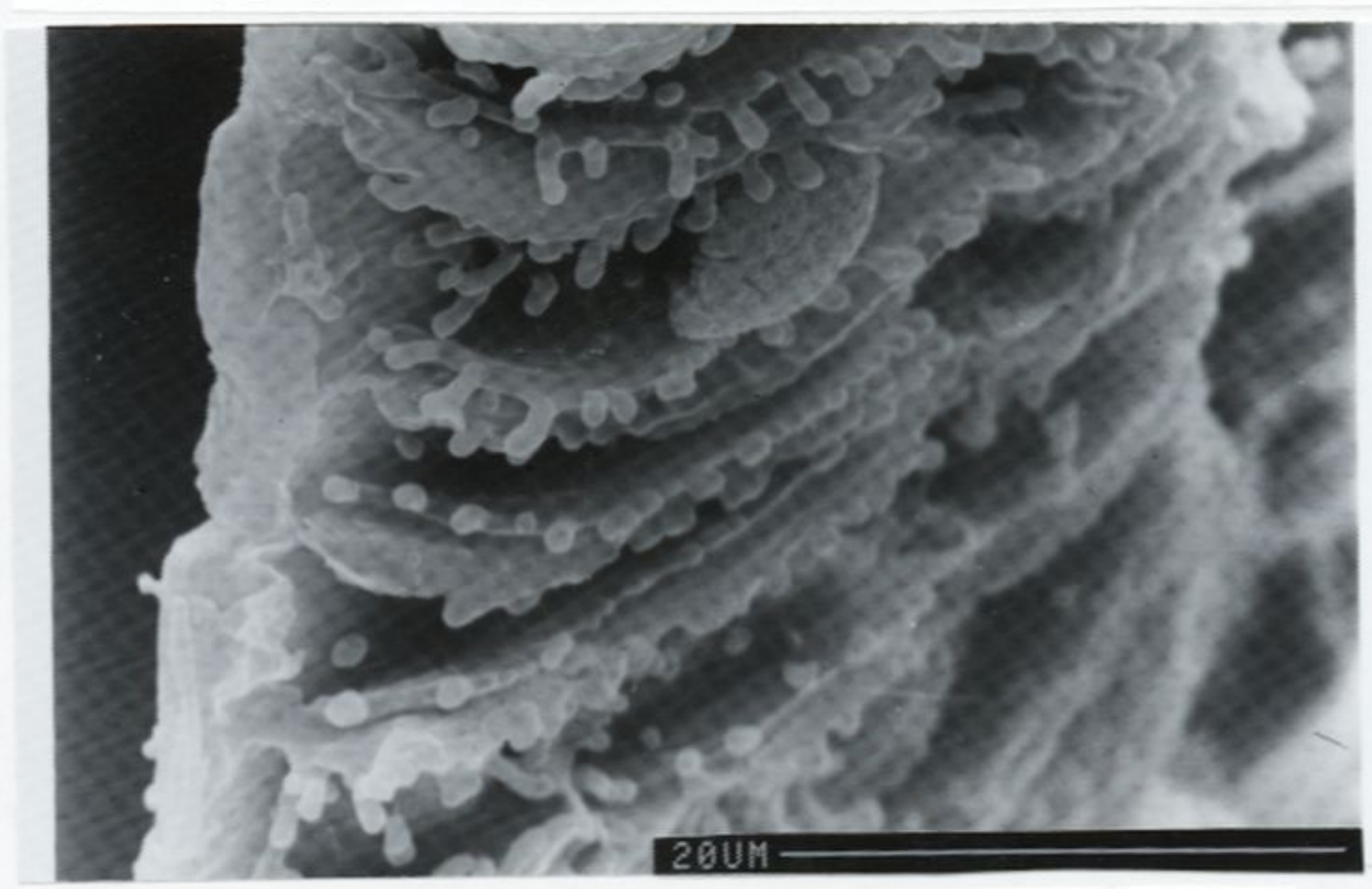

Fig. 3. *Pilopogon africanus*, adaxial side of peristome tooth (after *Frahm 8086*).

Paraleucobryum (Limpr.) Loeske

Paraleucobryum longifolium (Hedw.) Loeske ssp. *brasiliense* (Broth.) P.Müller & J.-P. Frahm
This is a sensational new record for Africa of the boreo-montane genus. It has been found with sporophytes at the summit region of Mt. Kahuzi on stem of *Senecio* between 3200 and 3300 m elevation.
The genus is known by three species mainly from the northern hemisphere (North America, Eurasia, Müller & Frahm 1987). *Paraleucobryum enerve* grows south to Mexico. From the southern hemisphere, *Paraleucobryum brasiliense* has been described from the Sierra do Itatiaia in SE-Brazil, where it has been collected recently growing as an epiphyte in the subalpine belt on *Drymis*. Because of strong structural affinities with the northern hemispheric *P. longifolium*, this species was combined as subspecies with the latter. The African specimen was found in a comparable habitat, also epiphytic in the subalpine region, but in equatorial latitudes. It resembles fully the brazilian plants with (in contrast to *P. longifolium* ssp. *longifolium*) longer, strongly hamate leaves and a broader costa. This taxon might have been overlooked in Africa, because of its strong resemblence to *Dicranum johnstonii* (even in fruiting condition), from which it can be distinguished only microscopically.
KB: 149, *Pócs 7717.*

Rhabdoweisioideae

Oreoweisia (B.S.G.) De Not.

O. erosa (C. Müll.) Kindb.
KB: 137, *Pócs 7263;* 146, *Pócs 7595*, det. Sollman.

Rhabdoweisia B.S.G.

**Rhabdoweisia africana* Dix. & Nav.
This species, previously recorded only from the type locality at Mt. Ruwenzori, Mt. Elgon and Kilimanjaro, was collected at Mt. Kahuzi, where it was found under a rock overhang at 3200 m. The specimen agrees well with the illustration of the type specimen and the peristome and description of the spore size in De Sloover (1973).
KB: 148, *Pócs 7875.*

Rhabdoweisia lineata Rich. & Arg.
This species resembles *R. fugax*, which is recorded for South but not from Central Africa. According to De Sloover (1973), it differs from *R. fugax by* the more regularly, longitudinally striate peristome teeth and verrucose, somewhat larger spores.
KB: 137: *Pócs 7260,* on vertical rocks.

BATRAMIACEAE

Bartramia Hedw.

Bartramia afro-ithyphylla Broth.
This species was found growing on soil in subalpine forests, on Mt. Kahuzi between 3000 and 3200 m and (more frequent) at Mt. Karisimbi between 3100 and 3300m.
Ka: 159, *Pócs 8181, Frahm 8099;* 161, *Frahm 8344;* 162, *Pócs 8293;* **KB:** 148, *Frahm 7692.*

Bartramia ruwenzoriensis Broth.
On rock overhang above elfin-forest in 3200 m elevation.
KB: 148, *Pócs 7865.*

Breutelia (B.S.G.) Schimp.
For a key to the African species see De Sloover (1975a).

Breutelia diffracta Mitt.
It is usually found together with *B. stuhlmannii* and in similar quantities. Both species seem to be the only representatives of the genus in the Kahuzi-Biega area. Other species are found in Central Africa only in the Virunga volcanoes.
KB: 132, *Frahm 6944, Frey & Kürschner 6894.*
Ka: 162, *Pócs 8093.*

Breutelia humbertii P. Varde & Thér.
It is a small species previously known only from volcan Muhavura and recorded here as new to Mt. Karisimbi. It was found on soil in the upper

Senecio-paramo and the alpine belt between 3900 and 4400 m.
Ka: 163, *Frahm 8154;* 164, *Pócs 8211, Frahm 8335.*

Breutelia stuhlmannii Broth.
With *B. diffracta* this is the most common species of the genus in the region. On Mt. Biega and Mt. Kahuzi, it has been found in the summit region above 2600 m, where it covers soil in the *Erica*-belt in large masses and occurs also on open rocks and cliffs. On Mt. Karisimbi it is comparably rare. On this mountain, a layer of terrestrial bryophytes consisting of *Breutelia, Sphagnum* or *Campylopus* species, as typical for the subalpine belt of other mountains is mostly lacking, perhaps due to a higher nutrients contents of the volcanic substrate. Only one restricted area with *Erica* vegetation has been found by Dr. Fischer with the typical bryophyte inventory as known from Mt. Kahuzi-Biega. In the forest belt, it is found only on open rocks of roadside cuts or in open heath forests.
Ka: 162, *Pócs 8093*; 163, *Pócs 8275*; 166, *Fischer 8062;* **KB:** 132, *Frahm 6925, Frey & Kürschner 6893;* 145, *Pócs 7814.*
Ny: 106, *Frahm 6274*

Leiomela (Brid.) Broth.

Leiomela africana Thér. & Nav.
This species was collected at the stem of *Cyathea*, which seems to be a typical habitat, since all records cited by De Sloover (1975b) were from the same substrate.
Ny: 111, *Frahm 6424.*

Philonotis Brid.

For a treatment of this genus, see the contribution by R. Ochyra in this volume (Taxonomic Results of the BRYOTROP Expedition to Zaire and Rwanda 20. Grimmiaceae, Funariaceae, Bartramiaceae (Philonotis), Amblystegiaceae, Plagiotheciaceae, Tropical Bryology 8: 181-187, 1993)

RHIZOGONIACEAE

Pyrrhobryum Mitt.

Pyrrhobryum pyriforme (Hedw.) Mitt.
(Rhizogonium spiniforme (Hedw.) Bruch)
The genus has its main distribution in Australasia and tropical America. *Rhizogonium spiniforme* is the only species of the genus in Central Africa and has a pantropical distribution. It is found nearly always with sporophytes, preferably on rotten wood, but also on humic soil and rarely as true epiphyte on horizontal branches. The altitudinal distribution ranges from 1300 to 2500 m.
KB: 124, *Frey & Kürschner 6681;* 126, *Pócs 6827*; *Frey & Kürschner 6690* ;130, *Pócs 7094*, 139, *Pócs 7291*; 145, *Frey & Kürschner 7499.*
Ny: 107, *Frahm 6298*, 108, *Frahm 6347*, 112, *Frahm 6449.*

RHACOCARPACEAE

Rhacocarpus Lindb.

Rhacocarpus purpurascens (Brid.) Par.
Found only on Mt. Kahuzi on open cliffs from 2800 m to the summit region, often in not accessible places. It is apparently lacking on Mt. Karisimbi because of the basic nature of the rocks.
KB: 144, *Frahm 7718 c. spor.* , 148, *Pócs 7751*.

HEDWIGIACEAE

Hedwigidium B.S.G.

Hedwigidium integrifolium (P. Beauv.) Dix.
Like the foregoing species, this species is found only at Mt. Kahuzi and also Mt. Biega on open cliffs in 2600 - 2800 m elevation.
KB: 137, *Frahm 6951*, 145: *Pócs 7766.*

Hedwigia P. Beauv.

Hedwigia ciliata (Hedw.) P. Beauv.
This specimen was found twice in Rwanda and Zaire, always on pavements of asphalt roads and not in natural habitats.
Ny: 104, *Frahm 6207*. **KB:** 144, *Frahm7672.*

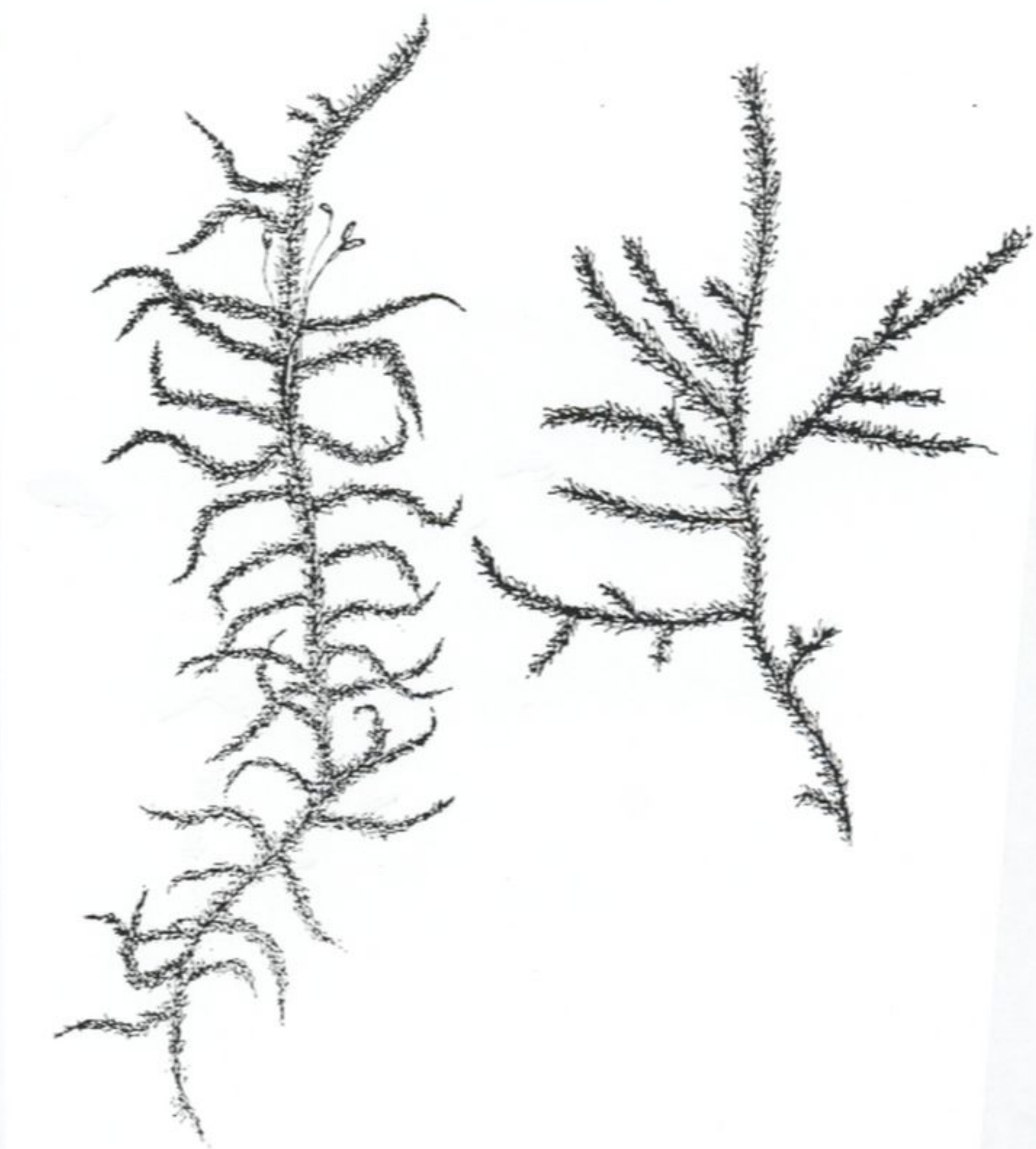

Fig. 4. Habit of *Antitrichia kilimandscharica* (left, after *Pócs 8176* from Mt. Karisimbi) and A. *curtipendula* (right, after *Wigger s.n.* from Portugal, hb. Frahm).

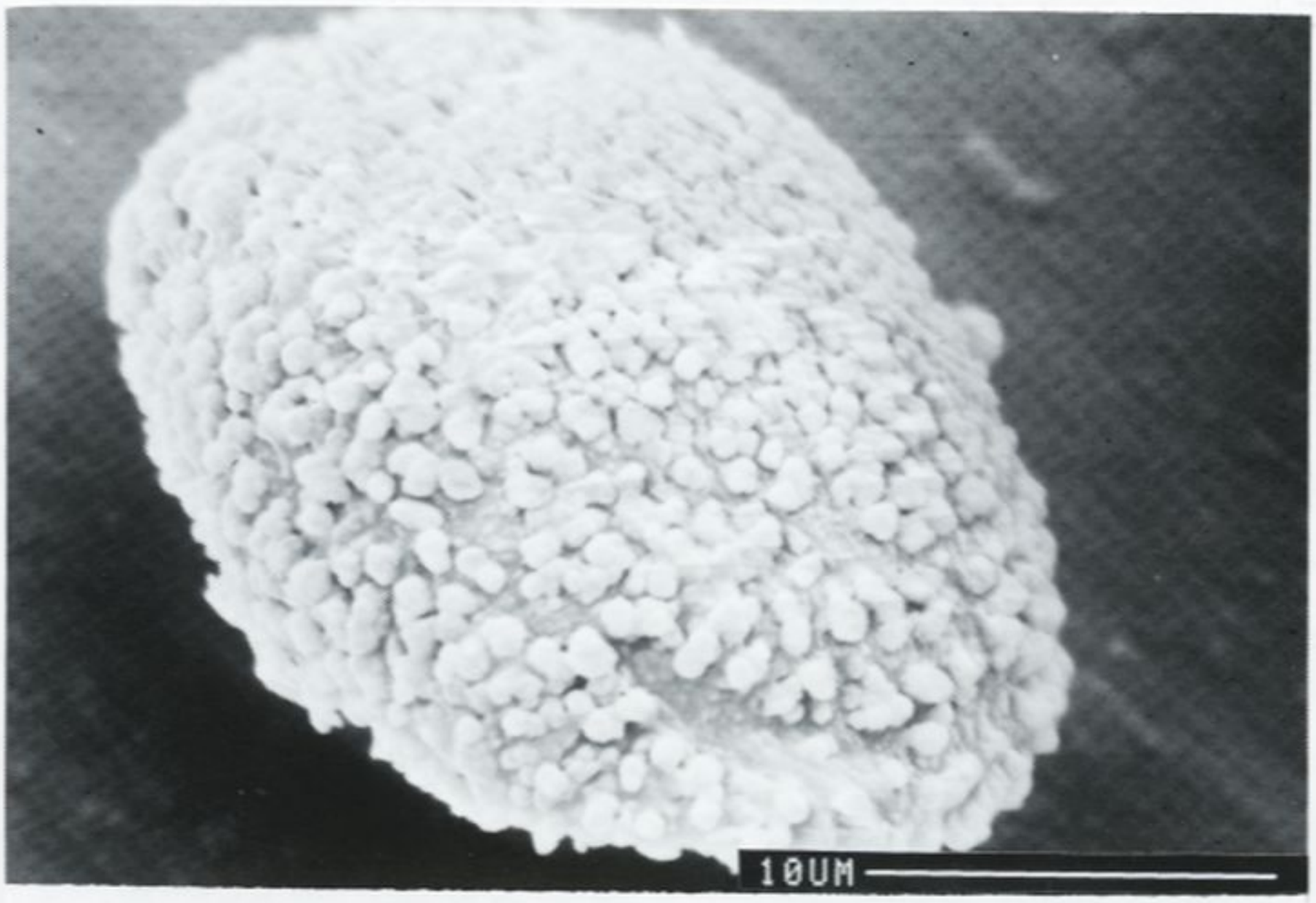

Fig. 5. SEM photograph of spore of *Antitrichia kilimandscharica* (*Pócs 8176,* hb. Frahm).

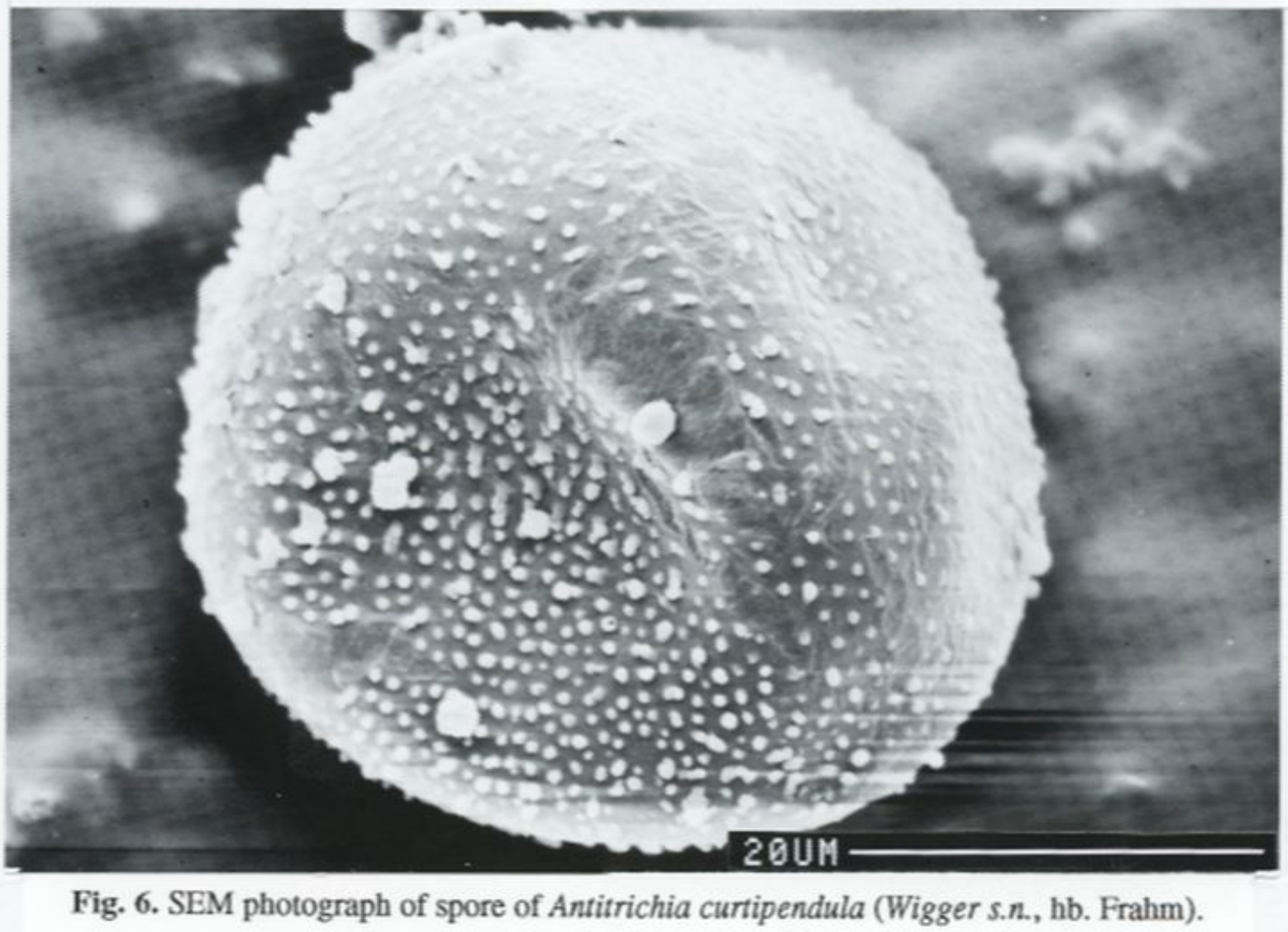

Fig. 6. SEM photograph of spore of *Antitrichia curtipendula* (*Wigger s.n.*, hb. Frahm).

CRYPHAEACEAE

Schoenobryum Dozy & Molk. (*Acrocryphaea* B.S.G. ex Broth.)

Schoenobryum robustum (Broth.) J.-P. Frahm, *comb. nov.*
Acrocryphaea robusta Broth. in Mildbr., Deutsch. Zentr. Afr. Exp. 1907-08,2: 158.
This species is corticolous and was found between 2200 - 2500 m.
Ny: 102, *Pócs 6076*. **KB:** 118: *Pócs 6576.*

LEUCODONTACEAE

Antitrichia Brid.

Antitrichia kilimandscharica Broth.
Except for *A. abyssinica* Schimp., which is a *nomen nudum*, this species is the only representative of the genus in tropical Africa. The species was described by Brotherus (1897) as *A. kilimandscharica*, but later placed into synonymy of *A. curtipendula* by Negri (1909). However, in contrast to European and North American material, the African population has a conspicuously different appearence in the field: The plants are regularly pinnate and the branches are smaller than the stem, flagelliform, and curved downwards (fig. 4). In addition, the side nerves of the costa in the leaves are weaker in African specimens (but not lacking as described by Brotherus 1925). These characters, regularly pinnate plants and weak side nerves, resemble *A. californica* Sull. This typical appearence did not change after transplantation into the Vosges Mts., France, where a specimen collected in 3700 m on Mt. Karisimbi was mounted in 650 m elevation on a branch of *Sambucus nigra*. (Both localities are roughly comparable. There is a mean annual temperature in the Vosges Mnts. at 650 m altitude of ca. 6°C and ca. 1800 mm annual precipitation and 7.8° mean annual temperature on Mt. Karisimbi at 3700 m. The precipitation is not known). Furthermore, spore size and spore ornamentation of both species are different. In European material of *A. curtipendula*, the spore diameter is 35-37 µm according to the author´s measurements, and 34-36 µm according to Smith (1978). In African material (*Pócs 8176*), the spore size is quite variable, 25-33 µm, but generally smaller. In addition, SEM studies proved that spores of *A. curtipendula* are nearly smooth, whereas they are warty in *A. kilimandscharica* (Fig. 5-6). This leads to the conclusion that the African specimens should be recognized as separate species and not placed into synonymy of *A. curtipendula.*
The species has been found during the BRYOTROP expedition only on Mt. Karisimbi, and had previously been found in Central Africa only on the Virunga volcanoes and Mt. Ruwenzori (cf. De Sloover 1976). It seems to be absent on the western side of the African rift valley in the Kahuzi-Biega area, which is surprising, since this species has been found often with sporophytes and the Kahuzi-Biega area is situated just across Lake Kivu, 120 km arial distance, and has comparable habitats on top of Mt. Kahuzi.
KA: 161, *Pócs 8176*, 162, *Frahm 8110*, 164, *Pócs 8 213*;.

Leucodon Schwaegr.

Leucodon maritimus (Hook.) Wijk & Marg. (*Leucodon assimilis* (C. Müll.) Jaeg.)

This is the only species of *Leucodon* which is reported from Central-Africa. According to Brotherus (1924-25), it has non-plicate leaves and grows on trees. Our specimen, however, has plicate leaves and grew on rock. In general, it is similar to a specimen of *L. sciuroides*, but sporophytes are lacking to confirm this identity.
KA: 168: *Frahm 8233.*

I like to thank C. LaFarge-England for correcting the English text, T. Pócs for nomenclatural and distributional remarks and Mrs. B. Marker for drawing of fig. 4. R. Ochyra and Ph. Sollman contributed additional identifications.

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