

## SUBGENUS *FISSIDENS* IN TROPICAL EASTERN AFRICA WITH EMPHASIS ON THE TANZANIAN COLLECTIONS BY TAMÁS PÓCS

MARIA ALIDA BRUGGEMAN-NANNENGA

**Abstract.** Illustrated revision of *Fissidens* subgenus *Fissidens* in tropical eastern Africa. *Fissidens artsii* Brugg.-Nann. is newly reported from Kenya, Tanzania and Uganda; *F. gomae* P. de la Varde & J.-F. Leroy to Uganda and *F. leucocinctus* Hampe to Angola; *F. magnicellulatus* Brugg.-Nann., *F. pachylomadelpus* Demaret & P. de la Varde, *F. robynsonianus* P. de la Varde, *F. roteteaui* P. de la Varde and *F. taylorii* Müll. Hal. are new to Tanzania. The last is also new for Africa. The following taxonomic changes are proposed: *Fissidens androgynus* Bruch in Krauss (*F. simensis* Schimp. ex Müll. Hal., *syn. nov.*, *F. longipes* Welw. & Duby, *syn. nov.*, *F. subremotifolius* Müll. Hal., *syn. nov.*, *F. gueinzii* Müll. Hal., *syn. nov.*, *F. malaco-bryoides* Müll. Hal., *syn. nov.*, *F. obsoletidens* Müll. Hal. var. *schistophila* Broth., *syn. nov.*, *F. platybryoides* Müll. Hal. var. *subimmarginatus* Dixon, *syn. nov.*, *F. crateris* Dixon, *syn. nov.*, *F. crateris* Dixon var. *sererekae* Dixon, *syn. nov.*), *Fissidens crispus* Mont. (*F. hoeegii* P. de la Varde *syn. nov.* and *F. cataractarum* Demaret & P. de la Varde, *syn. nov.*). Reinstatements: *F. pachylomadelpus* Demaret & P. de la Varde and *F. roteteaui* P. de la Varde (confirmed synonym *Fissidens schelpei* P. de la Varde).

**Key words:** Musci, *Fissidens* subgenus *Fissidens*, East Tropical Africa, Tanzania, taxonomy, distribution

Maria Alida Bruggeman-Nannenga, Griffensteijnseplein 23, NL 3703 BE Zeist, The Netherlands

### INTRODUCTION

Tanzania, particularly the Eastern Arc Mountains, is one of the bryologically best known areas in tropical Africa. This is for a large part due to Dr. Tamás Pócs who has collected there for many years and attracted many colleagues to join him. The detailed data on his labels greatly augment our knowledge of the habitats and substrates preferred by each species. The present paper treats the East African species of *Fissidens* subgenus *Fissidens*. It is based mainly on the Tanzanian collections by Dr. Tamás Pócs since 1986. His earlier collections were treated by Bizot. Some Tanzanian collections by other bryologists notably Dr. Cliff Townsend are also included. Earlier collections of East African *Fissidens* have been treated in several publications. For example Bizot *et al.* (1976, 1978, 1979), Kis (1985), Bruggeman-Nannenga (1993, 1997, 1999, 2005, 2006a, b, 2009), Bruggeman-Nannenga and Arts (2010), Bruggeman-Nannenga and Pursell (1995), O'Shea *et al.* (2001, 2003), O'Shea (2006) and Chuah-Petiot (2003). Kis (1985) listed all species then known from South-east tropical Africa with references, distribution

and where possible geographical details. O'Shea (2006) compiled a checklist of the mosses of sub-Saharan Africa with synonyms, distributions and references. Kis (1985) listed 30 subgenus *Fissidens* taxa from south-east tropical Africa including 24 from Tanzania. Since then several *Fissidens* species have been added to the Tanzanian Flora (Bruggeman-Nannenga 2009, 2013a, b) and a number of new synonyms have been proposed (Bruggeman-Nannenga 1993, 1997; Bruggeman-Nannenga & Pursell 1995; Shevock *et al.* (2013). As a result only 10 of the 24 species cited by Kis (1985) are maintained for the Tanzanian Flora, some under a different name. In addition 6 new Tanzanian indigenes, viz. *F. artsii* Brugg.-Nann. (also new to Kenya and Uganda), *F. magnicellulatus* Brugg.-Nann., *F. pachylomadelpus* Demaret & P. de la Varde, *F. robynsonianus* P. de la Varde, *F. roteteaui* P. de la Varde and *F. taylorii* Müll. Hal. are reported. The last is new for Africa under this name. Two species in Kis' list, *F. linearilimbatus* Müll. Hal. and *F. menyhartii* Müll. Hal. are excluded because the types could not be located.

The cosmopolitan subgenus *Fissidens* and subgenus *Pachyfissidens* sect. *Pachyfissidens* are relatively well represented in areas with a temperate climate and at high altitudes. Thus almost all European *Fissidens* species belong either to subgenus *Fissidens* or subgenus *Pachyfissidens* sect. *Pachyfissidens*, whereas only two European species (*F. exilis* Hedw. and *F. celticus* Paton) belong in the mainly tropical subgenus *Aloma*. In tropical Eastern Africa subgenus *Fissidens* occurs from sea-level to 3870 m. Above 2700 m it is both in species and number of specimens probably the best represented subgenus of *Fissidens*. Two species, *F. artsii* and *F. acrophilus* Brugg.-Nann., are restricted to high altitudes, whereas *F. robynsianus* seems to prefer them.

Most subgenus *Fissidens* species are mesophilous, hygrophilous or hydrophilous. The subgenus is found in a large variety of habitats. Four of the species included here (*F. leucocinctus*, *F. pachylomadelpus*, *F. robynsianus* and *F. obscurifrons* Brugg.-Nann.) grow on rocks in rivers or in the spray of waterfalls or other places that are subject to occasional or frequent inundation. Most species grow on soil, rocks or wood. Some are occasionally found on termite mounds, but none of the species included in this paper is restricted to this habitat, nor is any one of them exclusively corticolous.

In tropical eastern Africa subgenus *Fissidens* is represented by 18 species. Four of these, viz. *F. beckettii* Mitt., *F. crispus*, *F. curvatus* and *F. taylorii* are pantropical. The remaining 14 species are African endemics. All but one, *F. acrophilus* Brugg.-Nann., of the species included in this paper are known from Tanzania.

#### SOME MORPHOLOGICAL NOTES

The adaxial (towards the stem) part of the *Fissidens* leaf consists of the vaginant and apical (ventral) lamina. The *vaginant lamina* consists of two lamellae that clasp the stem; the *apical lamina* is the simple part distal of the vaginant lamina; the abaxial *dorsal lamina* stretches from the leaf insertion to the leaf apex. The two lamellae of the vaginant lamina can be equal, subequal or

unequal in size and shape. (Sub) equal lamellae are distally fused from costa to ( $\pm$ ) the margin. The vaginant lamina is then ( $\pm$ ) closed. Unequal lamellae are distally fused from the costa to some point on the lamina. When the lamellae are fused to a point closer to the margin than to the costa the vaginant lamina is *slightly open*; when the lamellae are fused to a point halfway between costa and margin the vaginant lamina is half open. When the smaller lamella ends at or near the costa the vaginant lamina is (completely) *open*. In most species the vaginant lamina is closed or slightly open. In *F. beckettii*, *F. gladiolus* Mitt., *F. magnicellulatus*, *F. pygmaeus* Hornsch. and *F. rufescens* Hornsch. it is open. When the vaginant lamina is open the distal part of the lesser lamella can be rounded (e.g., *F. asplenioides* Hedw.) or the smaller lamella can taper towards the costa and be acute to slightly rounded (see Fig. 4: 5–7).

#### AXILLARY CELLS AND NODULES

In some *Fissidens* species, notably those of subgenus *Pachyfissidens* sect. *Crispidium*, cortical stem cells in the leaf axils proliferate and form so-called large hyaline nodules (Iwatsuki & Pursell 1980). In many species axillary cells have thinner and paler walls than other cortical cells. This is indicated as ‘axillary cells differentiated’ or, when such thin-walled cells protrude from the stem, as weak axillary nodules or slightly differentiated (see Fig. 6: 13).

#### SOME PATTERNS OF VARIATION

The aim of the following is to help the reader recognize some general patterns of variation found in *Fissidens*. Not recognizing these will result in ‘comparing apples with oranges’ and in finding false overlap between species.

#### LEAVES

Size and shape of the leaves vary along the stem. The leaves that develop first (the basal  $\pm$  3 pairs of both fertile and vegetative stems) are smaller than and morphologically different from leaves that develop later. The latter (the so-called mid leaves)

are similar in size and shape. In vegetative stems mid and upper leaves are similar. In the upper part of perichaetial stems the leaves gradually change culminating in the specialized, imbricate, long perichaetial leaves. Except in very short stems mid leaves of perichaetial stems are more or less similar to those of vegetative stems, though some influence of the perichaetium is often recognizable. For example upper and mid leaves of perichaetial stems often have better developed limbidia than mid leaves of vegetative stems. Another rule is that the degree of development of the limbidium decreases with the distance from the perichaetium. There are, however, a few species (e.g., *F. robynsonianus*) in which there seems to be no relation between border development and distance from the perichaetium. In such species leaves with and without limbidium are arranged erratically along both vegetative and perichaetial stems.

It is important to appreciate these 'rules' when studying and comparing stems. In the present paper the term 'leaves' refers to mid and upper leaves of vegetative stems. When these were not available this is indicated. Some species are known from vegetative or from fertile stems only.

Leaves in subgenus *Fissidens* are typically unistratose, though bistratose stretches can occur particularly alongside the costa, in the corner between costa and upper vaginant lamina and near the insertion of the dorsal lamina (for instance in many hydrophilous species); small, unicellular bistratose dots in the mid apical and dorsal lamina are known from several species. These dots can be as deep as the lamina or protruding from it.

#### STEMS

*Fissidens* species have three kinds of stems. Perichaetial (sporophytic), perigonial and vegetative ones.

#### Perichaetial and vegetative stems

As discussed under 'leaves' the middle part of tall perichaetial stems differs very little from vegetative stems. However, short perichaetial stems with few leaf pairs have only morphological basal leaves and morphological upper and perichaetial

leaves. Thus such short perichaetial stems are different from vegetative stems. This difference is enhanced when the perichaetial stems have close, frondose leaves and the vegetative stems distant, pinnate leaves. Short perichaetial stems that differ markedly from the pinnate vegetative stems are characteristic of a number of species. The best-known example probably is *F. taxifolius* Hedw. Another nice example is *F. pygmaeus* from southern Africa. Examples in the present paper are *F. curvatus* and *F. taylorii*. I indicate this condition as heterocaulous. This term is derived from section *Heterocaulon* (now subsumed under subgenus *Fissidens*) which was created by Müller (1900) for species in which vegetative stems differ more markedly from perichaetial stems than usual. There is no sharp distinction between heterocaulous and non heterocaulous species.

#### Perigonial stems

Perigonial stems and branches can be long or short. In many species they are very short and bud-shaped. Traditionally (and also in this paper), interest in perigonia is limited to their position: free, attached to the stem base of (perichaetial) stems, terminal or lateral and the morphology of perigonial leaves is ignored.

#### LIMBIDIA

Limbidia of the dorsal and apical lamina are marginal in nearly all species; limbidia of the vaginant laminae are frequently intramarginal on the mid and basal part.

#### LAMINAL CELLS

Vaginant laminal cells differ essentially from dorsal and apical laminal cells. In dorsal and apical laminal cells the walls are exposed on both sides of the leaf and may be plane, convex, smooth or papillose. Vaginant laminal cells on the other hand have an exposed abaxial and a sheltered adaxial wall. The exposed walls resemble those of dorsal and apical laminal cells and can be plane, convex, smooth or papillose; the adaxial walls are plane or slightly convex and always smooth. Furthermore, laminal cells are not homogeneous throughout

a leaf. Inner dorsal and apical laminal cells are fairly similar, but nearness to the stem or the costa usually produces larger, more oblong cells with thicker, less ornamented walls. In species with narrow dorsal laminae, e.g. *F. gladiolus*, all inner cells are close to the costa. Marginal cells too tend to be morphologically different from inner cells. Similarly inner vaginant laminal cells often differ from inner dorsal and apical laminal cells. It is essential that only alike cells are compared. In my papers the term 'laminal cells' refers to inner dorsal laminal cells.

### Subgenus *Fissidens* section *Fissidens*

For synonymy see Pursell and Bruggeman-Nannenga (2004).

Subgenus *Fissidens* is characterized by leaves that are limbate on all laminae, smooth, small to medium sized laminal cells and bryoides type costae. The sporophyte has a theca with 40 or more columns of exothecial and a bryoides type peristome (see below). The operculum typically has a short and blunt rostrum.

### VARIABILITY

Subgenus *Fissidens* is gametophytically as well as sporophytically rather constant. Thus almost all species have limbidia on all laminae. In only a few species, for instance *F. taylorii*, *F. rotoreaui*, *F. bogosicus* Müll. Hal. and *F. obscurifrons* in the present paper, the limbidium is or can be restricted to the vaginant lamina.

Species of subgenus *Fissidens* typically have a bryoides type costa which is characterized by 2 large adaxial and 1 or more large central cells (see Fig. 16: 8) and 1 row of 2 large cells distal of the vaginant lamina (see Fig. 10: 11). One of the included species, *F. magnicellulatus*, has anomalous costae, whereas *F. megalotis* Schimp. ex Müll. Hal. subsp. *helictocaulos* (Müll. Hal.) Brugg.-Nann. does have bryoides type costae, but these are asymmetrical. *Fissidens pachylomadelphus* has 1 row of 2–4 large cells distal of the vaginant lamina.

Laminal cells of subgenus *Fissidens* typically have plane or convex, smooth evenly thickened

walls. In some species, however, e.g. *F. megalotis* subsp. *helictocaulos*, *F. rufescens* and *F. artsii* the cell walls are lenticularly thickened (see Fig. 3: 11 and 16: 10).

Further, this paper includes one species, *F. gladiolus*, in which the dorsal and apical lamina can be lacking. Such specimens lack the main characteristics of the family. However, the presence of dorsal and apical laminae in other specimens and the sporophyte make the position of *F. gladiolus* in subgenus *Fissidens* clear.

The sporophyte of subgenus *Fissidens* is rather constant in having a high number (40 or more) of columns of exothecial cells (found in all species in this paper) and a bryoides type peristome (see below). Only a few species (not in tropical east Africa) have anomalous peristomes. Confusion with subgenera other than *Aloma* is unlikely. In addition to gametophytic differences subgenus *Fissidens* and *Aloma* differ in their sporophytes. The subgenus *Aloma* sporophyte differs from the subgenus *Fissidens* sporophyte by the lower number ( $\pm 32$ ) of columns of exothecial files and the scariosus type of peristome (see below). Moreover, opercula in subg. *Aloma* often have longer and sharper rostra. So, differentiating between subgenus *Fissidens* and *Aloma* is usually easy. However, there are a few exceptions. For instance species with smooth laminal cells and limbidia restricted to the vaginant laminae are found in both subgenera. Furthermore, subgenus *Aloma* includes several species with limbate leaves and smooth laminal cells. Most of these are easily classified as subgenus *Aloma* by their large, inflated laminal cells as well as their *Aloma* type sporophyte. However, the gametophyte of one species, *F. zollingeri* Mont., looks deceptively like a subgenus *Fissidens* species as it has, except for the inflated vaginant laminal cells, smooth, medium sized cells and limbate leaves. Its sporophyte refers it to subgenus *Aloma*.

The bryoides – and scariosus type peristome differ in the exterior side of the basal undivided part and in the bifurcation of the teeth. The filaments are identical in both types. In the bryoides type the basal undivided part has trabeculae that are clearly distinct from and usually higher than the lamellae (see Fig. 2: 15), whereas in the scari-

osus type trabeculae of the basal undivided part are indistinct or only slightly distinct from the ± equally high to higher lamellae. The bifurcation of the bryoides type is variable. It has irregular trabeculae with coarse papillae and the vertical walls can be developed or not (see Fig. 2: 16, 17, and Fig. 11: 10); the bifurcation of the scariousus type on the other hand is constant with ± smooth trabeculae that are continuous with the smooth vertical walls.

KEY

Unless stated differently both in the descriptions and in the key ‘stem’ refers to vegetative stems and ‘leaves’ to mid leaves of vegetative stems (see section on patterns of variation above). The term ‘laminal cells’ refers to the inner dorsal laminal cells of mid leaves of vegetative stems (see section on patterns of variation above).

- 1. Dorsal and apical laminae poorly developed or lacking, upper leaves subulate; vaginant laminae elimbate; inner vaginant laminal cells long and narrow . . . . . 8. *F. gladiolus*
- 1\* Leaves with dorsal and apical laminae, upper leaves not subulate; vaginant laminae limbate; inner vaginant laminal cells wider (in one species long and narrow) . . . . . 2
- 2. All leaves limbate on all laminae . . . . . 6
- 2\* Limbidia restricted to the vaginant laminae (some leaves with limbidia on the mid dorsal lamina sometimes present) . . . . . 3
- 3. Costa percurrent; vaginant laminae of both vegetative and perichaetial stems limbate . . . 16. *F. rotereaui*
- 3\* Costa ending below the apex; extension limbidium various . . . . . 4
- 4. Distinctly heterocaulous, perichaetial plants small, frondose (Fig. 17: 4–6) and vegetative plants pinnate (Fig. 17: 3) . . . . . 18. *F. taylorii*
- 4\* Not distinctly heterocaulous, perichaetial plants longer (Fig. 17: 2; Fig 5: 1–4 and 7) or unknown . . . . . 5
- 5. Vaginant laminae of all leaves limbate, basal part of apical laminae often limbate; mid dorsal lamina infrequently weakly limbate . . . . 13. *F. obscurifrons*
- 5\* Vaginant laminae of vegetative plants elimbate or with a few oblong marginal cells near the insertion . . . . . 5. *F. bogosicus*
- 6. Vaginant lamina nearly or completely open . . . 7
- 6\* Vaginant lamina closed to half open . . . . . 9
- 7. Mid dorsal laminal cells thick-walled and convex, 5–13 × 5–8 µm, leaves obscure with contrasting limbidia . . . . . 17. *F. rufescens*
- 7\* Mid dorsal laminal cells thin-walled and plane, larger; leaves clear . . . . . 8
- 8. Mid dorsal laminal cells 9–25.5 × 6–12 µm . . . . . 4. *F. beckettii*
- 8\* Mid dorsal laminal cells 38.5–53 × 8–11 µm . . . . . 11. *F. magnicellulatus*
- 9. Periodically submerged or rheophilous; basal part of dorsal lamina often pluristratose . . . . . 10
- 9\* In humid or dry, not aquatic habitats; basal part of dorsal lamina mostly unistratose . . . . . 14
- 10. Heterocaulous with short archegonial stems and branches . . . . . 1. *F. acrophilus*
- 10\* Not distinctly heterocaulous . . . . . 11
- 11. Limbidia unistratose, ending below the leaf apices; basal parts of dorsal lamina unistratose . . . . . 9. *F. gomae*
- 11\* Limbidia pluristratose reaching the leaf apices or not; basal parts of dorsal lamina typically pluristratose . . . . . 12
- 12. Limbidia ending well below the leaf apex . . 13
- 12\* Limbidia nearly or completely reaching the leaf apex . . . . . 14. *F. pachylomadelpus*
- 13. Lower part of dorsal lamina often limbidoid (Fig. 14: 10, 11) . . . . . 15. *F. robynsianus*
- 13\* Lower part of dorsal lamina not limbidoid . . . . . 10. *F. leucocinctus*
- 14. Theca with ± 32 columns of exothecial cells . . . . . *F. zollingeri* (subg. *Aloma*)
- 14\* Theca with 40 or more columns of exothecial cells . . . . . 15
- 15. Laminal cells strongly convex, small (up to 9.5 µm long); leaves obscure . . . . . 16
- 15\* Laminal cells plane or lowly convex, larger (up to 17.5 µm); leaves clear . . . . . 18
- 16. Vaginant lamina slightly open; limbidia of the lamellae not confluent at the apex . . . . . 12. *F. megalotis* subsp. *helictocaulos*
- 16\* Vaginant lamina closed in all or most leaves; limbidia of the lamellae confluent at the apex . . . . . 17
- 17. Dorsal lamina frequently ending well above the insertion; leaf apex often hyaline . . . . . 3. *F. artsii*
- 17\* Dorsal lamina reaching the insertion often long decurrent; leaf apex not hyaline . . . . . 6. *F. crispus*
- 18. Heterocaulous . . . . . 7. *F. curvatus*
- 18\* Not distinctly heterocaulous . . . . . 19

19. *Limbodia* delicate, unistratose, ending below the apex, not reaching the insertion of the dorsal laminae ..... 9. *F. gomae*  
 19\*. *Limbodia* stout, 1–3 stratose, (±) reaching the apex, reaching the insertion ..... 2. *F. androgynus*

#### DESCRIPTIONS OF THE SPECIES

In a few cases it was impossible to make trans sections because of the paucity of material. This is indicated. Gemmae are only mentioned if they were observed.

Unless indicated differently all Tanzanian collections examined are cited. For some species a few additional collections from other countries are listed. The specimens are arranged by region. Citations of specimens are concise. Data on ecology and altitudes are omitted and summarized in the sections on habit, substrate and altitude. Descriptions of substrates and habitats are typically based on Tanzanian material.

The lists of synonyms in this paper are not complete. More synonyms can be found in O'Shea (2006) and in <http://www.tropicos.org>.

#### 1. *Fissidens acrophilus* Brugg.-Nann. Fig. 1

Polish Bot. J. **58**(1): 117, fig. 1. 2013. – TYPE: Kenya, Mount Elgon National Park, at the Suam River sources 1 km WSW of Koitoboss summit. *Carex runssorensis-Alchemilla* bog, on peaty soil. 3960 m. 17 January 1992. *Kungu 9222/AD* (HOLOTYPE: L; ISOTYPE: EGR).

MISAPPLIED NAME: *Fissidens anguste-limbatus* Mitt. (Bruggeman-Nannenga 2009).

Growing in mats; *stems* heterocaulous, with central strand; *rhizoids* basal and frequently axillary, brown, smooth; *axillary nodules* weakly differentiated; *perichaetial stems* shorter than vegetative stems; *vegetative stems* branched or not, 8.0–10.0 × 2.0–2.5 mm, pinnate; *leaves* pale green, older leaves often with dark costa and limbodia, distant to partly overlapping, up to 20

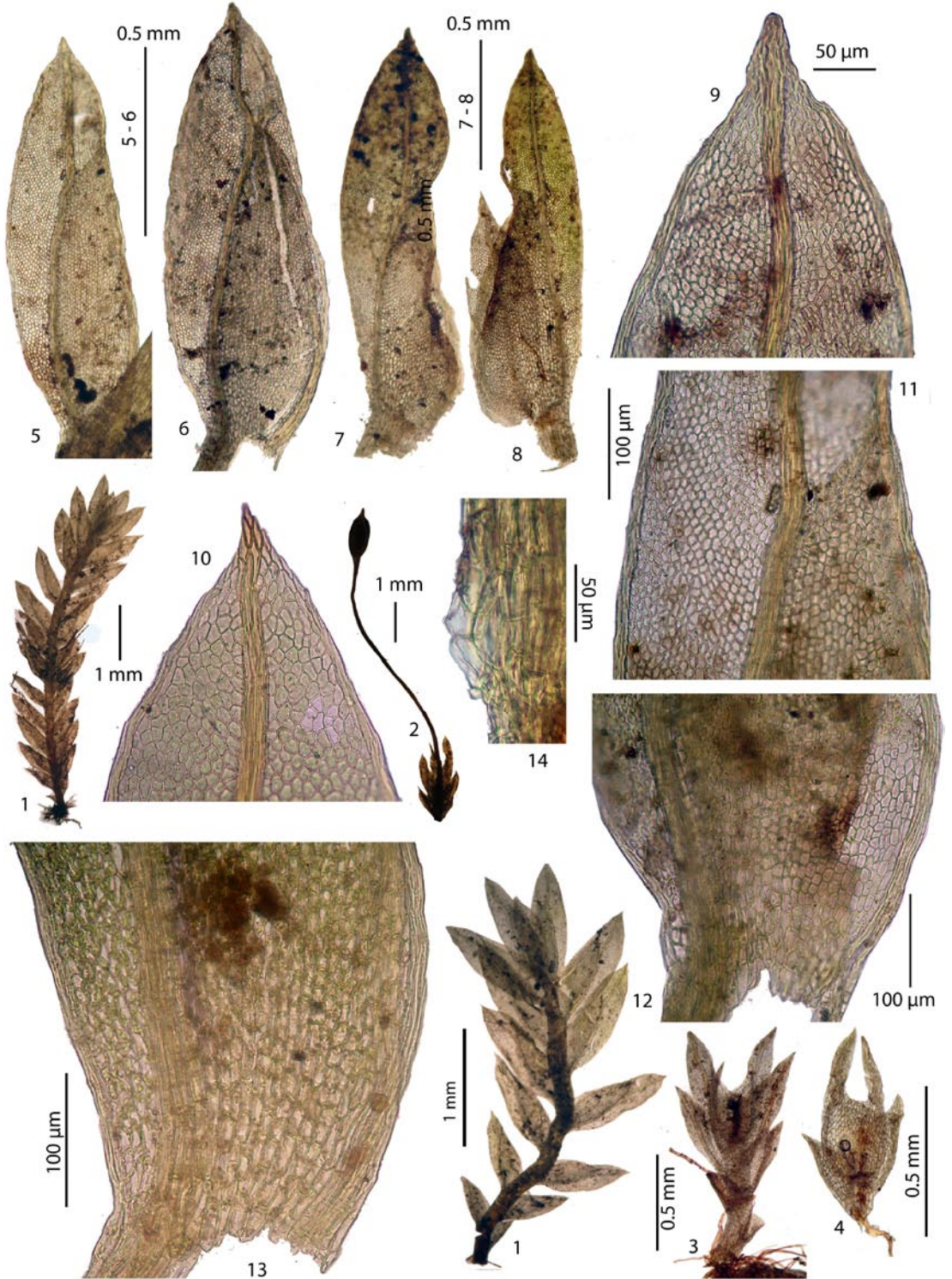
pairs, hardly crispate when dry, broadly lanceolate, acute-acuminate to acute-mucronate, 1.10–1.30 × 0.40–0.45 mm, L/W 3, limbate; *limbidium* ± reaching the leaf apex, confluent or not; confluent at the apex of the vaginant lamina, reaching the insertion of the vaginant lamina; reaching the insertion of the dorsal lamina, becoming indistinct on the decurrent part, in mid of dorsal lamina 24 µm wide, 1–2 stratose; on vaginant laminae 1–2 stratose, marginal; *vaginant lamina* 4/5 the leaf length, slightly open to closed, unistratose; *dorsal lamina* narrow, slightly rounded at base, reaching the insertion, often slightly decurrent, *dorsal* and *apical laminae* unistratose; *costa* per- to excurrent; mid dorsal *laminal cells* hexagonal, plane to slightly convex, 10.0–19.0 × 7.0–11.5 µm, smooth; mid vaginant laminal cells 10.0–20.5 × 5.0–11.0 µm.

*Fertile parts.* *Cladautoicous*, *perigonia* terminal on short, axillary branches, budlike or slender, 0.3–0.7 mm long, *antheridia* 200 µm long; *perichaetia* terminal on short stems and short branches; *perichaetial stems* 2–3 × 1 mm, unbranched, frondiform, in clusters at the base of vegetative stems; *leaves* crowded, up to 5 pairs, *perichaetial leaves* up to 1.7 mm long; *archegonia* ± 300 µm long; *sporophyte*, *seta* 6 mm long, smooth; *capsule* symmetrical to slightly oblique, 0.7–0.9 × 0.5 mm, ± 64 columns of oblong exothecial cells; *peristome* bryoides type, teeth 45.0–49.5 µm wide at base, short, 250 µm long; *operculum* 0.45 mm long; *calyptra* not seen; *spores* subglobose, 16.5–19.5 µm, coarsely papillose, green.

This species is characterized by its pale green, limbate, slightly decurrent, broadly lanceolate, acute-acuminate to acute-mucronate leaves with per- to excurrent costae and large, 10.0–19.0 × 7.0–11.5 µm, laminal cells; it has long, pinnate stems with basal clusters of short, frondiform perichaetial stems, short, axillary perichaetial and perigonial branches and short peristome teeth. Variability:

Fig. 1. *Fissidens acrophilus* Brugg.-Nann. 1 – vegetative stem (2×); 2 – sporophytic stem; 3 – perichaetial stem; 4 – perigonial branch; 5 & 6 – leaves; 7 & 8 – perichaetial leaves, 9 & 10 – leaf apices, 11 – mid leaf, 12 & 13 – leaves near insertion; 14 – weak axillary nodule. 1–3, 5–9, 11, 12 & 14 from *Kungu 9222/AD* (holotype L); 4, 10 & 13 from *Wesche 9085* (private herbarium Bruggeman-Nannenga). 1–3, 5–12 & 14 were also used in the protologue.





the type specimen differs from the other collection in the relatively long vaginant laminae. *Fissidens acrophilus* can be confused with large expressions of *F. curvatus*. This species can be distinguished by its limbidia that are confluent at the apex and its narrower, stiff vegetative leaves with dorsal laminae that are not decurrent. *Fissidens androgynus* can be separated by its terminal antheridia and archegonia. Moreover, it is not heterocaulous.

SUBSTRATE. On peaty soil, wet rocks.

HABITAT. *Carex runssorensis*-*Alchemilla* bog; afro-alpine zone unspecified.

ALTITUDE. 3250–3960 m.

DISTRIBUTION. Known only from Mt. Elgon (Kenya and Uganda).

SPECIMENS EXAMINED: KENYA, Mount Elgon National Park, *Kungu 9222/AD* (holotype: L; isotype: EGR). – UGANDA, Mt. Elgon, *Wesche 9085* (private herbarium Bruggeman-Nannenga).

## 2. *Fissidens androgynus* Bruch in Krauss

Fig. 2

Flora 29: 134. 1846. – LECTOTYPE (designated by Magill 1981): South Africa, Natal auf dem Cape. An Bächen an der Küste. VII 1838. *Krauss s.n.* (BM).

*Fissidens simensis* Schimp. ex Müll. Hal., Bot. Zeitung (Berlin) 22: 341. 1864. – TYPE: Ethiopia, Mons Bachit, *Schimper s.n.* (HOLOTYPE: BM, ISOTYPE: PC) – **syn. nov.**

*Fissidens longipes* Welw. & Duby, Mém. Soc. Phys. Genève 21: 224, tab. 4, fig. 3a–e. 1872. – TYPE: *Welwitsch*, iter Angolense 69 (ISOTYPES: BM, H-SOL) – **syn. nov.**

*Fissidens subremotifolius* Müll. Hal., Hedwigia 38: 54. 1899. – HOLOTYPE: South Africa, Transvaal, Lydenburg, Apr. 1887, *Wilms s.n.*, herb. Jack (G) – **syn. nov.**

*Fissidens gueinzii* Müll. Hal., Linnaea 37: 168. 1872.

– LECTOTYPE (designated by Magill 1981): South Africa, Cape, *Gueinzii s.n.* (BM) – **syn. nov.**

*Fissidens malaco-bryoides* Müll. Hal., Hedwigia 38: 55. 1899. – TYPE: South Africa, Cape, Somerset East, Boschberg, *Mac Owan s.n.* (LECTOTYPE designated by Magill 1981: G; ISOLECTOTYPES as Rabenhorst-Winter Bryoth. Eur. 1365: H-BR, S) – **syn. nov.**

*Fissidens obsoletidens* Müll. Hal. var. *schistophila* Broth., Wiss. Ergebn. Deut. Zentr.-Afr. Exped., Bot. 2: 143. 1910. – HOLOTYPE: Rwanda [Afr. or., Ruanda], Buganza, trockene Wasserrinne in einer Schlucht der Bergsteppe auf Tonschiefer, 1600 m, *Mildbraed 800* (H-BR as var. *schisticola*) – **syn. nov.**

*Fissidens platybryoides* Müll. Hal. var. *subimmarginatus* Dixon, Bull. Soc. Roy. Bot. Belgique 60: 13. 1927. – TYPE: Democratic Republic of the Congo [Congo], steppe à *Andropogon*, sur pierre calcaire, 24 IX 1914, c. fr., *Bequart 5857* (LECTOTYPE designated by Bruggeman-Nannenga 1993: BM as *Bequart 438*; ISOLECTOTYPE: PC as *Bequart 438*). NOTE: according to the protologue the number of the type specimen is 5857. The specimen in Dixon's herbarium (BM), however, is *Bequart 438* – **syn. nov.**

*Fissidens crateris* Dixon, J. Bot. 76: 219. 1938. – HOLOTYPE: Kenya [Brit. East Africa], Crater of Mt. Longonot, *Dummer 5049B* (BM) – **syn. nov.**

*Fissidens crateris* Dixon var. *sererekae* Dixon, J. Bot. 76: 220. 1938. – HOLOTYPE: Kenya [Kenya Colony], Serereka, 29 I 1908, *Balbo 63* (BM) – **syn. nov.**

NOTE. Except for *Fissidens obsoletidens* Müll. Hal. var. *schistophila* Broth. the above new synonyms were earlier synonymized with *F. bryoides* by Magill (1981) or *F. bryoides* s.l. by me (Bruggeman-Nannenga 1993).

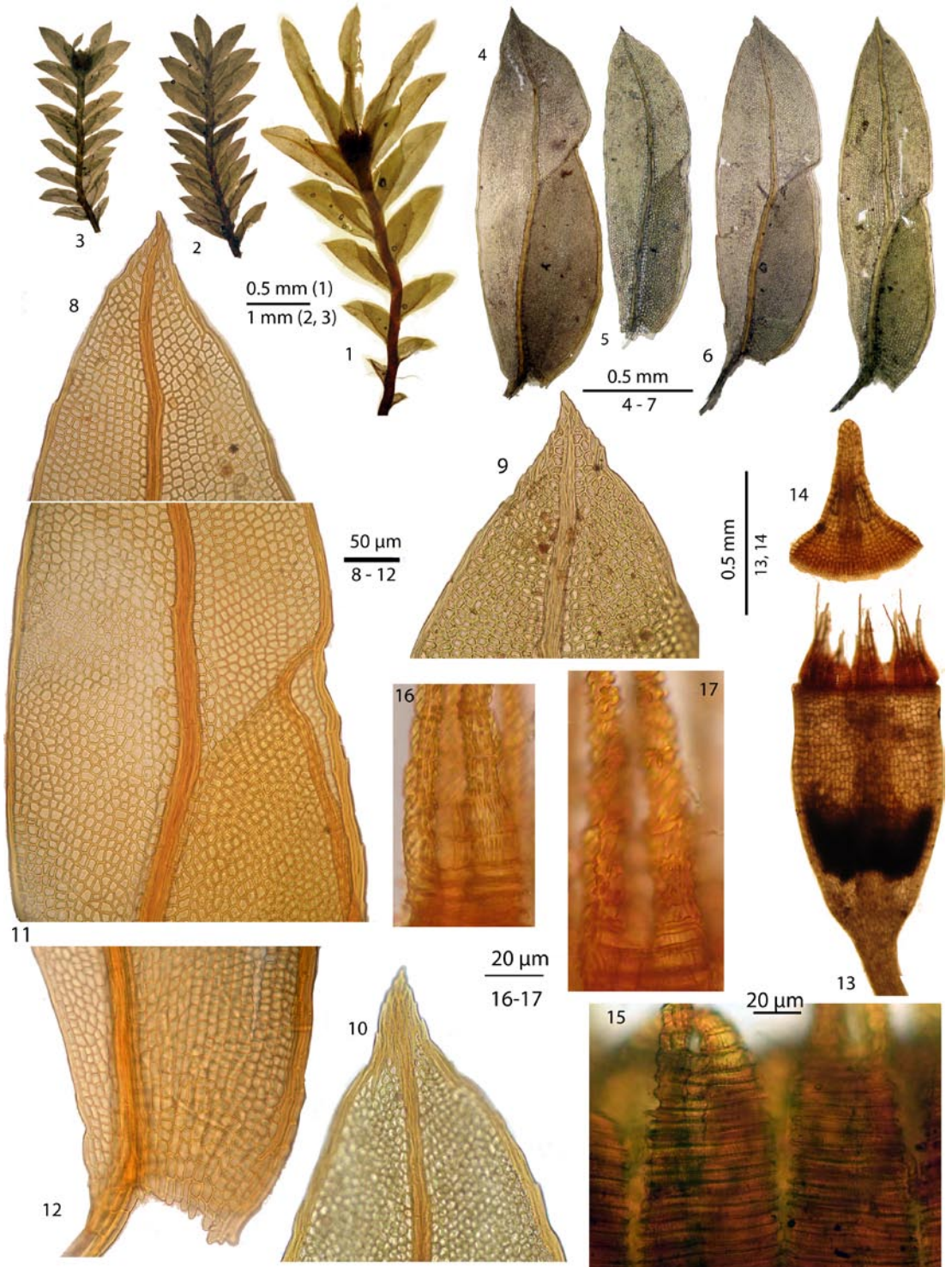
MISAPPLIED NAME: *Fissidens bryoides* Hedw. (Magill 1981; Bruggeman-Nannenga 1993).

Growing in mats or scattered between other mosses. *Stem* with central strand, branched or not, 3–10 × 1–2 mm, pinnate; *rhizoids* basal and axillary, bright brown to red, smooth; *axillary nodules*

→

**Fig. 2.** *Fissidens androgynus* Bruch in Krauss 1 – short perichaetial stem; 2 – vegetative stem; 3 – perigonal stem; 4–7 – leaves; 8–10 – leaf apices; 11 – mid leaf; 12 – basal part of leaf; 13 – capsule; 14 – operculum; 15 – undivided, basal part peristome; 16 & 17 – peristome teeth at bifurcation. 1 from *Pócs 88086/D* (private herbarium Bruggeman-Nannenga); 2, 3 & 7 from *Pócs 8664/E* (L); 4 & 6 from *Gilbert 8477* (L); 5 from *Pócs et al. 90021/AG* (EGR, private herbarium Bruggeman-Nannenga); 8, 11 & 12 from *Pócs & Chuwa 89025/W* (private herbarium Bruggeman-Nannenga); 10 from *Townsend 77/340* (E); 9 & 15 from *Kiss & Pócs 9112 /AM* (L); 13, 14, 16 & 17 from *Van Zanten & Pócs 86.07.228 W* (private herbarium Bruggeman-Nannenga). The brown coloring in 8, 11 & 12 is caused by 5% KOH.





lacking or weakly differentiated; *leaves* green, becoming brown in 5% KOH, costa and limbidium often brown in older specimens, close to distant, 10–21 pairs, crispate when dry, elliptical, oblong-lanceolate, broadly acute to obtuse, acuminate-mucronate to mucronate,  $1.0\text{--}1.7 \times 0.3\text{--}0.5$  mm, L/W 2.75–5.00, limbate; *limbidium* reaching or  $\pm$  reaching the leaf apex; reaching the insertion of the vaginant lamina, confluent at the apex of the vaginant lamina; reaching the insertion of the dorsal laminae, on decurrent part of dorsal lamina not or poorly developed; on mid dorsal lamina 8–16  $\mu\text{m}$  wide, 1–3 stratose; on the vaginant lamina 1–2 stratose, marginal throughout or intramarginal by 1 row of cells near the insertion of the vaginant laminae; *vaginant lamina* 1/2–7/10 leaf length, closed, unistratose; *dorsal lamina* slightly rounded to straight at the insertion, slightly undulate or not, reaching the insertion, not to long decurrent, *dorsal* and *apical laminae* unistratose occasionally with some small bistratose areas; *costa* per- to excurrent; mid dorsal *laminal cells* hexagonal-oblong, plane to slightly convex, smooth,  $8.0\text{--}16.0 \times 5.0\text{--}11.0$   $\mu\text{m}$ , walls firm; mid vaginant laminal cells  $9.5\text{--}16.0 \times 5.0\text{--}8.0$   $\mu\text{m}$ .

*Fertile parts*, *synoicia* infrequent, terminal; *perigonia* terminal on 1.5–8.0 mm long stems or on branches of perichaetial, perigonial or vegetative stems; *antheridia* 200–400  $\mu\text{m}$  long; *perichaetia* terminal; *perichaetial leaves* often considerably longer than stem leaves (to about twice as long), 1.2–2.3 mm long; *archegonia* 300–500  $\mu\text{m}$  long; *sporophyte*, *seta* 4.5–8.0 mm long, 1–2 per perichaetium, smooth; *capsule* ( $\pm$ ) symmetrical,  $0.5\text{--}1.1 \times 0.35\text{--}0.60$  mm, 56–60 columns of oblong exothecial cells; *peristome* bryoides type, tooth base 35–65  $\mu\text{m}$  wide; *operculum* 0.4–0.5 mm long with short, blunt rostrum; *calyptra* mitrate, smooth, 0.65–0.70 mm long; *spores* subglobose, 9.5–18.0  $\mu\text{m}$  long, smooth to finely papillose.

This common, variable species is characterized by its rather large size, clear,  $8.0\text{--}16.0 \times 5.0\text{--}11.0$   $\mu\text{m}$ , plane to slightly convex laminal cells; limbidia that reach or  $\pm$  reach the leaf apex; and antheridia terminal on 1.5–8.0 mm tall perigonial stems or on branches. *Fissidens androgynus* is

most likely to be confused with the pantropical *F. crispus* Mont. with which it often grows mixed. *Fissidens crispus* has uniform, small, quadratic, convex cells arranged in rows whereas *F. androgynus* has larger, less uniform, plane to slightly convex cells. At low magnifications *F. crispus* can usually be distinguished by its obscure leaves (see Fig. 6: 5–7). However, these diagnostic characters are not rigidly linked and not all collections can be identified with certainty. Particularly specimens with small cells arranged in rows that are not or hardly convex are hard to name. Moreover, in both species the dorsal laminae can end at the insertion or be long decurrent and the limbidia can be marginal or intramarginal. Specimens of *F. androgynus* with stout borders and mucronate leaf tips can be confused with *F. pachylomadelphus*. This species is distinguished by its rheophilous habitat, dorsal laminae that are 1–4 stratose near the insertion and thick limbidia (3–4 stratose on the mid dorsal lamina). *Fissidens gomei* P. de la Varde & J.-F. Leroy has more delicate, unistratose limbidia that end below the apex. *Fissidens bryoides* Hedw. (not known from Sub-Saharan Africa) typically has axillary perigonial buds. Axillary perigonial buds are not known in *F. androgynus*.

**HABITAT.** This species is known from a wide variety of wet to rather dry forests. For example, in *Cupressus lusitanica* plantation forests (10 $\times$ ), elfin forests (1 $\times$ ), montane rainforests (4 $\times$ ), submontane rainforests (1 $\times$ ), riverine forests (2 $\times$ ), mossy to dry evergreen forests etc.; once in Ericaceae belt just above the forest line; also known from stream and road banks.

**SUBSTRATE.** Most often lignicolous, on rotten wood as well as on bark; also frequently saxicolous and terrestrial.

**ALTITUDE.** 770–3960 m.

**DISTRIBUTION.** Widely distributed and common in Africa: Macaronesia (Cape Verde Islands); west tropical Africa (Ghana, Guinea, Ivory Coast, Nigeria); northeast tropical Africa (Ethiopia); west central tropical Africa (Bioko, Central African Republic, Cameroon, Democratic Republic of the Congo, Gabon); east tropical Africa (Kenya,

Rwanda, Tanzania, Uganda); south tropical Africa (Angola, Malawi, Zimbabwe); southern Africa (Lesotho, South Africa); and western Indian Ocean (La Réunion, Mascarenes); common and wide-spread in Tanzania: Arusha (Mt. Meru, Ngorongoro), Kilimanjaro (Mt. Kilimanjaro, South Pare Mts), Morogoro (Nguru Mts, Uluguru Mts), and Tanga (East and West Usambara Mts).

SELECTED SPECIMENS: TANZANIA, Arusha, Meru Mts, *Crosby 11107, 11169, 11172, 11189* (all MO), *Kis & Pócs 9141/B* (EGR, L), *Pócs 8664/E* and *F* (EGR, L), *Pócs 8690/G, 88085/D, 88086/D* and *G* (all EGR, private herbarium Bruggeman-Nannenga), *Pócs et al. 88096/F* (EGR, private herbarium Bruggeman-Nannenga), *Pócs & Nsolomo 88139/E* (EGR, private herbarium Bruggeman-Nannenga), *Pócs & Ochya 88144/X* and *88146/C* (both EGR, private herbarium Bruggeman-Nannenga), *Pócs et al. 88162/S* (KRAM, private herbarium Bruggeman-Nannenga), *Pócs 89263/C* (EGR, private herbarium Bruggeman-Nannenga), *Sharp et al. 27, 41A* and *708* (all EGR, L), *Sharp et al. 879B* (EGR, private herbarium Bruggeman-Nannenga) and *Whitehouse 26154* (MO); Ngorongoro, *Van Zanten & Pócs 86.07.228* (private herbarium Bruggeman-Nannenga, GRO), *86.07.231* (private herbarium Bruggeman-Nannenga, GRO), *86.08.286* (GRO, private herbarium Bruggeman-Nannenga), *Pócs & Chuwa 89017/B, 89025/W* and *89027/AF* (all: EGR, private herbarium Bruggeman-Nannenga) and *Crosby 11160* (MO); Kilimanjaro, Mt. Kilimanjaro, *Borrhidi et al. 87100/B* (EGR, private herbarium Bruggeman-Nannenga), *Gilbert 8477* (EGR, L), *Pócs et al. 88122/B* (KRAM, EGR, private herbarium Bruggeman-Nannenga), *Pócs, Mjatta & Linden 90021/AG* (EGR, private herbarium Bruggeman-Nannenga), *Pócs et al. 90027/N* (EGR, private herbarium Bruggeman-Nannenga), *Pócs 90131/A* (EGR, private herbarium Bruggeman-Nannenga), *Sharp 7150* (EGR, L, with *F. asplenioides*) and *Sharp et al. 7560/A* (EGR, L); South Pare Mts, *Pócs et al. 90042/AL* (EGR, private herbarium Bruggeman-Nannenga); Morogoro, Nguru Mts, *Kiss & Pócs 9112 /AM* (EGR, L); Uluguru Mts, *Crosby 7251 p.p.* (MO), *Pócs et al. 88110/CP* (EGR, private herbarium Bruggeman-Nannenga) and *Townsend 75/382* (E); Tanga, East Usambara Mts, near Amani, *Pócs 6095/CJ* (EGR, L); West Usambara Mts, *Pócs 8436/AD* (EGR, L) and *Pócs 8450/Q* (EGR, L).

SELECTED ILLUSTRATIONS: Bruggeman-Nannenga (2006a: fig. 1), Bruggeman-Nannenga & Arts (2010: fig. 11), Chuah-Petiot (2003: fig. 26), Magill (1981: fig. 10: 1–8 as *F. bryioides* Hedw.).

### 3. *Fissidens artsii* Brugg.-Nann. Fig. 3

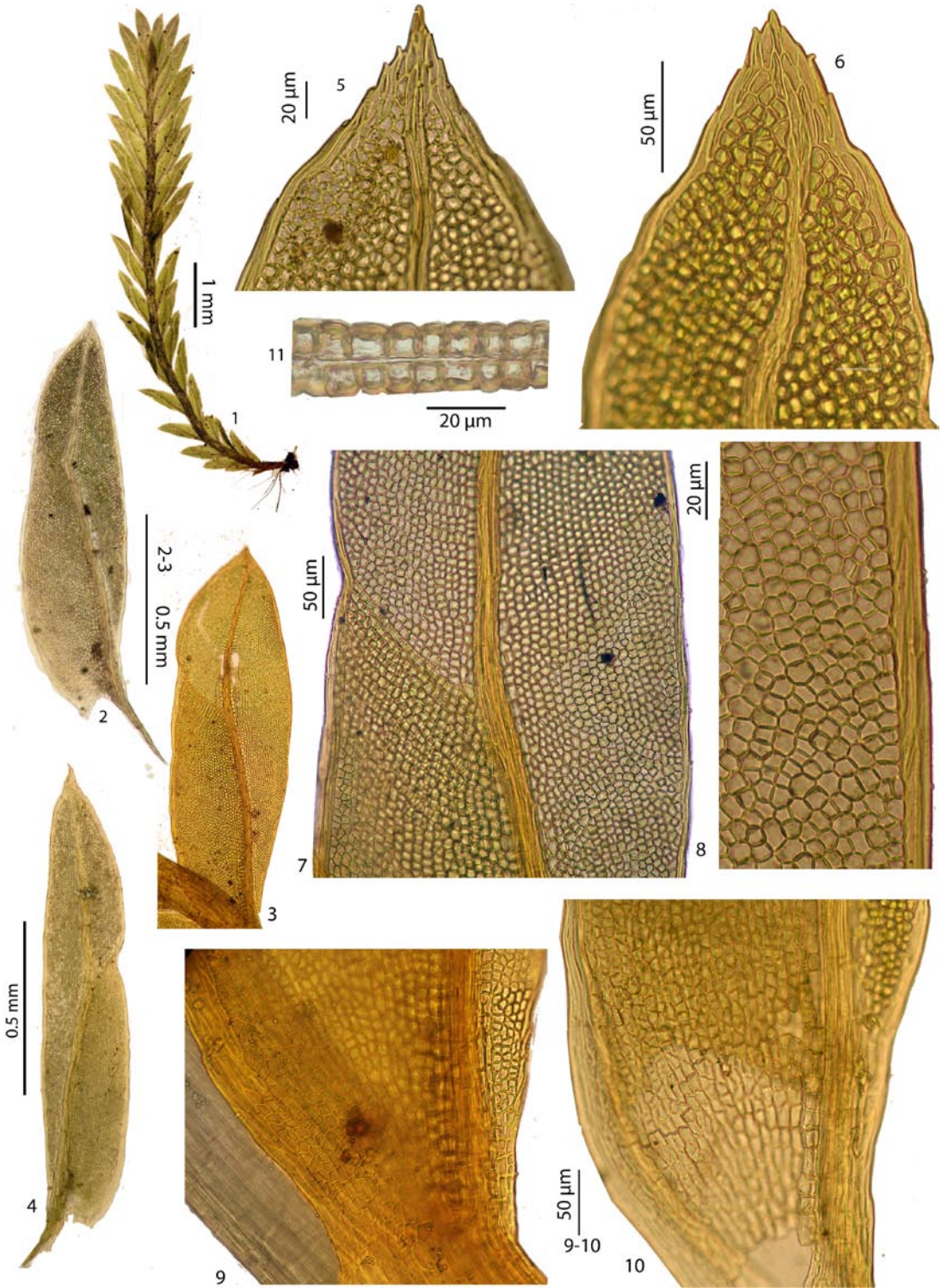
Trop. Bryol. **26**: 14, fig. 2. 2005. – TYPE: Réunion, La Caverne de la Glacière, sentier du Grand Bénard. On earth layer underneath overhanging volcanic rock, 2460 m, 8 III 1997, *Arts 13/09* (HOLOTYPE: BR; ISOTYPE: L).

Growing in loose mats scattered between other species. *Stem* with central strand, 5.0–20.0 × 1.5–2.5 mm, unbranched or branched, pinnate; *rhizoids* basal, brown and smooth; *axillary cells* differentiated, hardly bulging; *leaves* obscure, frequently with hyaline apex, up to 29 pairs, distant to close, not or slightly crispate when dry, lanceolate with acute-acuminate to rounded apiculate-mucronate apex, 0.8–2.2 × 0.2–0.5 mm, L/W 3–5; limbate on all laminae; *limbidium* infrequently branched, frequently dentate at the leaf apex, mostly (±) reaching the leaf apex; on the vaginant lamina distally confluent or not, reaching insertion of the vaginant lamina; in lower part of dorsal lamina often more or less fusing with costa; in mid dorsal lamina 4.5–9.5 µm wide and 1–2 stratose; on the vaginant lamina unistratose, marginal or weakly intramarginal; *vaginant lamina* 3/5–3/4 the leaf length, closed to slightly open, unistratose; *dorsal lamina* narrow, straight to slightly rounded at base, often reaching the insertion as one row of cells, reaching the insertion or ending well above it, particularly in lower leaves often limbidoid near the insertion, not decurrent; *dorsal* and *apical laminae* unistratose; *costa* pale, stout, per- to excurrent; mid dorsal *laminal cells* roundish-hexagonal to quadrate, convex often with lenticularly thickened walls, 5.0–9.5 × 4.5–8.0 µm; mid vaginant *laminal cells* 4.5–11.0 × 3.5–8.0 µm; cells in leaf apex often clear and larger, ± 15 µm long.

*Fertile parts*, *perigonia* terminal, male stems to 18 mm tall; *antheridia* 450 µm long; *perichaetia* terminal, perichaetial leaves 1.6–2.5 mm long, *archegonia* 320–600 µm long. *Sporophyte* and *calyptra* unknown.

This species is characterized by limbate leaves, small, convex, often lenticularly thickened laminal cells (Fig. 3: 11), leaf tips that are frequently dentate and hyaline and dorsal laminae that frequently do not reach the insertion. In KOH 5% it





colors yellowish. It resembles *F. megalotis* subsp. *helictocaulos* which also has lenticularly thickened cell walls, but can be separated by its slightly open vaginant laminae and limbidia that are frequently intramarginal. *Fissidens crispus* also has obscure, limbate leaves and small, convex cells, but lacks hyaline leaf apices. Moreover, whereas in *F. artsii* the dorsal lamina frequently ends well above the insertion that of *F. crispus* is often long decurrent. *Fissidens artsii* resembles the neotropical *F. wallisii* Müll. Hal. in the denticulate leaf apex and the strongly thickened cell walls. *Fissidens wallisii*, however, has thicker limbidia (2–3 stratoe instead of unistratoe on the vaginant laminae).

**HABITAT.** Tree-heath forest (unspecified), Ericaceous heath and *Phillipia* bush with *Erica arboorea*, on floor of cave; boulder in stream.

**SUBSTRATE.** On soil, respectively mud; also lignicolous and saxicolous.

**ALTITUDE.** 2460–3870 m.

**DISTRIBUTION.** East tropical Africa (Kenya, Tanzania, Uganda), and western Indian Ocean (La Réunion). New to Kenya, Tanzania and Uganda.

**SPECIMENS EXAMINED:** TANZANIA, Kilimanjaro, Kilimanjaro Mts, *Pócs & Van Zanten 86130/L* (EGR, L), *Van Zanten 86.08.437* (GRO) – KENYA, Mt. Elgon, *Townsend 77/116b* (E, private herbarium Bruggeman-Nannenga); UGANDA, Ruwenzori, *Newbould 5274* (E); Mt. Elgon, *Wesche 1772* (private herbarium Bruggeman-Nannenga). – LA RÉUNION, *Arts 13/09* (holotype: BR; isotype L).

**ILLUSTRATIONS:** Bruggeman-Nannenga (2005: fig. 2), Bruggeman-Nannenga & Arts (2010: fig. 12).

#### 4. *Fissidens beckettii* Mitt.

Fig. 4

J. Linn. Soc. Bot. **13**: 225, 1873. – TYPE: Sri Lanka [Ceylon], Prov. Centr., Maanagalla, *Beckett 9* (HOLOTYPE: NY; ISOTYPE: PC).

*Fissidens simii* Schelpe in Magill & Schelpe, Trans. Roy. Soc. South Africa **44**: 115. 1979 (new name for

*F. aristatus* Sim, Trans. Roy. Soc. South Africa **15**: 200, f. 1926, *hom. illeg.*). This synonymy is based on two isosyntypes, viz. South Africa, Natal, Alexandra Park, Maritzburg, *Sim 9907* (PC) and Zwart Kop Stream, *Sim 9909* (PC) (Bruggeman-Nannenga, 1997). The same numbers are in Sim's herbarium in PRE (Magill 1981). The lectotype should be chosen from these.

*Fissidens subpycnophyllus* P. de la Varde, Arch. Bot. Bull. Mens. **4**: 17, fig. 1: 1. 1930, *p.p.* – TYPE: Central African Republic [Oubangui], près Torogwadé, 60 km E. Bambari, *Tisserant s.n.* (LECTOTYPE designated by Bruggeman-Nannenga 1997: PC-PV). The type-collection contains two stems, both pictured in the protologue as *F. subpycnophyllus*. However, only the vegetative one is *F. beckettii*.

*Fissidens smiloides* P. de la Varde, Rev. Bryol. Lichénol. **5**: 84, fig. 1. 1933. – LECTOTYPE (nov.): Central African Republic [Oubangui], Bozoum, sur terre, savanne, 26 VII 1931, *Tisserant 549* [P Varde 4465B] (PC-PV).

*Fissidens acanthophyllus* P. de la Varde, Rev. Bryol. **9**: 197, fig. 2. 1937. – HOLOTYPE: Central African Republic [Oubangui], Bocaranga, *Eckendorff s.n.* [RPV 5970] (PC-PV).

Growing in dense mats or scattered between other mosses (often tiny *Fissidens* species); *stem* without central strand, mostly unbranched, more or less heterocaulous; *rhizoids* basal, brown to hyaline, smooth; *axillary cells* not differentiated; *perichaetial stems* frondiform to elongate frondiform, 2–6 × 1–2 mm; perichaetial stem *leaves* more or less crowded, 5–10 pairs, 0.90–1.40 × 0.25–0.50 mm, L/W ± 4; *vegetative stems* rare, pinnate, 1.5–6.0 × 0.7–2.0 mm wide; *leaves* more or less distant, 5–20 pairs, hardly altered when dry, lanceolate, ovate-lanceolate to elliptico-lanceolate with narrowly acute to long acuminate or mucronate apex, 0.40–0.85 × 0.10–0.25 mm, L/W 3–5, margin limbate; *limbidium* on all laminae of upper and mid leaves, in lower leaf pairs poorly developed to lacking, reaching the leaf apex or not, confluent with the costa or not; at the apex of smaller lamella of the vaginant lamina confluent with the costa, (±) reaching the insertion of the vaginant

←

**Fig. 3.** *Fissidens artsii* Brugg.-Nann. 1 – vegetative stem; 2–4 – leaves; 5 & 6 – leaf apices; 7 – mid leaf; 8 – mid dorsal lamina; 9 & 10 – basal parts of leaf; 11 – trans section vaginant lamina showing the lenticularly thickened exterior walls. 1, 2, 6 & 10 from type specimen *Arts 13/09* (L); 3 & 7 from *Pócs & Van Zanten 86130/L* (L); 5, 8 & 9 from *Townsend 77/116b* (E); 4 & 11 from *Newbould 5274* (E).

lamina, reaching the insertion of the dorsal laminae or not, in mid dorsal lamina 6–16  $\mu\text{m}$  wide and 1–2 stratose; on vaginant lamina 1–2 stratose, lax, marginal to indistinctly intramarginal near the insertion; *vaginant lamina* 1/2–7/10 the leaf length, nearly or completely open, unistratose; *dorsal lamina* tapering towards the insertion, slightly rounded to straight at insertion, reaching the insertion, in lower leaves sometimes ending above, not to hardly decurrent; apical lamina lacking in lower leaves; *dorsal* and *apical laminae* unistratose; *costa* stout, percurrent to long excurrent; *laminal cells* rather uniform throughout the leaf, clear, oblong-hexagonal; mid dorsal laminal cells plane, smooth, 9.0–25.5  $\times$  6.0–12.0  $\mu\text{m}$ ; mid vaginant laminal cells 16.0  $\times$  8.0–9.5  $\mu\text{m}$ ; tubers present in some collections.

*Fertile parts*, *perigonia* terminal on short,  $\pm$  0.5 mm long, stems; *antheridia* not observed; *perichaetia* terminal, rarely terminal on branches, *archegonia* 200–350  $\mu\text{m}$  long; *perichaetial leaves* 1.0–1.9 mm long; *sporophyte*, *seta* 3–7 mm long, smooth; *capsule* inclined to horizontal, rarely erect, 0.4–1.0  $\times$  0.3–0.5 mm, with 40–54 columns of oblong, exothecial cells; *peristome* bryoides type, tooth base 40–52  $\mu\text{m}$  wide; *operculum* rostrate, 0.25–0.45 mm long; *calyptra* not split; *spores* 9.5–22.5  $\mu\text{m}$  long, weakly papillose to smooth.

*Fissidens beckettii* is characterized by its open vaginant lamina; large, 9.0–25.5  $\times$  6.0–12.0  $\mu\text{m}$ , mid dorsal laminal cells; limbate, lanceolate leaves with a mucronate, acuminate or narrowly acute apex; percurrent to long excurrent costae; and inclined to horizontal capsules. Leaves of female stems are usually longer, wider and closer than those of sterile stems. Not all collections contain both fertile and vegetative stems. *Fissidens beckettii* can be confused with other species with an open vaginant lamina. Of these *F. magnicellulatus* can be distinguished by its vague, instead of distinct vaginant laminal limbidia and its even larger cells (32–60  $\times$  8–15  $\mu\text{m}$ ), whereas *F. rufescens* has smaller, 5–13  $\times$  5–8  $\mu\text{m}$ , laminal cells with convexly thickened walls. Specimens with recurved leaf tips can be taken for *F. pygmaeus* Hornsch. (not known from tropical eastern Africa) which

is easily distinguished by its elimbate dorsal and apical laminae. *Fissidens curvatus*, with which it may grow mixed, has closed to slightly open vaginant laminae.

East African collections of *F. beckettii* are rare and small. Therefore the description of the cross-sections is based on West African material (*Eckendorff s.n.*). The absence of a central strand is supported by observations by Iwatsuki and Suzuki (1982) and Pursell (2007). Limbidia are 1–2 stratose in *Eckendorff s.n.*, 1–2 stratose according to Iwatsuki and Suzuki (1982, plate XV) and unistratose according to Pursell (2007).

West African *F. beckettii* is distinctly heterocaulous and frequently has long vegetative stems with distant leaves (Fig. 4: 10, 11). Such long vegetative stems were not seen in East African material.

**HABITAT.** Occurring in a variety of forest types: montane rain forest, submontane rainforest, montane evergreen forest, microphyllous dry evergreen forest, dry and mesophilous forest, mixed deciduous woodland; also cultivated areas (garden and plantation).

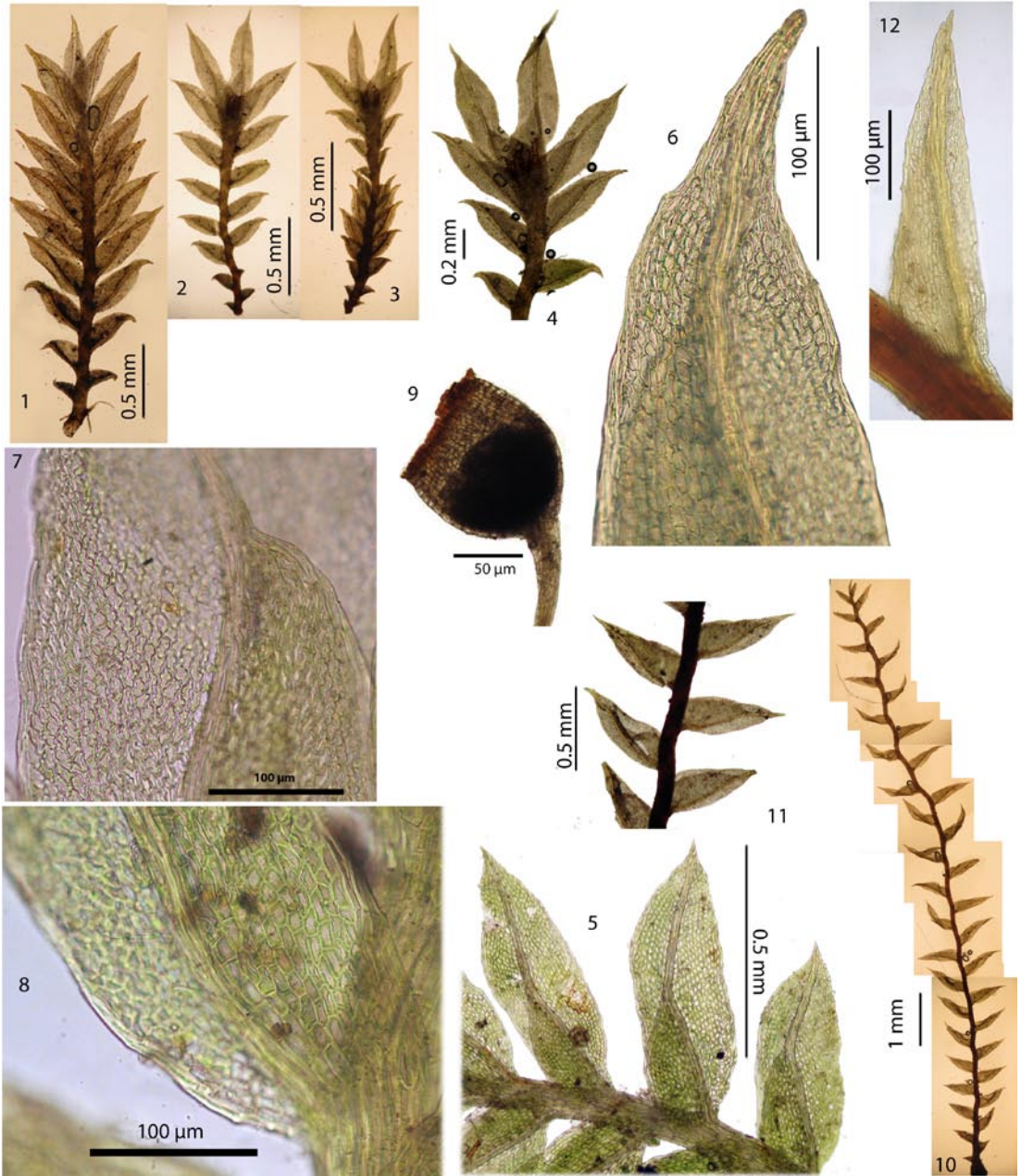
**SUBSTRATE.** In Tanzania mostly on soil; once on earth covered rocks, and once on a termite mound.

**ALTITUDE.** In Africa 25–2100 m.

**DISTRIBUTION.** Neotropics, Asia and Africa. In Africa known from west-central tropical Africa (Central African Republic), northeast tropical Africa (Ethiopia), east tropical Africa (Tanzania, Uganda), south tropical Africa (Zimbabwe) and southern Africa (South Africa). In Tanzania widespread, but uncommon: Arusha Region (Longido Hill), Dodoma Region (Chenene Hills), Mbeya Region (Mbeya), and Morogoro Region (Nguru Mts, Ukaguru Mts, S-Uluguru Mts).

**SPECIMENS EXAMINED:** TANZANIA, Arusha, Longido Hill, *Pócs 8693/AE*, a few stems mixed with other species (EGR, L), *Pócs et al. 87165/AC*, a few stems mixed with other *Fissidens* species (EGR, private herbarium Bruggeman-Nannenga); Dodoma, Chenene Hills, *Polhill & Paulo B9* (E, mixed with *F. curvatus*, PC); Mbeya, Mbeya District, *Townsend 75/330 p.p.* (E, 1 stem in mix); Morogoro, Nguru Mts, *Pócs 88041/B*





**Fig. 4.** *Fissidens beckettii* Mitt. (1–9 from Eastern Africa). 1 – vegetative stem; 2 & 4 – perichaetial stems; 3 – perichaetial stem (not branch) growing as continuation on a vegetative stem; 5 – mid leaves of vegetative stem; 6 – apex; 7 – mid leaf; 8 – basal part of leaf; 9 – capsule; (10–12 from Western Africa). 10 – vegetative stem; 11 – mid leaves of vegetative stem; 12 – vegetative leaf. 1 from *Wager 89* (BM); 2–4 & 6 from *Arts RSA 20/02* (BR); 5 from *Hylander 4535* (private herbarium Bruggeman-Nannenga); 7 & 9 from *Polhill & Paulo B9* (E); 8 from *Pócs 8693/AE* (L); 10 & 11 from *Eckendorff s.n.* (PC); 12 from *Tisserant 549* (PC).

a few stems mixed with *F. enervis* (EGR, private herbarium Bruggeman-Nannenga), *Kis & Pócs 9104/P* (a few stems mixed with *F. enervis* and *F. crispus* (EGR, L); Ukaguru Mts, *Pócs et al. 6743/D* (EGR, PC a few stems mixed with type of *F. pseudoenii*); S. Uluguru Mts, *Pócs 6212/D* p.p. a few stems only (PC, EGR). – CENTRAL AFRICAN REPUBLIC [Oubangui], affluent de la Pendé, *Eckendorff s.n.* (Potier de la Varde 6482) (PC-PV); Bocaranga, *Eckendorff s.n.* (PC-PV); Bozoum, *Tisserant 549* (PC-PV) and *Tisserant 667* (PC-PV). – ETHIOPIA, Kaffa, *Hylander 4535* (private herbaria: Hylander and Bruggeman-Nannenga). – SOUTH AFRICA, Cape Prov., *Arts RSA 20/20* (BR, private herbarium Bruggeman-Nannenga); Transvaal, Pretoria, *Townsend 82/6* (E, private herbarium Bruggeman-Nannenga).

SELECTED ILLUSTRATIONS: Arts (1998: fig. 6), Bruggeman-Nannenga (2006a: fig. 3), Iwatsuki & Suzuki (1982: pl. 15), Magill (1981: 47: fig. 25–31 as *F. simii*), Potier de la Varde (1932: fig. 1 as *F. smiloides*; 1936: fig. 2 as *F. acanthophyllus*), Pursell (2007: fig. 49 A–C).

### 5. *Fissidens bogosicus* Müll. Hal. in Venturi

Fig. 5

Nuovo. Giorn. Bot. Ital. 4: 10. 1872. – TYPE: Ethiopia, Bogos-area near Keren, 1870, *Beccari s.n.* (LECTOTYPE designated by Bruggeman-Nannenga 1997: H-SOL (re-examined for this paper); ISOTYPES: BM, NY, PC-PV).

*Fissidens microandrogynus* Dixon, S. African J. Sci. 18: 306. 1922. – TYPE: Zimbabwe [Southern Rhodesia], Bailee, *Wager 895* (HOLOTYPE BM; ISOTYPE PC-PV). Synonymy confirmed for this paper.

*Fissidens hyalobasis* Dixon in Sim, Trans. Roy. Soc. South Africa 15: 195, f. 1926. – TYPE: South Africa, Transvaal, Moorddrift, *Wager 406* (HOLOTYPE BM; ISOTYPES: H-BR, PC-PV, both *s.n.*). Synonymy confirmed for this paper based on a photograph of the type-specimen.

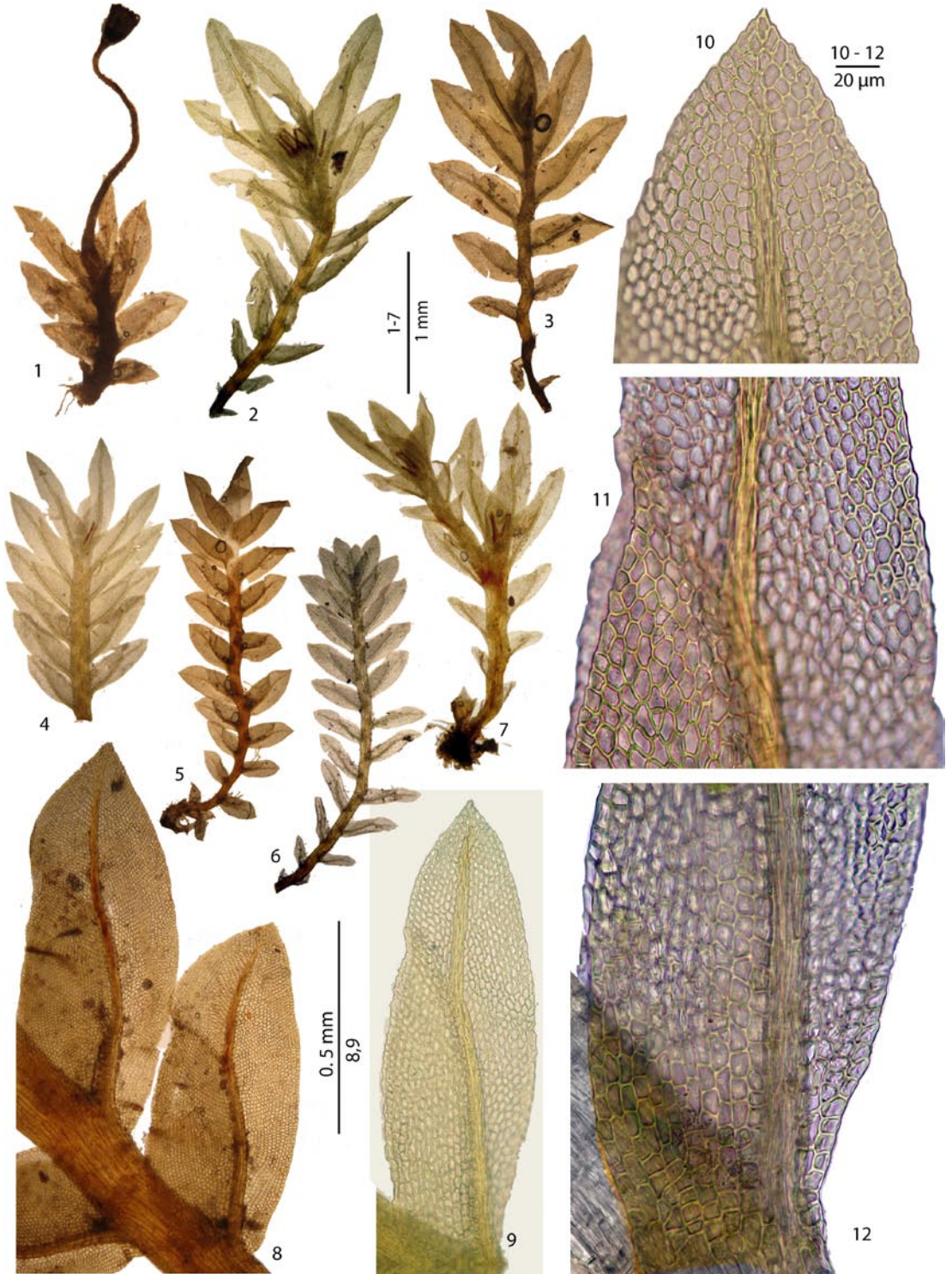
Growing scattered or in loose mats; *stem* with weak central strand; *rhizoids* basal and axillary, hyaline to pale brown, smooth; *axillary* cells weakly differentiated; slightly heterocaulous; *vegetative*

*stems* unbranched, 2.2–3.0 × 1.0 mm, pinnate; *leaves* distant, 11–16 pairs, slightly crispate or inflexed when dry, elliptical, elliptical-lanceolate, elliptico-oblong, acute less often broadly acute to obtuse, 0.35–0.80 × 0.17–0.23 mm, L/W 2.5–3.5, margin subentire to weakly and irregularly crenulate, elimbate or infrequently with a weak limbidium of a few elongated cells near the insertion of the vaginant laminae (vaginant lamina of upper and mid leaves of perichaetial stems partly or completely limbate with intramarginal or marginal, unistratose limbidia); *vaginant lamina* 3/5 the leaf length, unistratose, slightly open to almost completely open; in perichaetial leaves sometimes open; *dorsal lamina* narrow and slightly rounded at the insertion, reaching the insertion or not, not decurrent, *dorsal* and *apical laminae* unistratose; *costa* ending 2–4 cells below the apex; mid dorsal *laminal cells* clear, hexagonal, plane, smooth, 9.5–14.5 × 8.0–11.0 µm; mid vaginant *laminal cells* hexagonal to oblong, 8.0–17.5 × 5.0–1.0 µm; vaginant *laminal cells* of perichaetial stems frequently inflated, 17.0–51.0 × 8.0–16.0 µm.

*Fertile parts.* Perigonia, perichaetia and infrequently synoicia. *Perigonia* terminal on short stems at base of perichaetial stems and terminal on branches, male stems budlike or longer, 0.4–3.5 mm long; *antheridia* 150–270 µm long; *perichaetia* and synoicia terminal, occasionally a few archegonia in axils of subperichaetial leaves; *perichaetial* and synoicial plants similar, unbranched to strongly branched, variable, 2.5–4.0 × 1.0–2.0 mm, with 6–10 pairs of distant leaves (crowded in the perichaetium); *perichaetial leaves* 1.0–1.2 mm long with broadly acute to rounded obtuse apices; *archegonia* 220–350 µm long. *Sporophyte*, *seta* 3–6 mm long, smooth, 1–2 per perichaetium; *capsule* slightly inclined or erect, 0.6–0.9 × 0.35–0.55 mm, 62 columns of oblong exothecial cells; *peristome* bryoides type, tooth base 32–64 µm wide; *operculum* rostrate,

→  
**Fig. 5.** *Fissidens bogosicus* Müll. Hal. 1 – sporophytic stem; 2–4 – perichaetial plants; 5 & 6 – vegetative stems; 7 – perichaetial stem with perichaetial branch and small basal perigonial stem; 8 & 9 – leaves; 10 – leaf apex; 11 – mid leaf; 12 – basal part of leaf. 1, 5 & 8 from type *F. bogosicus* (H-SOL); 2 & 6 from *Pócs & Magombo 9176/O* (L); 3 from *Hodgets 2360A* (private herbarium Bruggeman-Nannenga); 4, 7, 9–12 from *Pócs 90070/C* (private herbarium Bruggeman-Nannenga). Rusty coloring of 1, 3, 5 & 8 is caused by 5% KOH. The coloration of 11 & 12 has been manipulated to make some details better visible.





0.3–0.4 mm long; *calyptra* smooth, 0.4 mm; *spores* 17.5–33.0  $\mu\text{m}$  long, papillose.

This variable species is characterized by vegetative stems with elimbate or  $\pm$  elimbate leaves, and perichaetial stems with partly or completely limbate vaginant laminae on upper and mid leaves. It is most likely to be confused with other incompletely limbate species. Of these *F. taylorii* differs by being distinctly heterocaulous with short, frondose perichaetial stems with narrower leaves and leaf apices (compare Fig. 17: 2 and Fig. 5: 1–4, 7 with Fig. 17: 4, 5). Moreover, *F. taylorii* frequently has (weak) limbidia on all laminae in the upper leaves of perichaetial plants. In vegetative state the two species cannot be distinguished (Fig. 17: 1 and 3). *Fissidens rotareaui*, with which it may grow mixed, differs by vaginant laminae that are limbate in both vegetative and perichaetial stems and by ex- to percurrent costae. *Fissidens gomae* often has similarly shaped perichaetial stems, but is easily distinguished by its limbate leaves.

NOTE. My earlier concept of *F. bogosicus* (Bruggeman-Nannenga 1997) included *F. taylorii* and *F. rotareaui*. Therefore, all synonyms proposed there need to be re-examined. This is not finalized in this paper.

HABITAT. Montane evergreen forest fragment, riverine evergreen forest, xerophyta bush, river bank, *Syzygium* thicket.

SUBSTRATE. Saxicolous, less often on soil.

ALTITUDE. 930–2200 m.

DISTRIBUTION. Northeast tropical Africa (Ethiopia, Eritrea); east tropical Africa (Tanzania); south tropical Africa (Malawi, Zambia); and southern Africa (Botswana, South Africa).

The distribution in O'Shea (2006) needs revision as it is in part based on *F. taylorii* and *F. rotareaui*.

SPECIMENS EXAMINED: TANZANIA, Kilimanjaro Mts, *Pócs 90070/C p.p.* with *F. megalotis* subsp. *helictocaulos* and *F. cryptoneuron* (EGR, private herbarium Bruggeman-Nannenga). – BOTSWANA, *Long 12465* (private herbarium Bruggeman-Nannenga). – ERITREA, *Schweinfurth s.n.* (H-BR). – ETHIOPIA, *Beccari s.n.* (H-SOL). – MALAWI, *Pócs & Magombo 9176/O* (EGR, L) and *9182/C* (EGR, L, 2 stems in mix); *Hodgetts 2360A* (E, private herbarium Bruggeman-Nannenga). – ZAMBIA, *Townsend 75/19* (E, private herbarium Bruggeman-Nannenga).

## 6. *Fissidens crispus* Mont.

Fig. 6

Ann. Sci. Nat., Bot., sér. 2, 9: 57. 1838. – TYPE: Peru, ad terram arenosam in sylvis Provinciae Corrientes secus flumen S. Lucie cum *Hypno microphylo* et *Gymnostomo orbigniano*, d'Orbigny s.n. (HOLOTYPE: PC-Mont; ISOTYPES: BM, FH, PC. Not seen).

*Fissidens schmidii* Müll. Hal., Bot. Zeit. (Berlin) 11: 18. 1853. – TYPE: India. Nilgiri, *B. Schmid 43b* (not seen, probably lost).

?*F. mobukensis* G. Negri, Ann. Bot. (Rome) 7: 163. 1908. – TYPE: M. Ruwenzori, in rupem inter Ibanda et Bihunga m. 2000 ca (not seen). This is probably a synonym as according to the protologue the type has limbate leaves and small quadratic cells, but the type still needs to be checked.

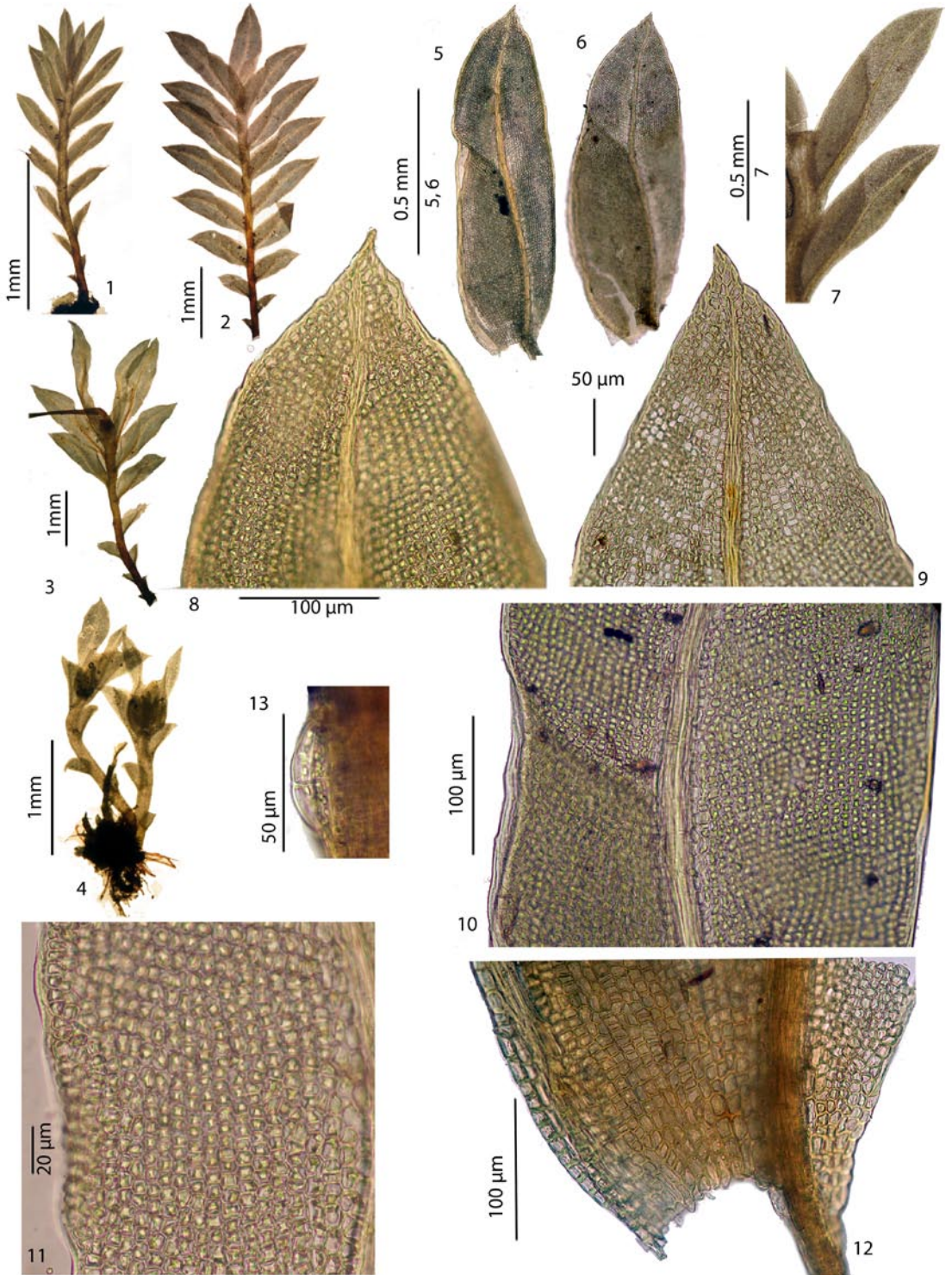
*Fissidens hoeegii* P. de la Varde, Kongel. Norske Vidensk. Selsk. Forh. 5: 130, fig. 1–8. 1932. – TYPE: South Africa [Africa australis], prov. Natal, distr. Umgeni prope Pietermaritzburg in umbratis lapidibus, *O. A. Høeg 423* (LECTOTYPE designated by Bruggeman-Nannenga 1997: PC-PV; ISOLECTOTYPE: BM) – **syn. nov.**

*Fissidens cataractarum* Demaret & P. de la Varde, Bull. Jard. Bot. État Brux. 27: 755, fig. 77. 1957. – TYPE: Democratic Republic of the Congo [Congo belge], Distr. des Lacs Edouard et Kivu: Ruwenzori, Kyandolire, cascade de la Mulaka, alt. 1750 m, Juin 1953, *Demaret 5939* (HOLOTYPE: BR; ISOTYPE: PC-PV). – **syn. nov.**

Scattered or in large mats; *stem* with central strand, branched or not, 1.5–5.5  $\times$  1.2–2.7 mm, pinnate; *rhizoids* basal, brown, smooth; *axillary*

Fig. 6. *Fissidens crispus* Mont. 1 & 2 – vegetative stem; 3 – sporophytic stem; 4 – perigonial stems; 5–7 – leaves; 8 & 9 – leaf apices; 10 – mid leaf; 11 – margin mid dorsal lamina; 12 – basal part of leaf; 13 – axillary nodule. 1 & 7 from *Pócs 8405/N* (L); 2–5, 8, 12 & 13 from *P 88281/N* (private herbarium Bruggeman-Nannenga); 6 from *Pócs et al. 88295/D* (private herbarium Bruggeman-Nannenga); 9 from *Maas Geesteranus 5147/F* (L); 10 from *Pócs 8664/ F* (L); 11 from *Pócs & Ochyra 88144/V* (private herbarium Bruggeman-Nannenga).





cells weakly differentiated; *leaves* green, obscure, close to distant, up to 15 pairs, strongly crispate when dry, elliptical, elliptico-lanceolate, broadly lanceolate to oblong, acute to acute-acuminate to obtuse apiculate,  $0.6\text{--}1.2 \times 0.2\text{--}0.3$  mm, L/W 2.5–4.5, limbate; *limbidium* reaching the leaf apex or ending below; on dorsal laminae ending well above the insertion to reaching it, on the decurrent part present or not, in mid dorsal lamina  $4.5\text{--}16$   $\mu\text{m}$  wide, uni- to bistratose; on vaginant lamina reaching the insertion and confluent at the apex, uni- to bistratose, marginal to intramarginal by 1–2 cell rows; *vaginant lamina*  $3/5\text{--}3/4$  the leaf length, closed, unistratose; *dorsal lamina* straight to slightly rounded below, undulate or not, reaching the insertion, not to long decurrent; *dorsal* and *apical laminae* unistratose or unistratose with some bistratose dots; *costa* ending 2 cells below the leaf tip to percurrent; *laminal cells* obscure, quadratic to oblong, often arranged in rows, convex, in mid dorsal lamina  $3.0\text{--}9.5(-12.0) \times 3.0\text{--}7.5$   $\mu\text{m}$ ; mid vaginant laminal cells  $8.0\text{--}13.0 \times 5.0\text{--}8.0$   $\mu\text{m}$ .

*Fertile parts.* *Perigonia* terminal on stems and on (not bud-like) branches, male stems 1–4 mm long, *antheridia* 150–300  $\mu\text{m}$ ; *perichaetia* terminal, *perichaetial* stems 3.4–4.0 mm long, hardly different from vegetative stems; *archegonia* 300–400  $\mu\text{m}$  long; *perichaetial leaves* 1.6–2.2 mm long, in some collections almost twice as long as mid stem leaves; *seta* 3–5 mm long, smooth, 1 per perichaetium; *capsule* symmetrical,  $0.65\text{--}1.00 \times 0.30\text{--}0.45$  mm with 52–58 columns of oblong exothecial cells; *peristome* bryoides type, tooth base 30–56  $\mu\text{m}$ ; *operculum* rostrate, 0.4 mm long; *calyptra* mitrate, smooth, 0.6–0.7 mm; *spores* subglobose, 12.0–22.5  $\mu\text{m}$  diam.,  $\pm$  smooth to faintly papillose.

This species is characterized by obscure leaves, small, slightly to strongly convex  $\pm$  quadratic laminal cells arranged in rows. Most collections can be recognized at a low magnification by the obscure leaves and often delicate limbidia. When *F. crispus* does not flatten in water 5% KOH will usually help. In KOH the specimens turn brown, particularly the costa and limbidia. Specimens that are hard to distinguish from *F. androgynus* are

frequently seen (see also under *F. androgynus*). Both species are common and occur in a wide variety of habitats on a wide variety of substrates and often grow mixed. Typically *F. androgynus* has clear leaves and larger, not quadratic, plane to slightly convex laminal cells. Both species can have long decurrent dorsal laminae and marginal or intramarginal limbidia. For differentiation from *F. artsii* see under that species.

**HABITAT.** In a wide variety of wet to dry habitats, but mostly in forests, e.g. rainforests (montane 2 $\times$ , submontane 1 $\times$ ); dry evergreen forests (5 $\times$ ), mesic evergreen montane forests 1 $\times$ ; riverine evergreen forests 1 $\times$ ), dry semideciduous forests (2 $\times$ ), *Hagenia* forests (4 $\times$ ), *Cupressus lusitanica* plantations (6 $\times$ ); unspecified forests; mature, mist affected, but heavily grazed *Acacia* stand; remnants of *Juniperus excelsa* forest; also in xeric bush on rock outcrop (1 $\times$ ); dambo-like swamp and moorland vegetation (1 $\times$ ); on sandy/peaty bank by stream in deep shade (1 $\times$ ); near cascades (2 $\times$ ); and on a roadside bank.

**SUBSTRATE.** Most often lignicolous (corticolous or on roots (9 $\times$  of which 2 on coniferous bark) and on (rotting) wood (8 $\times$ ); also frequently rupicolous (8 $\times$  including 2 finds on concrete and one from an earth covered rock) and on soil (10 $\times$ ).

**ALTITUDE.** 1000–2500 m. In Bruggeman-Nanenga (2006b) this species (as *F. schmidii*) was reported from 3870 m. This specimen, however, is now identified as *F. artsii*.

**DISTRIBUTION.** Pantropical, in Africa known from west tropical Africa (Guinea, Nigeria, Sao Tome); west-central tropical Africa (Bioko, Central African Republic, Cameroon, Democratic Republic of the Congo, Gabon); northeast tropical Africa (Ethiopia); east tropical Africa (Kenya, Tanzania, Uganda); and southern Africa (Lesotho, South Africa). Widespread and common in Tanzania: Arusha (Mt. Meru, Ngorongoro); Kilimanjaro (Kilimanjaro Mts); Iringa (Southern Highlands); Mbeya (Mbeya); and Tanga (West Usambara Mts).

**SELECTED SPECIMENS:** TANZANIA, Arusha, Mt. Meru, *Pócs 8664/B*, *C, F, P* (EGR, L), *Pócs 8678/R* (with *F. megalotis* subsp. *helictocaulos*), *T, U, V* (EGR, L),



*Pócs 88085/D, J* (EGR, private herbarium Bruggeman-Nannenga), *Pócs et al. 88086/D, G, X* (EGR, private herbarium Bruggeman-Nannenga), *Pócs 88139/E* (KRAM, private herbarium Bruggeman-Nannenga), *Pócs & Nsolomo 88140/D* (EGR, KRAM, private herbarium Bruggeman-Nannenga), *Pócs & Nsolomo 88140/Q* (EGR, private herbarium Bruggeman-Nannenga), *Pócs 88141/A* (EGR, private herbarium Bruggeman-Nannenga), *Pócs & Ochrya 88144/J, V, Z* (EGR, private herbarium Bruggeman-Nannenga), *Pócs et al. 88162/S* (KRAM, private herbarium Bruggeman-Nannenga), *Pócs et al. 88295/D* (EGR, private herbarium Bruggeman-Nannenga), *Sharp 858A* (EGR, L), *Sharp, Gilbert & Suso 9786 p.p.* plus *F. megalotis* subsp. *helictocaulos* (EGR, L); Ngorongoro Conservation Area, *Pócs & Chuwa 88280/S* (EGR, private herbarium Bruggeman-Nannenga), *88281/AA, N* (EGR, private herbarium Bruggeman-Nannenga), *89019/T* (EGR, private herbarium Bruggeman-Nannenga), *89031/AW p.p.* (EGR, private herbarium Bruggeman-Nannenga), *Van Zanten & Pócs 86.07.220 and 86 07 227* (both GRO, private herbarium Bruggeman-Nannenga); Kilimanjaro, Kilimanjaro Mts, *Pócs 6237/F* (PC), *Pócs 90126/E* (EGR, private herbarium Bruggeman-Nannenga); *Pócs 90134/E* mixed with *F. loennbergeri* (EGR, private herbarium Bruggeman-Nannenga), *Gilbert 21/B* (EGR), *29B* (EGR, L), *Van Zanten & Pócs 86.08.334* (GRO, private herbarium Bruggeman-Nannenga); Iringa, Southern Highlands, *Pócs 8637/L* (EGR, private herbarium Bruggeman-Nannenga); Mbeya District, *Townsend 75/330 p.p.* (E); Tanga, West Usambara Mts, *Pócs 8405/N* (EGR, L), *8436/Z* (EGR, L) and *8546/D* (EGR, L).

ILLUSTRATIONS: Bruggeman-Nannenga (2006b: fig. 22 as *F. schmidii*), Demaret & Potier de la Varde (1957: 77 as *F. cataractarum*), Iwatsuki & Suzuki (1982: pl. X as *F. bryoides* var. *schmidii*), Magill (1981: fig. 9: 8–14 as *F. hoeegii*), Pursell (2007: fig. 38: A–E).

### 7. *Fissidens curvatus* Hornsch.

Linnaea **15**: 148. 1841. – TYPE: South Africa, Cape Prov., 4 X 1827, *Ecklon s.n.* (LECTOTYPE designated by Magill 1981: H-BR; ISOLECTOTYPES: S, BM both as ‘An einer Mauer in Mr. Auret’s Garten unter dem Löwenrücken, 24 October. 1827, *Ecklon s.n.*’).

#### *F. curvatus* var. *curvatus*

Fig. 7

*Fissidens algarvicus* Solms, Tent. Bryo-geogr. Algarv.: 41. 1868. – HOLOTYPE: Portugal, in Algarve humidusculus argillaceis ad oppidum silves Perrara stirps, *Leptotrichi subulati* caespitibus parce immixta; *Flora*

*lusitanica* Algarve 18. Silves ad terram. Solms, 1866 (GOET).

*Fissidens macleanus* J. Shaw, Cape Monthly Mag. **17**: 314. 1878. – TYPE: South Africa, Cape Prov., Graaf Reynett, *MacLea s.n.* as Rehmann Musci Austro-Africani 583 (easily misread as 533) (LECTOTYPE designated by Bruggeman-Nannenga 1997: H-BR; ISOLECTOTYPE: PC mixed with a few stems of *F. megalotis*).

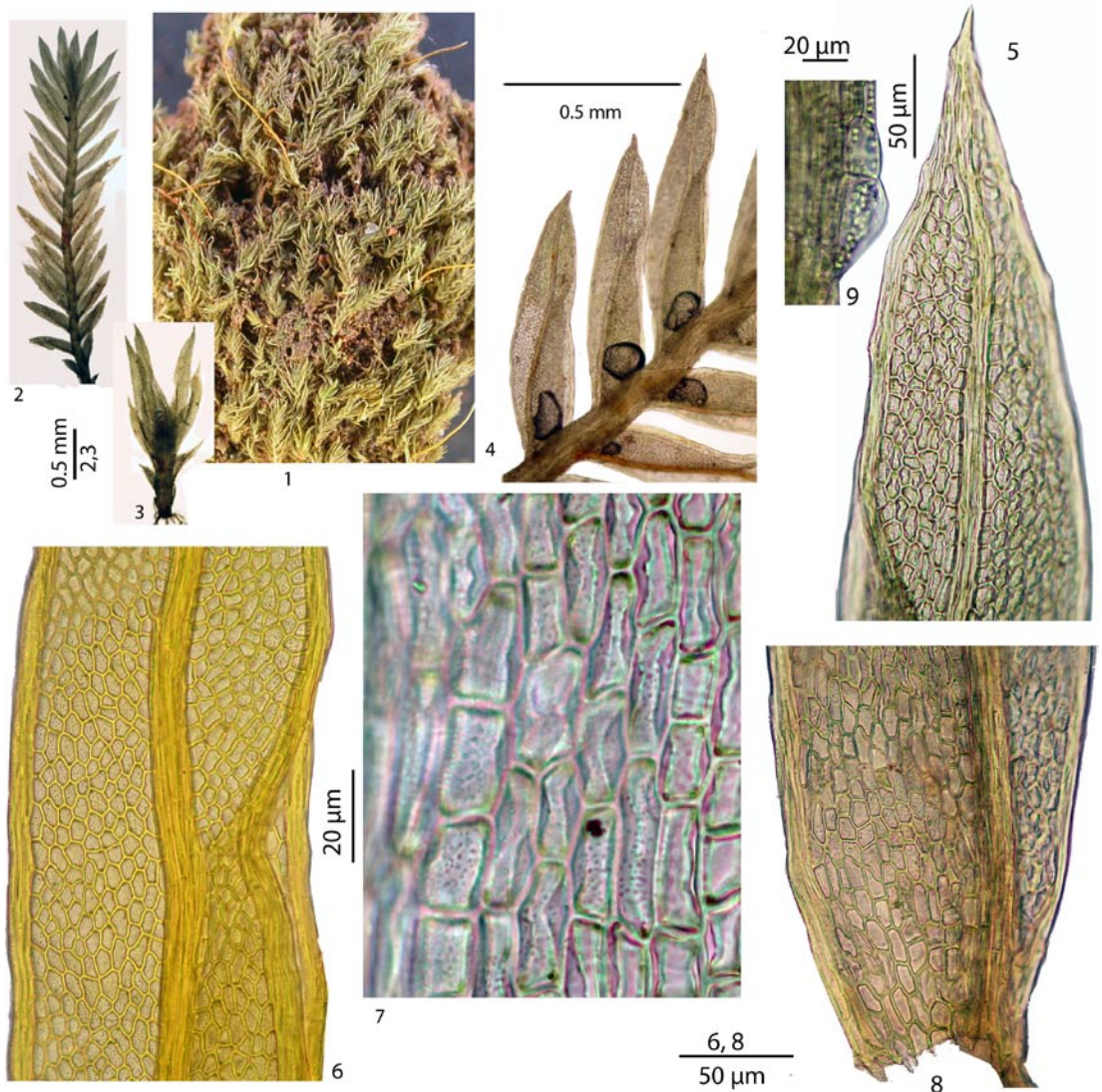
*Fissidens sericeus* Broth., Bot. Jahrb. Syst. **20**: 181. 1894. – TYPE: Tanzania, Usambara, Kwa Mshusa-Station, bei Msingo, 1600 m, am Boden, *Holst 9195, p.p.* (HOLOTYPE: H-BR; ISOTYPE: PC).

*Fissidens attenuatus* Bryhn, Kongel. Norske Vidensk. Selsk. Skr. (Trondheim) **8**: 16. 1908. – LECTOTYPE (nov.): Tenerife, Las Mercedes. Lat. sept. 28 30', 600 m, 19 V 1908. *Bryhn s.n.* (H-BR).

*Fissidens fritzei* Geh., Biblioth. Bot. **73**: 55, T. IA. 1910. – LECTOTYPE (nov.): Madeira, *Fritze s.n.* (H-BR).

*Fissidens angustinervis* Thér., Recueil Publ. Soc. Havraise Etudes Diverses **90**: 80. 1923. – TYPE: Madagascar, Tananarive, *Décary s.n.* (HOLOTYPE: PC; ISOTYPE: H-BR).

Growing in dense mats. *Stem* with central strand, heterocaulous; *rhizoids* basal, bright brown, smooth; *axillary nodules* weakly differentiated, hyaline; *perichaetial stems* branched or unbranched, 1.4–1.6 × 0.7–0.8 mm (occasionally longer and similar to vegetative stems); *perichaetial stem leaves* ± frondiform, crowded to slightly distant, up to 6 pairs that differ much in shape and size; *vegetative stems* mostly unbranched, 2.0–5.0 × 0.7–1.2 mm, pinnate; *leaves* green, distant to somewhat crowded, up to 20 pairs, hardly altered when dry, linear-elliptical to linear-lanceolate, acute-acuminate to mucronate, symmetric or asymmetric, 0.70–0.95 × 0.15–0.20 mm, L/W 3.5–6, limbate on all laminae of all leaves; *limbidium* confluent at the leaf apex, reaching the insertions of the dorsal and vaginant lamina, confluent at the apex of the vaginant lamina; on mid dorsal lamina 13.0–14.5 µm wide, bistratose; on vaginant laminae 1–2 stratose, marginal; *vaginant lamina* 2/3–3/4 the leaf length, closed, unistratose; *dorsal lamina* narrowed below, reaching the insertion to ending well above, in basal part often limbidoid, not decurrent, *dorsal* and *apical laminae* unistratose; *costa* per- to long excurrent; mid dorsal *laminal cells* smooth (but see



**Fig. 7.** *Fissidens curvatus* Hornsch. 1 – habit; 2 – vegetative stem; 3 – perichaetial stem; 4 – leaves; 5 – leaf apex; 6 – mid leaf colored yellow by 5% KOH; 7 – mid vaginant laminal cells with (pseudo?) papillae; 8 – basal part of leaf; 9 – weak axillary nodule. 1, 4 & 7 from *Pócs 8540/Q* (L); 2, 3, 6 & 8 from *Pócs 8401/J* (L); 5 from *Pócs 8450/P* (L); 9 from *Pócs 8540/Q* (L).

note below), plane, oblong-hexagonal,  $8.0\text{--}16.5 \times 5.0\text{--}8.0 \mu\text{m}$ ; mid vaginant laminal cells oblong,  $6.0\text{--}17.5 \times 4.5\text{--}6.5 \mu\text{m}$ .

*Fertile parts*, *perigonia* terminal on short, often bud-like stems at base of perichaetial and vegetative stems, less often on short, budlike or longer branches of perichaetial stems; perigonial stems  $0.35\text{--}0.90 \text{ mm}$  long; *antheridia*  $150\text{--}180 \mu\text{m}$

long; *perichaetia* terminal on stems or less often on branches from lower stem half; *perichaetial leaves*  $0.6\text{--}1.0 \text{ mm}$  long, *archegonia*  $170\text{--}230 \mu\text{m}$  long; *seta*  $3.5\text{--}6 \text{ mm}$  long, smooth, 1 per perichaetium; *capsule* strongly inclined to horizontal,  $0.70 \times 0.45 \text{ mm}$ , with  $40\text{--}48$  columns of oblong exothecial cells; *peristome* bryoides type, tooth base  $36\text{--}51 \mu\text{m}$  wide; *operculum* conical to short

rostrate, 0.2–0.3 mm long; *calyptra* 0.5 long, not split, smooth; *spores* 11–18 × 8–13 µm, distinctly papillose.

*Fissidens curvatus* is characterized by limbate leaves, per- to excurrent costae and stout limbidia that are confluent with the costa; large, clear mid dorsal laminal cells; and pinnate vegetative stems with small, even-sized leaves that differ markedly from the shorter, frondose perichaetial stems. Characteristic, though not found in all collections are large oblong vaginant laminal cells (Fig. 7: 7, 8). Equally characteristic and again not seen in all collections, are laminal cells that seem to be finely pluripapillose (see below). In the field *F. curvatus* is usually easily recognized by its stiff, pinnate vegetative stems with linear leaves (Fig. 7: 1, 2, 4). *Fissidens curvatus* colors yellow in 5% KOH. It may be confused with *F. taylorii* which differs by less well developed limbidia that do not reach the leaf apex and in the Tanzanian specimens are ± restricted to the vaginant laminae mid and upper leaves of perichaetial stems.

Laminal cells of *F. curvatus* and *F. rotareauii* frequently seem finely papillose (Fig. 7: 7 and Fig. 15: 10). This was discussed by Potier de la Varde (1929). With a light microscope it is impossible to establish whether these cells are papillose or pseudopapillose.

**HABITAT.** In Tanzania most often on road banks and road cuttings; often in plantation forests; in addition in submontane rainforest (1×), montane rainforest (1×), remnants of *Juniperus excelsa* forest with *Hagenia abyssinica* (1×), and mixed deciduous woodland (1×).

**SUBSTRATE.** Most Tanzanian specimens grow on soil and only rarely on rocks or wood; once collected on a termite mound.

**ALTITUDE.** 0–3250 m.

**DISTRIBUTION.** Cosmopolitan, in the neotropics found from southern USA to Chile and Argentina; further known from St Helena, southwestern Europe, Australia, and New Zealand (Bruggeman-Nannenga & Pursell 1995). African distribution: Macaronesia (Azores, Canary Islands, Madeira); west tropical Africa (Nigeria); east tropical Af-

rica (Kenya, Rwanda, Tanzania, Uganda); south tropical Africa (Malawi, Zimbabwe); southern Africa (Lesotho, South Africa, Swaziland); and western Indian Ocean (La Réunion, Madagascar). In Tanzania known from Arusha (Mt. Meru), Dodoma (Chenene Hills), Kilimanjaro (S. Pare Mts). Morogoro District (Nguru Mts, S-Uluguru Mts), Rukwa (Ufipa District), and Tanga (West Usambara Mts).

**SPECIMENS EXAMINED:** TANZANIA, Arusha, Mt. Meru, *Laaka* 879, 884, 886 (H), *Pócs et al.* 88085/J, *p.p.* (EGR, private herbarium Bruggeman-Nannenga), *Pócs et al.* 88145/Q (EGR, private herbarium Bruggeman-Nannenga), *Crosby* 14447 with *F. ovatus* Brid. (MO); Dodoma, Chenene, *Polhill & Paulo* B9 mixed with *F. beckettii* (E); Kilimanjaro, South Pare Mts, *Pócs et al.* 90042/AL (EGR, private herbarium Bruggeman-Nannenga); Morogoro District, Nguru Mountains, *Kiss* 9128/F (EGR, L), S-Uluguru Mts, *Pócs* 6212/D with *F. beckettii* (EGR, PC), *Pócs* 6812/C (EGR, PC); Rukwa, Ufipa District, *Townsend* 80/275 (E); Tanga, West Usambara Mts, *Pócs* 8401/J (EGR, L), 8450/P, S, R, S (EGR, L), 8540/Q, V (EGR, L), 89254/F (EGR, private herbarium Bruggeman-Nannenga).

**SELECTED ILLUSTRATIONS:** Beever *et al.* (2002: 24), Iwatsuki & Suzuki (1982: pl. XVI as *F. strictulus* Müll. Hal.), Magill (1981: fig. 11: 1–8), Pursell (1994: fig. 43; 2007: fig. 51), Smith (1978: fig. 87: 5–7 as *F. algarvicus*).

## 8. *Fissidens gladiolus* Mitt. Fig. 8: 1–5

Trans. Linn. Soc. London **23**: 55, tab. 6, fig. 16: 1–3. 1860; *Nanobryum gladiolum* (Mitt.) Bizot, Rev. Bryol. Lichénol. **38**: 593. 1971[1973]. – HOLOTYPE: interior of Africa, *Mungo Park* (NY).

*Nanobryum dummeri* Dixon, J. Bot. **60**: 101, pl. 564: 1a–g. 1922. – LECTOTYPE designated by Bizot 1963: Uganda, on damp earth and hollows of fallen trees in forest, Muhange, Nov. 1920, *Dummer* 4080A (BM).

*Anisothecium pallidisetum* P. de la Varde, Bull. Soc. Bot. France **73**: 380, fig. 32. 1926. – HOLOTYPE: Central African Republic, 7 km S Ippy. Rochers du Kaga Lekpwa. Endroit humide. 25 VII 1929, *Tisserant* 98 (PV 2079) (PC-PV).

Sparsely scattered between other species, rarely in mats; *vegetative* stems unknown, *perichaetial stem* unbranched, elongate frondiform, 1.0–6.0 × 0.8–2.5 mm; *rhizoids* basal, pale brown and

smooth, protonemata persistent (not observed in all collections); *axillary nodules* and cells not checked; *leaves* distant, 3–5 pairs, tortuose, difficult to straighten, linear-lanceolate; *perichaetial leaves* with or without dorsal and apical laminae, subulate,  $1.5\text{--}2.9 \times 0.2\text{--}0.25$  mm, L/W 7.5–11.5, margin entire, elimbate or limbate; *limbidia* often present on dorsal and apical lamina, in mid dorsal lamina *ca* 10.5  $\mu\text{m}$  wide, marginal; lacking or ill-defined on the vaginant lamina; *vaginant lamina*  $\pm 1/2$  as long as the leaf, unistratose, open, widely gaping, distal end of lesser lamella tapering or ending in a sharp, free tooth or deeply indented before tapering toward the costa; *dorsal lamina* when present tapering towards the insertion, reaching the insertion; *dorsal* and *apical laminae* probably unistratose (no trans-sections made) sometimes lacking; *costa* stout, percurrent in the long subula; mid *dorsal laminal cells* narrowly oblong, clear, firm-walled, variable in size,  $45.0\text{--}82.5 \times 4.5\text{--}9.0$   $\mu\text{m}$ , smooth; inner *vaginant laminal cells* narrowly oblong, variable in size,  $45.0\text{--}144.0 \times 9.5\text{--}19.0$   $\mu\text{m}$ , smooth; marginal vaginant laminal cells longer, forming an ill-defined limbidium.

*Fertile parts*, *perigonia* terminal on small, budlike stems; *antheridia* 150  $\mu\text{m}$  long; *perichætia* terminal, *archegonia* 280–370  $\mu\text{m}$  long. *Sporophyte*, *seta* 3–8 mm long, erect, smooth, 1–2 per perichaetium; *capsule* inclined to cernuous,  $0.50\text{--}0.80 \times 0.25\text{--}0.50$  mm, 40–60 columns of irregularly oblong to quadratic exothecial cells; *peristome* bryoides type (only basal OP seen), teeth 39–51  $\mu\text{m}$  wide at base; *operculum* rostrate, 0.45–0.50 mm long; *calyptra* smooth, mitrate; *spores* subglobose, 9–15  $\mu\text{m}$  long, smooth to faintly papillose.

This curious little species is characterized by perichaetial stems with long, subulate upper leaves with poorly developed, or occasionally lacking

dorsal and apical laminae;  $\pm$  elimbate vaginant laminae of large, prosenchymatous cells; and persistent, thalloid protonemata (sometimes lacking). It is unlikely to be confused with any other species, except *F. magnicellulatus*. For differences see under that species and Fig. 8.

Unfortunately, *F. gladiolus* is known only from perichaetial stems with 3–5 leaf pairs. These are too short to have ‘morphological mid stem leaves’. The species is variable and sometimes shows anomalies. For instance two specimens, including an isotype of *F. gladiolus* in BM, have extra laminae in addition to the usual dorsal and apical.

HABITAT. *Eucalyptus* plantation; dry evergreen forest.

SUBSTRATE. On soil.

ALTITUDE. 770–2000 m.

DISTRIBUTION. West tropical Africa (Nigeria); west-central tropical Africa (Central African Republic, Gabon); east tropical Africa (Tanzania, Uganda); and southern Africa (South African Republic). A record from Zambia (Bruggeman-Nannenga 2009) refers to *F. magnicellulatus*. Tanzanian distribution: Morogoro (Bizot & Pócs 1979) and Tanga (West Usambara Mts).

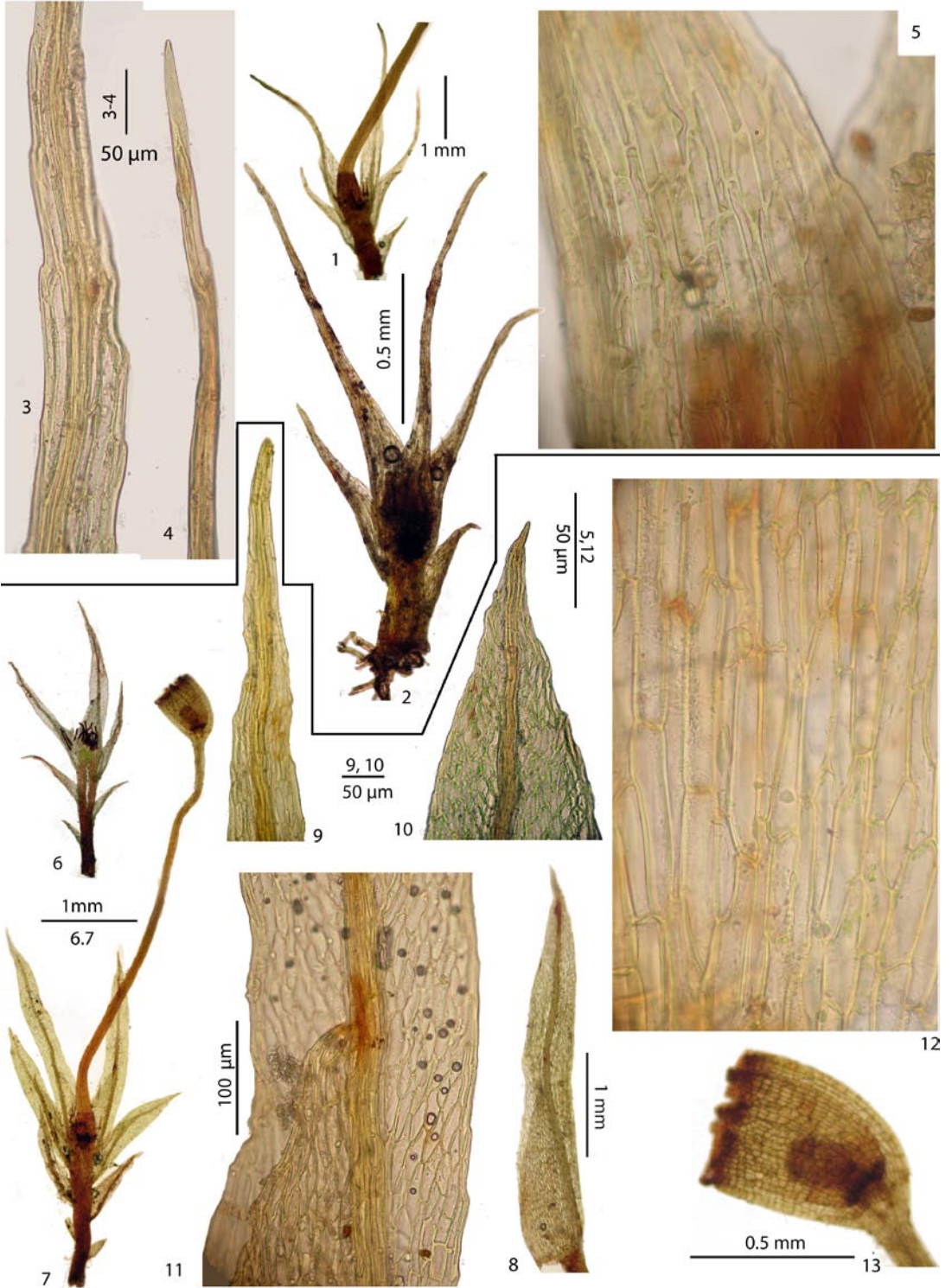
SPECIMENS EXAMINED: TANZANIA, West Usambara Mts, Pócs, *Ochyra* & *Bednarek-Ochyra* 88116/E a single stem mixed with *F. megalotis* subsp. *helictocaulos* (KRAM). – UGANDA, Bunyore Prov., Jones 572 (PC-PV); Kabarole, Wigginton U 3109A (E, L, 1 stem). – NIGERIA, Abeokuta province, Berry 902 (PC-PV). – CENTRAL AFRICAN REPUBLIC, Assel 416 (PC).

SELECTED ILLUSTRATIONS: Bruggeman-Nannenga (2006a: fig. 9), Dixon (1922: pl. 564, fig. 1a–g as *Nanobryum dummeri*), Pursell & Reese (1980: fig. 1–11), Potier de la Varde (1926: fig. 32a–f as *Anisothecium palidisetum*; 1928: fig. 9a–o as *Nanobryum dummeri*).



**Fig. 8.** *Fissidens gladiolus* Mitt. (1–5). 1 – sporophytic stem; 2 – perichaetial stem; 3 – part of perichaetial leaf, distal part of vaginant lamina on the right and vestigial dorsal lamina on the left; 4 – subula of perichaetial leaf; 5 – vaginant lamina of perichaetial leaf with long, narrow cells and ill-defined limbidium. *F. magnicellulatus* Brugg.-Nann. (6–13). 6 – perichaetial stem; 7 – sporophytic stem; 8 – perichaetial leaf; 9 – apex perichaetial leaf; 10 – apex subperichaetial leaf; 11 – termination of the vaginant lamina of mid perichaetial leaf; 12 – basal part vaginant lamina showing the long, narrow cells; 13 – capsule. 1 from Jones 572 (PC-PV); 2 & 5 from Wigginton U 3109A (L); 3 & 4 from Assel 416 (PC); 6, 9 & 11 from Pócs & Nsolomo 88139/E (EGR 1 broken stem); 7, 8, 10, 12 & 13 from Townsend 75/21 (holotype L).





9. *Fissidens gomae* P. de la Varde & J.-F. Leroy  
in J.-F. Leroy Fig. 9

Bull. Jard. Bot. État Brux. **18**: 156, fig. 10. 1947. – TYPE: Democratic Republic of the Congo [Congo belge], sous-district de la plaine de lave et des formations sclérophylles. Goma, sur la lave, grande crevasse, mai 1936, Leroy 163 [LECTOTYPE (nov.): BR (mixed with a few *F. zollingeri* Mont.); ISOTYPE: PC-PV].

Growing in loose mats. *Stems* mostly unbranched, 2.0–4.0 × 1.2–1.5 mm, pinnate with distinct, red or colorless central strand; *rhizoids* basal, pale brown, smooth; *axillary cells* weakly differentiated; *leaves* green, distant to close, 9–15 pairs, crispate when dry, oblong, broadly elliptical and oblong-obovate with broadly acute, rounded apiculate or obtuse apiculate apex, 0.50–1.20 × 0.15–0.40 mm, L/W 2.5–4, margin subentire to weakly crenulate where elimbate; limbidium present on all laminae of mid and upper leaves of both perichaetial and vegetative stems, in lower leaves frequently restricted to the vaginant laminae, confluent at the apex of the vaginant lamina or not, reaching the insertion of the vaginant lamina or not; ending well below the leaf apex; frequently ending well above the insertion of the dorsal lamina, in mid dorsal lamina, 4.5–11.0 µm wide, unistratose, rarely locally bistratose; on vaginant lamina unistratose, marginal to intramarginal by 1 row; *vaginant lamina* 1/2–3/5 the leaf length, closed or slightly open, unistratose; dorsal lamina narrowing and ± straight to slightly rounded towards the insertion, reaching the insertion, not decurrent; *dorsal and apical laminae* unistratose; costa ending 1–3 cells below the apex; mid dorsal laminal cells clear, hexagonal, smooth, plane, 8.0–17.5 × 6.5–11.0 µm; mid vaginant laminal cells 8.0–24.0 × 6.5–11 µm.

*Fertile parts.* *Perigonia, perichaetia* and *synoicia* terminal, less often on short branches from upper part of stem, *perigonial stems* 3.5 mm long; *antheridia* 200–250; *synoicial leaves* 0.65–

0.70 mm long, *perichaetial leaves* 0.95–1.40 mm long; *archegonia* 200–350 µm. *Sporophyte, seta* 2 mm long, smooth, 1 per perichaetium; *capsule* symmetrical, 0.75 × 0.35 mm, with 56 files of oblong exothecial cells; *peristome* of the bryoides type, at the base 33.5–50.0 µm wide; *operculum* not seen; *calyptra* not seen; *spores* 14.5–18 µm long, smooth, pale brownish green.

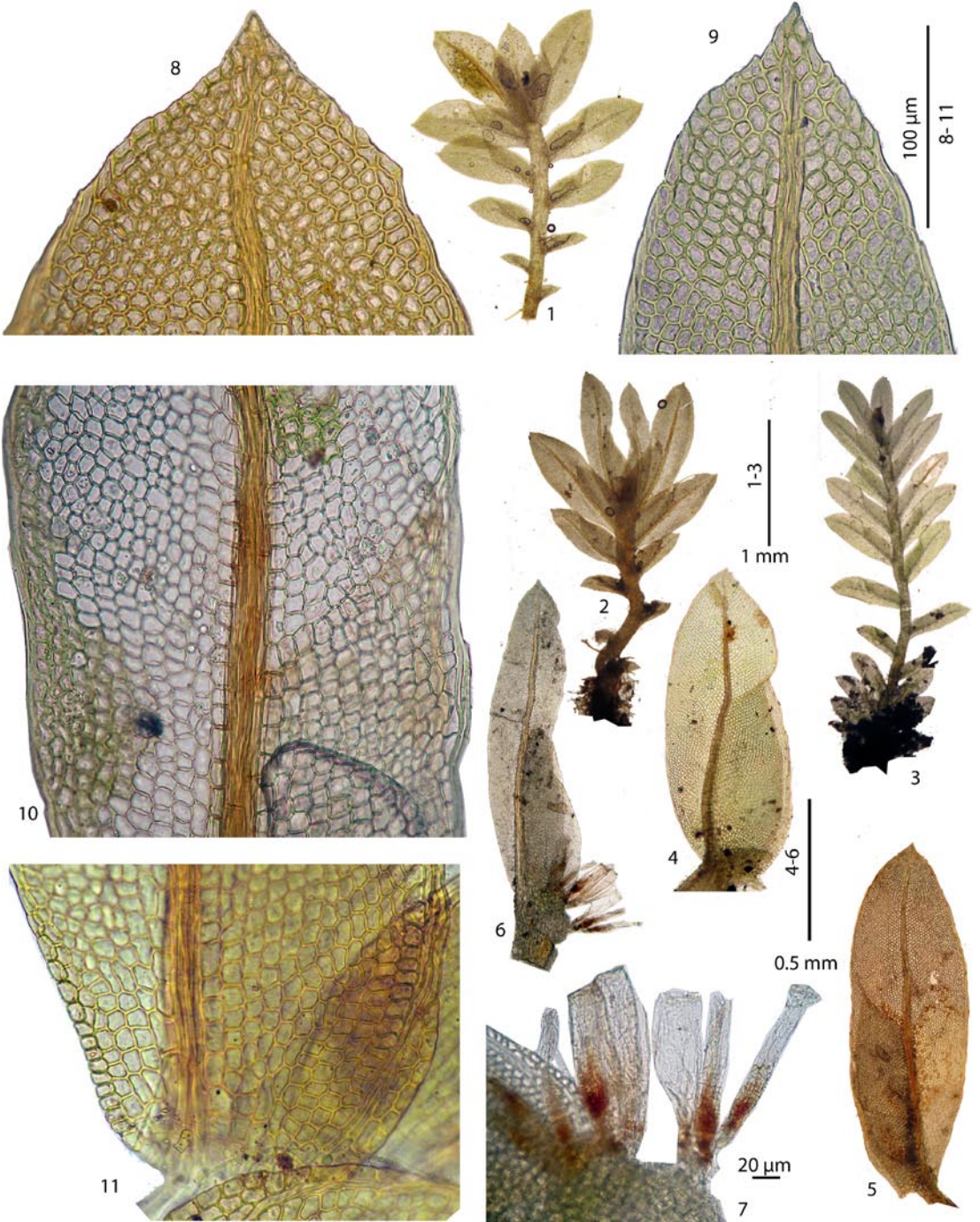
This species is characterized by its small size, large clear cells, leaves of perichaetial stems and the upper and mid leaves of vegetative stems limbate on all laminae, in lower leaves limbidium often restricted to the vaginant laminae, and by delicate, 1(2) stratose limbidia that end below the leaf apex and above the insertion of the dorsal lamina. Synoicia and perichaetia of Tanzanian collections are often rather lax with the perichaetial and subtending leaves less crowded than in most *Fissidens* species. In such gametangia the terminal cluster of archegonia (or archegonia plus antheridia) tends to fall apart in several distinct axillary clusters (Fig. 9: 6, 7). Most Tanzanian specimens, as well as the Uganda specimen, are from places that are periodically inundated or sprayed (e.g., riverine forests, cascades). The type specimen of *F. gomae*, however, was collected in a dry habitat. Morphologically the semiaquatic specimens resemble the type. *Fissidens gomae* can be taken for a weak *F. androgynus* or a weak *F. leucocinctus*. Both, however, are more robust and have pluristratose limbidia. *Fissidens taylorii* and *F. bogosicus* can be distinguished by their elimbate to poorly limbate leaves.

NOTE. A collection of this species (*Jones & Pócs 6314/E*) was earlier recorded as *F. crassipes* var. *philibertii* Besch. (Bizot & Pócs 1979: 238).

HABITAT. Tanzania: riverine forests (4×), groundwater forest (1×), lowland rainforest (2×); near waterfall. Several collections are covered by diatoms.

Fig. 9. *Fissidens gomae* P. de la Varde & J.-F. Leroy 1 – stem (probably a young perichaetial one before forming of archegonia); 2 – perichaetial stem; 3 – vegetative stem; 4 & 5 – leaves; 6 – synoicial leaf with 2 axillary synoicial clusters (lower leaf removed); 7 – detail 6; 8 & 9 – leaf apices; 10 – mid leaf; 11 – basal part of leaf. 1 & 4 from Pócs & Ndosí 9001/E (private herbarium Bruggeman-Nannenga); 2, 5–8, 10 & 11 from Pócs, Minja & Towo 87202/L (private herbarium Bruggeman-Nannenga); 3 from Van Zanten & Pócs 86.08.313 (private herbarium Bruggeman-Nannenga); 9 from type *F. gomae* (BR). Brown coloring 5 by KOH 5%.





**SUBSTRATE.** Tanzania: saxicolous (on shady, concrete bridge pillar, on irrigated rocks, on volcanic rocks); less often on soil. In Tanzania the species seems to prefer limestone.

**ALTITUDE.** 480–1500 m.

**DISTRIBUTION.** African endemic. Known from west-central tropical Africa (Democratic Republic of the Congo, eastern part), and east tropical Africa (Tanzania, Uganda). In Tanzania known from Arusha (Mt. Meru, Tenguru), Dodoma (Usagara Mts), Kilimanjaro (foot of Kilimanjaro Mts), and Morogoro (Mahenge Plateau). New to Uganda.

**SPECIMENS EXAMINED:** TANZANIA, Arusha, Mt. Meru, *Pócs & Van Zanten 86125/K*, p.p. (EGR, L), *86125/O* (EGR, L); Tenguru, *Van Zanten & Pócs 86.08.313* (GRO, private herbarium Bruggeman-Nannenga); Dodoma, Usagara Mts, *Jones & Pócs 6314/E* (EGR, PC); Kilimanjaro, S. foot of Kilimanjaro Mts, *Pócs & Ndosí 9001/E* (EGR, private herbarium Bruggeman-Nannenga); Morogoro, Mahenge Plateau, *Pócs, Minja & Towo 87202/L* (EGR, private herbarium Bruggeman-Nannenga); Mahenge Scarp forest reserve, *Pócs, Minja & Towo 87207/N*, a few stems mixed *Fissidens sciophyllus* and a few *F. flaccidus* (EGR, private herbarium Bruggeman-Nannenga). – DEMOCRATIC REPUBLIC OF THE CONGO, Goma, *Leroy 163* (BR, PC-PV). – UGANDA, Toro District, *Lock 88/24* (E, private herbarium Bruggeman-Nannenga).

### 10. *Fissidens leucocinctus* Hampe Fig. 10

Linnaea **38**: 222. 1874. – TYPE: Madagascar, *Borgen 23* (LECTOTYPE designated by Bruggeman-Nannenga 1997: BM; ISOLECTOTYPES: PC, NY both as *Borgen s.n.*).

*Fissidens crispopachyloma* Dixon, J. Bot. **76**: 220. 1938. – HOLOTYPE: Kenya, [Kenya Colony], on rocks, along Massaoia, 20 VIII 1908, *Balbo 127* (BM).

*Fissidens rutenbergii* Paris, Index Bryol. Suppl.: 164. 1900 (new name for *F. pauperrimus* Müll. Hal., Hedwigia **38**: 54. 1899, *hom. illeg.*). – LECTOTYPE (designated by Bruggeman-Nannenga 1993): South Africa [Süd-Africa], Thal nach dem Malappa's place, Juni 1877, *Rutenberg s.n.* (PC).

*Fissidens malaco-bryoides* Müll. Hal. var. *irriguus* P. de la Varde, Rev. Bryol. Lichénol. **25**: 213, fig. 2, 16–17. 1956. – HOLOTYPE: Uganda, Kapchorwa, Sebei County, alt. 6500 ft. Rocks in stream near camp, *Lind 128* (PC-PV).

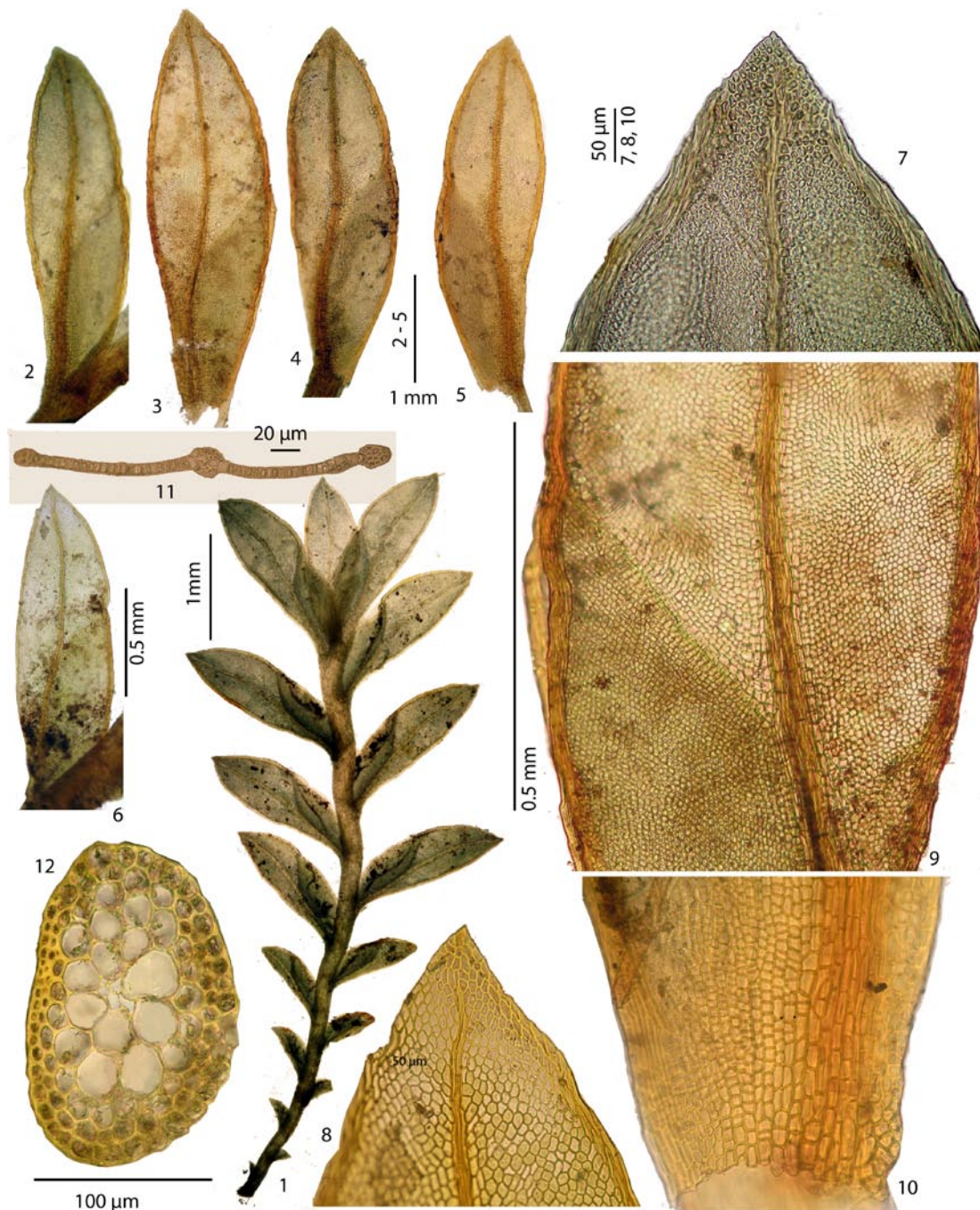
Growing in mats, submerged or not; *stem* with weak central strand, unbranched or branched, 5–30 × 2–3 mm, pinnate; *rhizoids* basal, a few axillary, bright brown, smooth; *axillary nodules* not to weakly developed; *leaves* obscure, close but not overlapping, up to 30 pairs, slightly crispate when dry, elliptical, elliptico-oblong, obovate, broadly acute to obtuse, 0.7–2.6 × 0.2–0.7 mm, L/W 3–4, limbate on all laminae (young stems and short branches sometimes elimbate on dorsal and apical laminae); *limbidium* ending well below the apex and above the insertion of the dorsal lamina or becoming indistinct toward the insertion, reaching the insertion of the vaginant lamina, confluent at the apex of the vaginant lamina; in mid dorsal lamina 32–33 µm wide, 2–5 stratoze; on vaginant lamina 1–3 stratoze, marginal or intramarginal by one row of cells; *vaginant lamina* 1/2–3/5 the leaf length, slightly open, unistratoze, near the costa 1–2 stratoze; *dorsal lamina* abruptly narrowed, narrowing and straight towards the insertion, reaching the insertion, not to indistinctly decurrent, *dorsal* and *apical laminae* unistratoze with small to large bistratoze areas, near costa and border 1–3 stratoze, 1–3 stratoze at the insertion; *costa* ending 4–5 cells below the leaf apex; mid dorsal *laminal cells* obscure, hexagonal, plane and smooth, 6.5–13.5 × 5.0–9.5 µm, deep; mid vaginant *laminal cells* 6.5–11.0 × 5.0–8.0 µm; infrequently with rhizoid-like brown files of short cells with transverse cross-walls (*gemmae*).

*Fertile parts*, *perigonia* terminal, perigonial stems 9 mm tall; *antheridia* 400 µm; *perichaetia* terminal; *perichaetial leaves* 2.2 mm long; *archegonia* 500 µm long; *sporophyte* unknown.

*Fissidens leucocinctus* is a hydrophilous to rheophilous species that is characterized by broadly elliptical, elliptico-oblong and obovate, limbate leaves; stout limbidia that typically fail well below the leaf apices and well above the insertion of the dorsal lamina; and smooth, plane to slightly convex laminal cells; basal parts of the dorsal lamina are typically pluristratoze.

According to the original description it has papillose laminal cells. The type specimen, however, has highly convex, but smooth laminal cells.





**Fig. 10.** *Fissidens leucocinctus* Hampe 1 – vegetative stem; 2–5 – leaves; 6 – leaf from expression with thin limb; 7 – leaf apex; 8 – leaf apex from expression with thin limb; 9 – mid leaf; 10 – basal part of leaf; 11 – trans section of leaf above the vaginant lamina; 12 – trans section of stem. 1 from *Pócs 90127/A* (L); 2–5, 7, 9–12 from *Pócs 6208/N* (L); 6 & 8 from *Jones & Pócs 6314/B* (PC).

*Fissidens leucocinctus* can be confused with *F. pachylomadelphus* which differs by limbidia that nearly or completely reach the insertion of the dorsal lamina and leaf apex. Small expressions can be confused with *F. obscurifrons* which has narrower leaves and poorly developed or lacking limbidia on the dorsal and apical lamina.

ABERRANT COLLECTIONS: *Pócs, Minja & Towo 87202/A* is completely encrusted in lime. An expression with atypical thin limbidia (*Jones & Pócs 6314/B, C and D*) was earlier reported as *F. crassipes* var. *philibertii* Besch. [= *F. crassipes* subsp. *warnstorffii* (M. Fleisch.) Brugg.-Nann.] by Bizot & Pócs (1979). These specimens differ from *F. crassipes* subsp. *warnstorffii* in their pluristratose basal dorsal laminae. Another collection from the same locality, *Jones & Pócs 6314/E* that was also cited as *F. crassipes* var. *philibertii* Besch. appeared to be *F. gomae*.

HABITAT. Irrigated places, near streams, streamlets and waterfalls; also in irrigation ditches. In riverine forests; primary and secondary lowland and montane rainforests; often submerged.

SUBSTRATE. Saxicolous on basalt, limestone and unspecified rocks; typically on regularly inundated or sprayed rocks, stones and pebbles near streams and waterfalls; rarely on wood (aerial roots) or soil.

ALTITUDE. 0–2100 m.

DISTRIBUTION. West-central tropical Africa (Cameroon, Democratic Republic of the Congo, Gabon); northeast tropical Africa (Ethiopia); east tropical Africa (Kenya, Tanzania, Uganda); south tropical Africa (Angola, Zambia, Zimbabwe); southern Africa (South Africa); and western Indian Ocean (Comores, La Réunion, Madagascar). Distribution in Tanzania: Arusha (Ngorongoro), Dodoma (Usagara Mts), Kilimanjaro (Kilimanjaro Mts), and Morogoro (Mahenge Plateau). New to Angola.

SPECIMENS EXAMINED: TANZANIA, Arusha, Ngorongoro Crater, *Pócs & Chuma 89027/AO* (EGR, private herbarium Bruggeman-Nannenga); Dodoma, Usagara Mts, *Jones & Pócs 6314/B, C and D* (EGR,

PC); Kilimanjaro, Kilimanjaro Mts, *Pócs 6208/N* (EGR, L); *Pócs, Harrison & Mushi 90127/A* (EGR, private herbarium Bruggeman-Nannenga); and Morogoro, Mahenge Plateau, Mselezi Forest, *Pócs, Minja & Towo 87202/A* (EGR, private herbarium Bruggeman-Nannenga). – ANGOLA, Distrito do Cuanza-Sul, Seles, *Gossweiler 9* (BM). – DEMOCRATIC REPUBLIC OF THE CONGO, Prov. Kivu, *Pócs 6613* (BONN, private herbarium Bruggeman-Nannenga). – ETHIOPIA, *Hylander 4417* (private herbarium Bruggeman-Nannenga). – SOUTH AFRICA, Transvaal, *Brenan M 3294* (E).

ILLUSTRATIONS: Bruggeman-Nannenga (2006a: fig. 13a–e), Bruggeman-Nannenga & Arts (2010: fig. 15), Renauld (1909: pl. 37: 1 as *F. luridus* Renauld & Cardot).

### 11. *Fissidens magnicellulatus* Brugg.-Nann.

Fig. 8: 6–13

*Lindbergia* 36: 13, fig. 2. 2013. – TYPE: Zambia, Lusaka Distr. On damp vertical earth bank in *Syzygium* thicket by Bothasrus road 8 km from the Wilfred Watson turn-off from the Lusaka/Mumbwa road, alt. ca 1275 m, 10 II 1975, *Townsend 75/21, p.p.*, mixed with *F. bogosicus* (HOLOTYPE: private herbarium Bruggeman-Nannenga; ISOTYPE: E).

MISAPPLIED NAME: *Fissidens gladiolus* Bruggeman-Nannenga (2009).

Growing in mats; vegetative stems unknown; perichaetial stems 2.5–4.0 × 1.1–3.5 × 1.3–1.7 mm, unbranched, elongate frondiform, with weak central strand; rhizoids basal, pale brown to hyaline, smooth, a few persistent protonemata; axillary cells not differentiated; leaves close to distant, 4–5 pairs, crispate when dry, lanceolate, narrowly acute, subulate, upper leaves 1.35–2.20 × 0.25 mm, L/W 5.5–9.0, limbate; limbidia on all laminae, reaching the leaf tips and confluent with the costae, reaching the apex of the lesser lamella and confluent with the costa, ± reaching the base of the dorsal and vaginant lamina, in mid dorsal lamina 15–17 µm wide (1–2 stratose?); on vaginant lamina distinct to ill-defined, unistratose, marginal; vaginant lamina (of upper leaves) 1/2–3/5 the leaf length, ± open, unistratose; dorsal lamina tapering below, ± reaching the insertion in perichaetial and subperichaetial leaves, ending well above the insertion or lacking all together on mid and lower

leaves, *dorsal* and *apical laminae* unistratose; *costa* long excurrent, in trans-section anomalous with a variable number of irregularly arranged large cells; mid dorsal *laminal cells* hexagonal, smooth, plane,  $32\text{--}60 \times 8\text{--}15 \mu\text{m}$ ; mid vaginant laminal cells  $56.0\text{--}87.0 \times 14.5\text{--}21.0 \mu\text{m}$ .

*Fertile parts*, *perigonia* terminal on small, ca 0.4 mm tall, budlike stems at the base of sporophytic stems; *perichaetia* terminal; *perichaetial leaves* 1.9–2.2 mm long; *archegonia* 200–300  $\mu\text{m}$  long. *Sporophyte*, *seta* 2.5–5.0 mm long, smooth, 1 per perichaetium; *capsule* inclined to horizontal,  $0.5\text{--}0.6 \times 0.4 \text{ mm}$ ,  $\pm 40\text{--}(60)$  columns of thin walled, oblong exothecial cells; *peristome* bryoides type (only basal OP seen), teeth  $40.0\text{--}41.5\text{--}(55.0) \mu\text{m}$  wide at base; *operculum* not seen; *calyptra* not seen; *spores* subglobose, 13  $\mu\text{m}$  long, probably smooth, green.

*Fissidens magnicellulatus* is characterized by its large laminal cells, limbate dorsal and apical laminae, long per- to excurrent costae and  $\pm$  open vaginant laminae. In several respects it is similar to *F. gladiolus*. Both have laminal cells that are large for the subgenus and stout, long ex- to percurrent costae, long, narrow inner vaginant laminal cells, poorly developed to lacking dorsal and apical laminae in mid and lower leaves, strongly inclined capsules and bryoides type peristomes. Both are known only from fertile stems. They can be separated by the perichaetial and subperichaetial leaves which have well developed apical and dorsal laminae in *F. magnicellulatus*, whereas in *F. gladiolus* they are at best weak and narrow, or often lacking altogether. Moreover, *F. gladiolus* has longer subulae. In Tanzania known from a single stem. *Fissidens magnicellulatus* can also be confused with *F. beckettii* Mitt. This species also has open vaginant laminae and strongly inclined capsules but differs by its smaller, relatively wider laminal cells (mid dorsal laminal cells  $12.0\text{--}22.5 \times 6.0\text{--}12.0 \mu\text{m}$ ; mid vaginant laminal cells  $16.0 \times 8.0\text{--}9.5 \mu\text{m}$ ) and in having distinct limbidia on the vaginant laminae.

**HABITAT.** On damp vertical earth bank in *Syzygium* thicket and in a dry evergreen forest.

**SUBSTRATE.** Soil and bark.

**ALTITUDE.** 1275–2000 m.

**DISTRIBUTION.** Zambia, Tanzania. Rare. New to Tanzania.

**SPECIMENS EXAMINED:** TANZANIA, Arusha, Meru Mts, *Pócs & Nsolomo 88139/E* (EGR 1 broken stem). – ZAMBIA, *Townsend 75/21* (E, private herbarium Bruggeman-Nannenga).

**NOTE.** To make comparison of the two species easier the figures of the present species are in the same figure as those of *F. gladiolus*.

## 12. *Fissidens megalotis* Schimp. ex Müll. Hal.

Bot. Zeitung (Berlin) **16**: 15. 1858. – TYPE: South Africa, Prom. Bonae spei, Groenekloof, *Breutel s.n.* (HOLOTYPE: BM, ISOTYPE: PC).

This species is characterized by crispate stems and leaves, more or less open vaginant laminae, small, bulging laminal cells, limbidia that are typically intralaminal on the vaginant laminae and decurrent dorsal laminae.

### KEY TO THE SUBSPECIES

1. Vaginant lamina typically nearly or completely open, margin of vaginant laminae often serrate . . . . . *F. megalotis* subsp. *megalotis*
- 1\* Vaginant lamina slightly open, margin of vaginant lamina entire . . . . . *F. megalotis* subsp. *helictocaulos*

### *F. megalotis* subsp. *megalotis*

*Fissidens megalotis* subsp. *megalotis* is found in southern Africa, Australia and New Zealand, whereas subspecies *helictocaulos* has a more northern exclusively African distribution.

*F. megalotis* subsp. *helictocaulos* (Müll. Hal.) Brugg.-Nann. Fig. 11

J. Hattori Bot. Lab. **81**: 163. 1997. *Fissidens helictocaulos* Müll. Hal., Bot. Zeitung (Berlin) **22**: 341. 1864. – LECTOTYPE (designated by Bruggeman-Nannenga 1997): Ethiopia, [Abyssinia], Amba Sea, 6000 ft., 8 September 1847, *Schimper s.n.* (as *F. schimperii helictocaulos*) (PC).

*Fissidens pseudorufescens* Müll. Hal., Flora **62**: 376. 1879. – LECTOTYPE (designated by Bruggeman-Nannenga 1997): Kenya, [Ost-Afrika], Ndāra (Taita), *Hildebrandt s.n.* (BM).

*Fissidens latifolius* Dixon, S. African J. Sci. **18**: 305. 1922. – LECTOTYPE (designated by Bruggeman-Nannenga 1997): Zimbabwe, alt. 3000 ft, *Sim 8766* (BM).

*Fissidens vesiculosus* Demaret & J.-F. Leroy, Explor. Parc Natl. Albert, Mission Lebrun (1937–1938) **6**: 5. F. 1–4. 1944. – TYPE: Democratic Republic of the Congo, Parc national Albert, Lac Mungunga. Berges rocheuses, alt. 1500 m, XI 1937, *Lebrun 8826* (HOLOTYPE: BR not seen; ISOTYPE: PC-PV).

Only synonyms from tropical eastern Africa are listed.

Usually growing in large mats; *rhizoids* basal and axillary, bright to pale brown, smooth; *axillary* cells not to weakly differentiated; *stem* with well-developed central strand, pinnate, simple or branched, branches frequently arising from stem apex, 0.8–7.0 (10.0 mm including branches) × 1.5–2.0 mm (2.5 mm in perichaetium); *leaves* green to brown, strongly crispate when dry, hardly flattening in water, more or less flattening in 5% KOH, distant to crowded, up to 17 pairs, oblong-lanceolate to oblong to ovate-lanceolate, broadly acute to rounded obtuse, acute-acuminate to obtuse mucronate, 0.9–1.4 × 0.3–0.5 mm, L/W 2.5–5.0, limbate; *limbodium* reaching the leaf apex to ending 3–4 cells below, not confluent with the costa; reaching the insertion of the vaginant lamina or ending well above, reaching the apex of the smaller lamella of the vaginant laminae, but not confluent with the limbodium of the other lamella; reaching the insertion of the dorsal laminae or not, in mid dorsal lamina 7.5–9.5 µm wide, 1–2 stratose; on vaginant lamina 1–2 stratose, in the basal part of the vaginant lamina intramarginal by 1–5 cells rows, often marginal in some leaves; *vaginant lamina* 1/3–3/5 the leaf length, slightly to half open (in perichaetial leaves open), gaping,

unistratose; *dorsal lamina* wide and rounded or wide and tapering towards the insertion, reaching the insertion, frequently long decurrent; *dorsal* and *apical laminae* unistratose or with some bistratose dots; *costa* per- to excurrent, in trans-section asymmetrical (i.e., better developed in the larger lamella of the vaginant lamina); mid dorsal *laminal cells* round-hexagonal, convexly to lenticularly thickened, smooth, 4.5–8.0 × 3.0–6.5 µm; mid vaginant *laminal cells*, 6.5–9.5 × 6.5 µm.

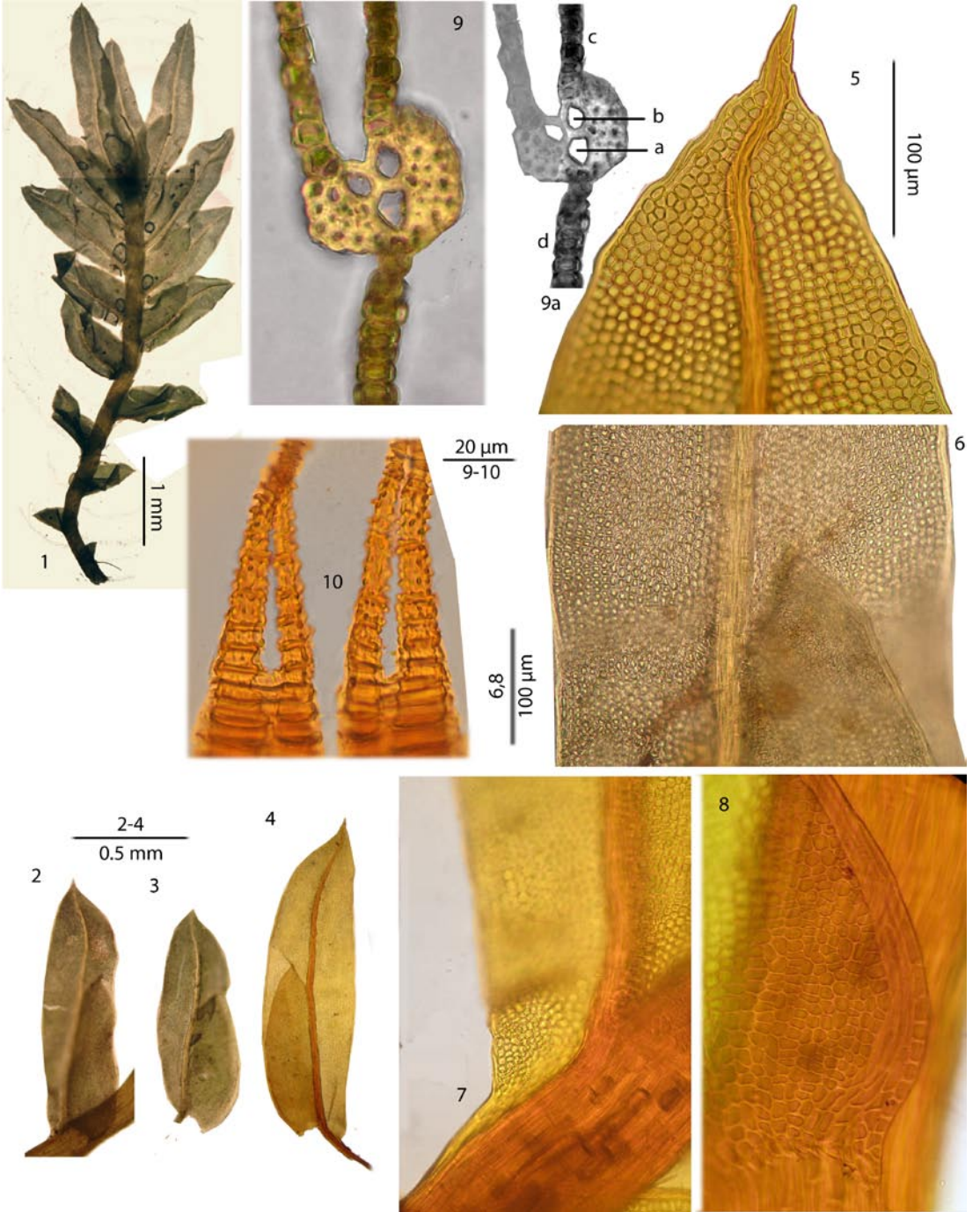
*Fertile parts.* *Perigonia* not observed; *perichætia* terminal, *perichætial leaves* 1.7–2.4 mm long, *archegonia* 300–500 µm long. *Sporophyte*, *seta* 4.5–8.0 mm long, smooth, 1–2 per perichaetium; *capsule* inclined to strongly inclined or curved, 0.65–0.85 × 0.35–0.50 mm, 40–56 columns of oblong exothecial cells; *peristome* bryoides type, tooth base 50–53 µm wide; *operculum* rostrate, 0.3 mm long; *calyptra* not observed; *spores* 16–24 diam., smooth, green.

*Fissidens megalotis* subsp. *helictocaulos* is characterized by its slightly open, gaping vaginant lamina with the limbodium of the smaller lamella ending on the lamina and not confluent with that of the larger lamella; intramarginal limbodia on the vaginant laminae of some or all leaves; and small, highly convex, thick walled laminal cells. Also characteristic are vaginant laminal lamellae that form a ± continuous blade with the apical laminae to which the smaller vaginant laminal lamellae seem to be obliquely attached. This is also expressed in the anatomy of the costa in which one of the two large central cells (a) and the right adaxial cell (b) make a more or less straight line connecting the right lamella of the vaginant lamina (c) and the dorsal lamina (d) (Fig. 11: 9, 9a). For a trans section of a symmetrical bryoides type costa see Fig. 16: 9. In 5% KOH the leaves first turn yellowish-green then bright orange-brown. *Fissidens*



**Fig. 11.** *Fissidens megalotis* subsp. *helictocaulos* (Müll. Hal.) Brugg.-Nann. 1 – short perichaetial stem; 2–4 – leaves; 5 – leaf apex; 6 – mid leaf; 7 – insertion of dorsal lamina; 8 – insertion vaginant lamina with intramarginal limbodium; 9 & 9a – trans section of asymmetrical costa (a – large central cell; b – large adaxial cell; c – larger vaginant laminal lamella; d – dorsal lamina); 10 – bifurcations of peristome teeth (bryoides type). 1–3 from *Kis & Pócs 9104/L* (L); 4, 5, 7–9 from *Pócs & Nsolomo 89192/H* (private herbarium Bruggeman-Nannenga); 6 from *Pócs & Chuwa 89023/J* (private herbarium Bruggeman-Nannenga); 10 from *Pócs 8678/R* (private herbarium Bruggeman-Nannenga).





*megalotis* subsp. *helictocaulos* can be confused with *F. artsii*, *F. crispus* and *F. androgynus* which all differ by their closed vaginant laminae. From subsp. *megalotis* it differs by vaginant laminae that are slightly but not completely open, entire vaginant laminal margins, less strongly crispate leaves and limbidia that are intramarginal by fewer cell rows.

**HABITAT.** Found in a wide variety of wet, humid and dry habitats, natural as well as secondary and cultivated. In spray zone of falls (2×), plantations and gardens (6×), in forests (riverine forest (4×), groundwater forest (2×), montane rain forest (1×), submontane rainforest (2×), montane evergreen forest on N slope dominated by *Olea africana* and *Cassipourea malosana* (1×), submontane evergreen forest (1×), *Hagenia* forest (1×), microphyllous dry evergreen forest (1×), dry evergreen forest (5×), dry semi-evergreen forest (1×), dry semi-deciduous forest (5×), savanna bos (1×); further in bushes etc. (secondary bush (2×), secondary evergreen bush, slope with succulents and Velloziaceae bushes (1×), *Catha edulis* bush, xeric type (1×), and semi-desert scrub and dry rocky grassland (1×). This species is probably the most drought-tolerant species in this paper.

**SUBSTRATE.** Mostly rupicolous, frequently on soil, rarely lignicolous. Rupicolous without further indication (6×), rupicolous on shady/half shady rocks and stones (10×); on lava/volcanic rocks (5×), on gneiss (3×), on dry rocks (1×); on irrigated or wet rocks (2×); on brick drains (1×); on earth covered rocks (2×); terricolous without further indication (12×); on shady soil (5×) and lignicolous: on roots (2×) and once on bark. Substrate from outside Tanzania: termite hill (Zambia, *Townsend 75/187* (E).

**ALTITUDE.** 0–2900 m.

**DISTRIBUTION.** Widespread in Africa, most common in the eastern part. Known from Macaronesia (Cape Verde Islands); west-central tropical Africa (Cameroon, Democratic Republic of the Congo); east tropical Africa (Kenya, Tanzania, Uganda); south tropical Africa (Malawi, Zambia, Zimbabwe); northeast tropical Africa (Eritrea,

Ethiopia, Somalia, Sudan); and western Indian Ocean (La Réunion, Socotra). In southern Africa it is replaced by *F. megalotis* subsp. *megalotis*. Wide-spread and common in Tanzania. Distribution in Tanzania: Arusha (Babati District, Longido Hill, Mbulu Highlands, Monduli Mts, Mt. Meru, Ngorongoro, Tenguru), Iringa (Livingstone Mts), Kilimanjaro (Kilimanjaro Mts, Moshi, South Pare), Mbeya (Mbeya District), Morogoro (Morogoro Town, Ukaguru Mts, Uluguru Mts, Nguru), and Tanga (Mafi Hill, West Usambara Mts).

**SPECIMENS EXAMINED:** TANZANIA, Arusha, Babati District, *Pócs 90026/E, F* (EGR, private herbarium Bruggeman-Nannenga); *Pócs & Linden 90086/K* (EGR, private herbarium Bruggeman-Nannenga); Longido Hill, *Pócs et al. 8693/U, V* (EGR, L); *Pócs & Nsolomo 88169/L* (EGR, L); *Pócs & Nsolomo 89192/H* (EGR, private herbarium Bruggeman-Nannenga); Mbulu Highlands, *Pócs 90096/ACD* (EGR, private herbarium Bruggeman-Nannenga); *Sharp et al. 879B* (EGR, private herbarium Bruggeman-Nannenga); *Sharp, Gilbert & Suso 8809/A* and *9786* (both EGR, L); *Van Zanten & Pócs 86.08.312* (GRO); *Whitehouse 26138* (MO, L), *26182* (MO) and *26138* (MO, L); Monduli Mts, *Pócs et al. 88160* (KRAM, private herbarium Bruggeman-Nannenga); Mt. Meru, *Pócs 8678/P, Q, R, S, U* (EGR, L); *Pócs & Van Zanten 86125/L* (EGR, L), *86125/M* and *Q* (both EGR, private herbarium Bruggeman-Nannenga); *Pócs 88141/A* (EGR, private herbarium Bruggeman-Nannenga); *Pócs 88166/O* and */P* (both EGR, private herbarium Bruggeman-Nannenga) and *Q* (EGR, L), *Pócs & Nsolomo 89183/AA, AE, AF* (EGR, private herbarium Bruggeman-Nannenga); Ngorongoro, *Pócs & Chuwa 88280/V* (EGR, private herbarium Bruggeman-Nannenga), *Pócs 89010/AE* (EGR, private herbarium Bruggeman-Nannenga); *Pócs & Chuwa 89023/J* (EGR, private herbarium Bruggeman-Nannenga); *Pócs & Chuwa 89031/AN* (EGR, private herbarium Bruggeman-Nannenga); *Pócs 89036/K, L, M, N* (EGR, private herbarium Bruggeman-Nannenga); Tenguru, *Van Zanten & Pócs 86.08.318* (GRO, private herbarium Bruggeman-Nannenga); Iringa, Livingstone Mts, *Iversen et al. 87136/D* (EGR, private herbarium Bruggeman-Nannenga); Kilimanjaro, Kilimanjaro Mts, *Pócs 88048/U* (EGR, private herbarium Bruggeman-Nannenga); *Pócs 90051/F* (EGR, private herbarium Bruggeman-Nannenga); *Pócs 90069/D* (EGR, private herbarium Bruggeman-Nannenga); *Pócs 90070/D* (EGR, private herbarium Bruggeman-Nannenga); Moshi, *Pócs 8672/H* (EGR, L); *Sharp et al. 7059* (EGR, L); South

Pare Mts, *Pócs et al. 89244/A* (EGR, private herbarium Bruggeman-Nannenga); *Pócs et al. 89247/A* (EGR); *Pócs et al. 90077/AA, Y* (EGR, private herbarium Bruggeman-Nannenga); Mbeya, Mbeya District, *Pócs, Farkas, Krog 89127/A* (EGR, private herbarium Bruggeman-Nannenga); *Townsend 75/339* (E, private herbarium Bruggeman-Nannenga); Morogoro, Morogoro town, *Pócs et al. 8675/G* (EGR, L); Nguru Mts, *Kis & Pócs 9103/B and 9104/L* (both EGR, L); Ukaguru Mts, *Pócs et al. 8699/K* (EGR, private herbarium Bruggeman-Nannenga); Uluguru Mts, *Pócs 8663/N* (EGR, L); S. Uluguru Mts, Mindu Hill, *Pócs & Ochyra 88100/C* (EGR, private herbarium Bruggeman-Nannenga); Tanga, Mafi Hill, *Pócs 8525/C* (EGR); West Usambara Mts, *Borhidi 8543/D* (EGR, L); *Pócs 8436/AB* (EGR, L); *Pócs et al. 88115/F* (EGR, L); *Pócs & Ochyra 88115/J, M* (EGR, private herbarium Bruggeman-Nannenga); *Pócs et al. 88116/C* (EGR, private herbarium Bruggeman-Nannenga); *88116/E* (EGR, KRAM, private herbarium Bruggeman-Nannenga).

ILLUSTRATIONS: Kürschner (1999: figs 1–5), Bruggeman-Nannenga (2006b: fig. 14), Bruggeman-Nannenga & Arts (2010: fig. 16), Demaret & Leroy (1944: figs 1–4 as *F. vesiculosus*), Potier de la Varde (1943: 241: fig. 1 as *F. alatus* P. de la Varde), Tongiorgi (1938: 220 as *F. badoglioi* Tongiorgi).

### 13. *Fissidens obscurifrons* Brugg.-Nann.

Fig. 12

Polish Bot. J. **58**(1): 118, fig. 2. 2013. – TYPE: Tanzania, Nguru Mts, Kanga Forest Reserve, on the SE slope of Mt. Kanga. Lowland rainforest, on irrigated rocks under small waterfall. 700–800 m. 4 December 1987, *Pócs, Nsolo & Temu 87226/AL* (HOLOTYPE: L; ISOTYPE: EGR).

Growing from a dense mat of rhizoids, thalloid protonemata (Fig. 12: 11) present or not; *stem* with weak or lacking central strand, unbranched, 1.5–3.5 × 0.8–1.7 mm, pinnate; *rhizoids* basal, bright brown, smooth, up to 33 µm wide; *axillary* cells weakly differentiated; *leaves* distant to close, up to 13 pairs, hardly altered when dry, obscure, elliptical, elliptico-lanceolate and oblanceolate, acute, 0.5–1.0 × 0.1–0.6 mm, L/W 3–9, margin subentire, partly limbate; *limbidium* mostly restricted to the vaginant lamina and basal part (up to 150 µm) of the apical lamina, on dorsal laminae lacking or represented by a few cells in the mid part; on mid of dorsal lamina 0–16 µm wide, unistratose;

on the vaginant lamina unistratose, marginal or intramarginal; *vaginant lamina* 1/2–3/5 the leaf length, closed to slightly open, unistratose; *dorsal lamina* narrow, hardly rounded at the insertion, reaching the insertion, not decurrent, dorsal and *apical lamina* unistratose with scattered bistratose dots, 1–2 stratose alongside the costa and near the insertion; *costa* ending 5–7 cells below the leaf apex; mid dorsal *laminal cells* hexagonal, 5.0–11.5 × 5.0–8.0 µm, smooth; mid vaginant *laminal cells* 6–13 × 3–8 µm. *Fertile parts* unknown.

This species is known by its vegetative state only. It is characterized by narrow, obscure, elliptical, elliptico-lanceolate to oblanceolate leaves; limbidia extending the length of the vaginant laminae and up to 150 µm onto the apical laminae; dorsal laminae frequently elimbate. Leaves of poorly developed stems poorly limbate to elimbate. *Fissidens obscurifrons* could be taken for a small *F. leucocinctus*. Both species grow in places that are frequently inundated and have leaves that are attenuated below. *Fissidens leucocinctus* can be separated by its larger, wider (L/W 3–4) leaves, stout 3–5 stratose limbidia that are present on all laminae of all leaves and its longer stems (5–30 × 2–3 mm). *Fissidens bogosicus* and *F. taylorii* resemble *F. obscurifrons* in their incompletely limbate leaves but are not aquatic (for more differences see key).

ECOLOGY. Saxicolous on shady rocks, sprayed or irrigated rocks. Near waterfalls and in riverine and lowland rainforests.

ALTITUDE. 700–1000 m.

DISTRIBUTION. Tanzania, Kilimanjaro (S-Pare Mts) and Morogoro (Nguru Mts).

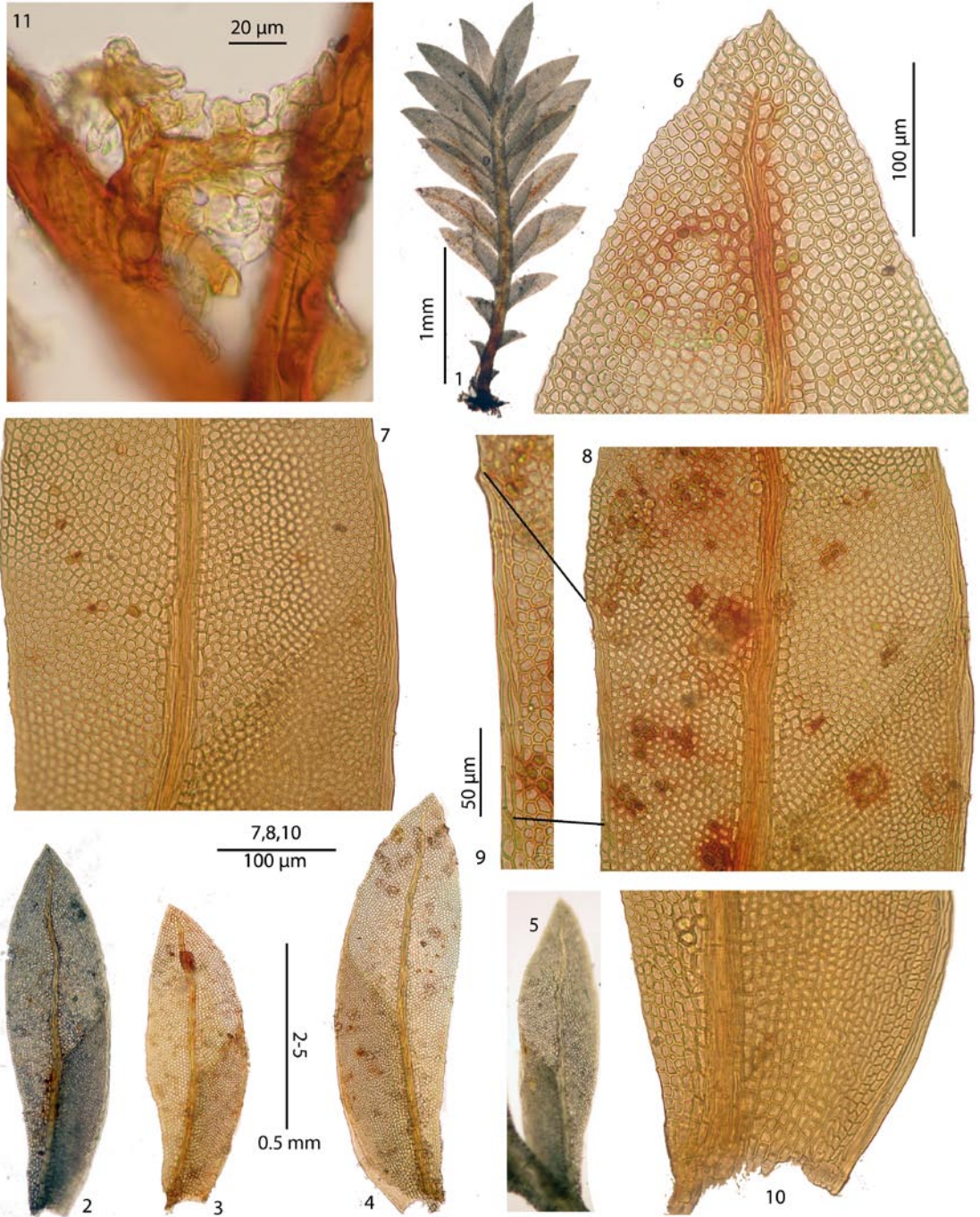
SPECIMENS EXAMINED: TANZANIA, S-Pare Mts, *Pócs 6716/J* (EGR, L); Nguru Mts, *Pócs, Nsolo & Temu 87226/AL* (EGR, L).

### 14. *Fissidens pachylomadelphus* Demaret & P. de la Varde

Fig. 13

Bull. Jard. Bot. État Brux. **27**: 758, fig. 79. 1957. – TYPE: Democratic Republic of the Congo, Distr. des Lacs Edouard et Kivu, Ruwenzori, Kyandolire, cascade de la Mulaka, alt. 1750 m, roche périodiquement inondée





**Fig. 12.** *Fissidens obscurifrons* Brugg.-Nann. 1 – vegetative stem; 2–5 – leaves; 6 – leaf apex; 7 – mid leaf with elimbate dorsal lamina; 8 – mid leaf with weakly limbate dorsal lamina; 9 – detail of 8 showing the limbidium; 10 – basal part of leaf; 11 – rhizoids with thalloid protonemata; 1, 5–7 from *Pócs, Nsolo & Temu 87226/AL* (holotype L); 2–4, 8–11 from *Pócs 6716/J* (paratype L) (the same figures were used in the protologue); brown coloring in 3, 4 & 6–10 is caused by 5% KOH.



dans le torrent, Juin 1953, *Demaret 5997* (LECTOTYPE designated by Bruggeman-Nannenga 1993: BR; ISOTYPE: PC-PV).

Rheophilous, firmly attached, in tufts; *stems* branched or not,  $3.0\text{--}6.0 \times 1.2\text{--}2.0$  mm, pinnate, central strand present or not; *rhizoids* basal, brown and smooth; *axillary cells* not to weakly differentiated; *leaves* green, distant, slightly overlapping, up to 10 pairs, slightly crisped when dry, lanceolate to oblong, acute-acuminate to bluntly mucronate,  $0.50\text{--}0.60 \times 0.15\text{--}0.17$  mm, L/W 3–5, limbate; *limbidium* stout, reaching the leaf apex and confluent with the costa or ending well below the apex; confluent at the apex of the vaginant lamina, reaching the insertions of the vaginant and dorsal laminae; in mid of dorsal lamina  $27 \mu\text{m}$  wide, 1–4 stratoise; on the vaginant lamina 1–2 stratoise, marginal; *vaginant lamina*  $\pm 1/2$  the leaf length, closed, unistratoise; *dorsal lamina* slightly rounded towards the insertion, straight in the basal-most part, reaching the insertion, not decurrent; *dorsal* and *apical laminae* unistratoise, dorsal lamina at the insertion 1–4 stratoise; *costa* per- to excurrent, cross section above the vaginant laminae with 1 row of 2(–4) large cells; mid dorsal laminal cells clear, oblong-hexagonal, plane,  $9.5\text{--}14.5 \times 5.5\text{--}9.5 \mu\text{m}$ ; mid vaginant laminal cells  $14.5\text{--}17.5 \times 6.5\text{--}9.5 \mu\text{m}$ .

*Fertile parts*, perigonial and perichaetial stems in same collection, *perigonia* terminal on *ca* 4 mm long stems; *antheridia*  $320\text{--}350 \mu\text{m}$  long; *perichaetia* terminal; *perichaetial leaves* 1.9 mm long with long excurrent costae; *archegonia*  $350 \mu\text{m}$  long; *sporophyte*, *seta* 4.5–6.0 mm long, smooth; *capsule* symmetrical,  $0.75 \times 0.50$  mm,  $\pm 60$  columns of oblong exothecial cells; *peristome* bryoides type, teeth  $56\text{--}65 \mu\text{m}$  wide at base; *operculum* rostrate, 0.5 mm long; *calyptra* not seen; *spores* subglobose to distinctly ellipsoid,  $16\text{--}12 \mu\text{m}$ ,  $\pm$  smooth.

This rheophilous, saxicolous species has stout limbidia, dorsal laminae with pluristratoise basal parts and weakly developed or lacking central strands. Rheophilous species sometimes have astomatoise capsules. In the present species stomata were present in at least one capsule. *Fissidens pachylomadelphus* resembles the variable

*F. androgynus* and in 1993 I synonymized the two (Bruggeman-Nannenga, 1993). However, *F. androgynus* is not rheophilous, has well developed central strands and dorsal lamina with unistratoise basal parts. *Fissidens pachylomadelphus* further resembles other rheophilous subgenus *Fissidens* species with stout limbidia, e.g., *F. rivularis* from Europe, northern Africa, Turkey and Azerbaijan. The latter can be distinguished by its axillary antheridial buds (next to which a few terminal antheridia can occur).

ECOLOGY. Saxicolous, in spray-zone of cascades and in periodically inundated places in rivers and streamside rainforests.

ALTITUDE. 1750–2400 m.

DISTRIBUTION. Democratic Republic of the Congo (Rwenzori [Ruwenzori] Mts), Rwanda (Pref. de Cyangugu) and Tanzania (Nguru Mts). Rare. New to Tanzania

SPECIMENS EXAMINED: TANZANIA, Nguru Mts, *Kis & Pócs 9129/BY* (EGR) and *Kis & Pócs 9136/N* (EGR, L). – DEMOCRATIC REPUBLIC OF THE CONGO, *Demaret 5997* (BR, PC-PV). – RWANDA, *Frahm 6203* (BONN, private herbarium Bruggeman-Nannenga).

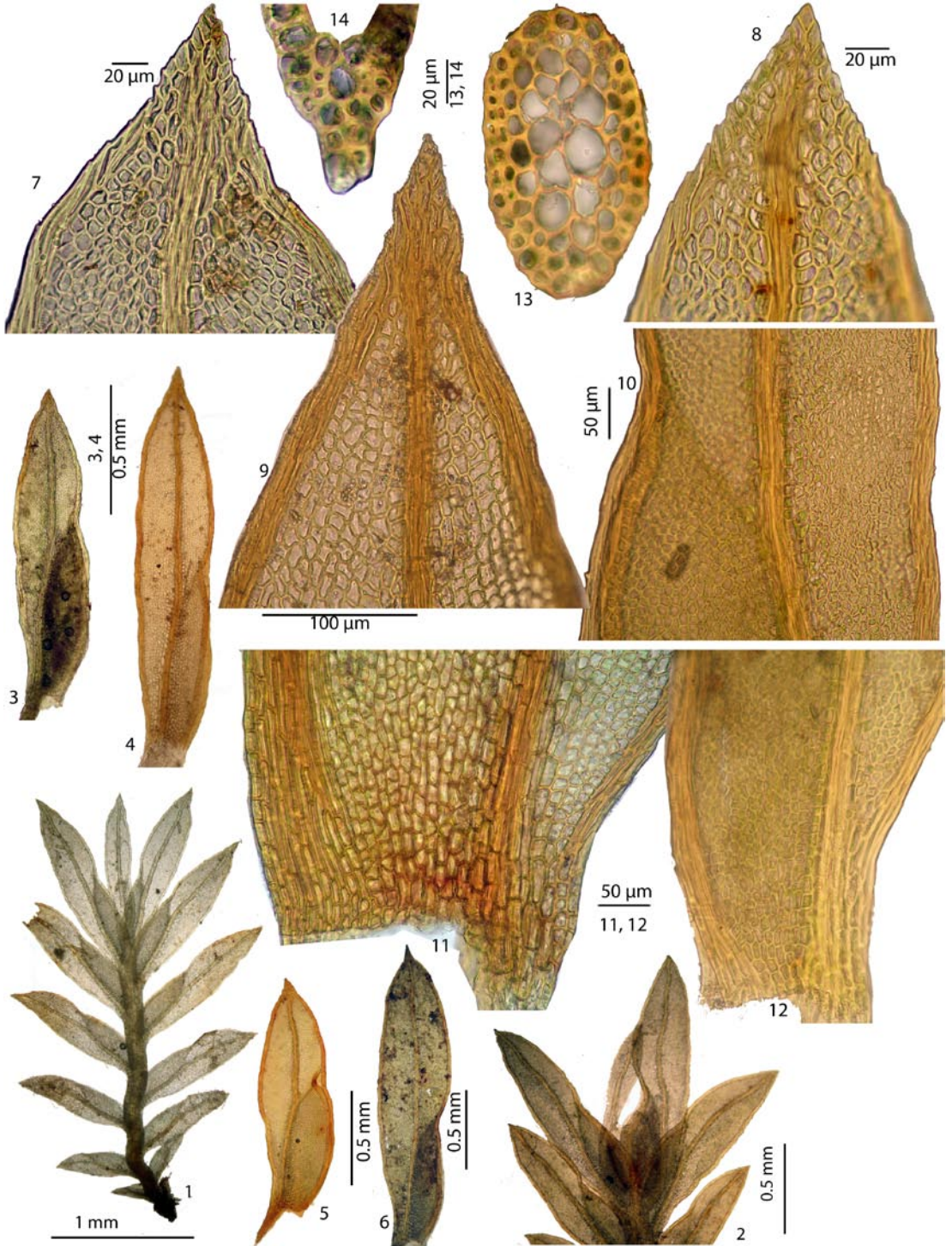
ILLUSTRATION: Demaret & P. de la Varde (1957: fig. 79).

#### 15. *Fissidens robynsianus* P. de la Varde

Fig. 14

Bull. Jard. Bot. Etat Brux. 27: 757, fig. 78 a–d. 1957. – TYPE: Democratic Republic of the Congo, Distr. des Lacs Edouard et Kivu, tributary of the Mososa river, rocks in waterfall, alt. 3180 m, *Demaret 5257* (HOLOTYPE: BR; ISOTYPE PC-PV).

Growing in mats or tufts, firmly attached to the substrate, tufts blackish when old with pale green fresh shoots; *stem* with central strand, unbranched or rarely branched,  $3.5\text{--}10.0 \times 0.4\text{--}1.0$  mm, pinnate; *rhizoids* basal, a few axillary, brown, smooth, to  $48 \mu\text{m}$  wide (sometimes wide, brown, short celled with transverse cross-walls); *axillary nodules* not to weakly differentiated; *leaves* close to distant, up to 27 pairs, hardly altered when dry, lanceolate, elliptico-lanceolate to linear-oblong, linear-



lanceolate or linear-oblongate, acute, 0.5–1.5 × 0.1–0.3 mm, L/W 3.5–6, margin typically limbate, subentire where elimbate; *limbidium* variable, typically on all laminae of all leaves, rarely restricted to the vaginant lamina; ending well below the leaf apex, reaching the insertion of vaginant lamina and confluent at its apex; reaching the insertion of the dorsal lamina or ending well above it, on the mid dorsal lamina infrequently branched, marginal or rarely intramarginal by one row of cells, 7.5–24.0 µm wide, 1–5 stratose; on the vaginant lamina 1–3 stratose, marginal or intramarginal by 1–2 rows of cells; *vaginant lamina* 2/3–7/10 the leaf length, closed, in perichaetial leaves open, unistratose, near the costa 1–2 stratose; *dorsal lamina* in the basal 1/5–7/10 part narrow and limbidoid, reaching the insertion or not, not decurrent; *dorsal* and *apical laminae* unistratose, sometimes bistratose alongside the costa, rarely a few small dots in the mid lamina; limbidoid part of dorsal lamina to 6 stratose; *costa* ending 1–5 cells below the leaf apex to percurrent; mid *dorsal laminal cells* clear, hexagonal, smooth, ± plane, 6.0–14.5 × 5.0–9.5 µm; mid *vaginant laminal cells* 5.0–14.5 × 5.0–8.5 µm.

*Fertile parts, perigonia* and *perichaetia* on separate stems; *perigonia* terminal on ± 2 mm long stems, on branches and in perigonial buds; *antheridia* 200–340 µm long; *perichaetia* terminal on stems and branches, female stems often shorter than sterile stems, 2.5–3.5 × 1.0–1.5 mm; *perichaetial leaves* up to 1.8 mm long, dorsal laminae of (sub)perichaetial leaves in basal part or over almost their whole length limbidoid, apical laminae partly limbidoid or not; *archegonia* 350–500 µm long; *sporophyte* unknown.

This species is characterized by limbate leaves with acute elimbate tips, costae ending 1–4 cells below the apex to percurrent and dorsal laminae that towards the insertion run down the costa as a pluristratose, narrow, often limbidoid band

(Fig. 14: 10) that reaches the insertion or not. It is one of the few *Fissidens* species in which the limbidia of the dorsal lamina can be intramarginal (Fig. 14: 7). Like many rheophilous species it is often worn off and shows many irregularities (rheomorphoses). Limbidia can be lacking on the dorsal and apical lamina of upper and mid leaves even when leaves lower in the same stem have strongly limbate dorsal and apical lamina (typically limbidia of lower leaves are less well developed than those of higher leaves). The type specimen is particularly rich in rheomorphoses. For instance in some perichaetial and upper leaves the basal 2/3 of the dorsal lamina is limbidoid, whereas in mid leaves the limbidia are sometimes confluent with costal branches (Fig. 14: 9; Demaret & Potier de la Varde 1957, fig. 78A). *Fissidens robynsianus* differs from the rheophilous to hydrophilous *F. leucocinctus* by its narrower leaves that are not or hardly attenuated below and the frequent occurrence of rheomorphoses; from the rheophilous *F. pachylomadelphus* it differs by its elimbate leaf apices (in *F. pachylomadelphus* the limbidia are confluent with the costae into a mucronate apex). *Fissidens curvatus*, though not a rheophilous species, may occur in similar places. It differs by being heterocaulous and having limbate leaf apices.

**ECOLOGY.** Rheophilous and saxicolous. On wet, sprayed and irrigated rocks in and along rivers and near waterfalls.

**ALTITUDE.** (1000) 2490–3870 m.

**DISTRIBUTION.** Democratic Republic of the Congo (Rwenzori), Kenya, Tanzania (Arusha and Kilimanjaro), and Uganda. Rare. New to Tanzania,

**SPECIMENS EXAMINED:** TANZANIA, WSW slope of Mt. Meru, *Kis & Pócs 9145/S* (EGR, L); S-Pare Mts, *Pócs 6716/J* mixed with *F. obscurifrons* (EGR, L). – DEMOCRATIC REPUBLIC OF THE CONGO, *Demaret*



**Fig. 13.** *Fissidens pachylomadelphus* Demaret & P. de la Varde 1 – vegetative stem; 2 – perigonium; 3–6 – leaves; 7–9 – leaf apices; 10 – mid leaf; 11 & 12 – basal parts of leaves; 13 – trans section of stem; 14 – trans section of costa and dorsal lamina near insertion; 1, 4, 9 & 11 from *Bryoptrop 6203* (private herbarium Bruggeman-Nannenga); 2, 3, 5, 7–8, 10, 12–14 from *Kis & Pócs 9136/N* (L); and 6 from *Kis & Pócs 9129/BY* (EGR) (red brown coloration in 4, 5, 9, 10 & 12 is caused by 5% KOH).







5257 (BR) and 5259 (BR). – KENYA, *Pócs, Kungu, Szabo 9211/BN, BO, AW* (EGR, L). – UGANDA, *Wesche 9107* (private herbarium Bruggeman-Nannenga).

ILLUSTRATIONS. Demaret & Potier de la Varde (1957: fig. 78), Bruggeman-Nannenga (2006b: fig. 21, g–j).

16. *Fissidens rotereaui* P. de la Varde Fig. 15

Mém. Soc. Sci. Nat. Cherbourg **43**: 63, fig. 1. 1938. – HOLOTYPE: Madagascar, Manisana, sur la terre, 20 May 1906, *Rotereau 9* (PC-PV).

*Fissidens schelpae* P. de la Varde, *Rev. Bryol. Lichénol.* **22**: 10, fig. 3. 1953. – TYPE: Kenya, Marania river, Mt. Kenya (North sector). On moist earth bank in deep shade underneath grass tussocks, 9800 ft. 2 VIII 1949. *Schelpae 2538* (HOLOTYPE: PV-PC (3 stems); ISOTYPE: BM).

Growing scattered or in mats; *stems* weakly heterocaulous, with weak or lacking central strand, mostly unbranched, pinnate, 2.0–3.0 × 0.7–1.2 mm; *rhizoids* basal, brown, smooth; *axillary nodules* not to hardly differentiated; *leaves* green, distant, 10–14 pairs, slightly crispate when dry, lanceolate, acute to acuminate, often notched at the apex of the vaginant lamina, 0.65–0.90 × 0.20–0.25 mm, L/W 3.0–3.5, margin subentire, limbate on vaginant lamina; *limbidium* present on all leaves of both vegetative and fertile stems, typically restricted to the vaginant lamina (rarely few stems of a collection have weak limbidia on the mid dorsal lamina), extending the complete length of the vaginant laminae, less often shorter, often extending slightly onto the apical laminae, mostly not confluent at the apex of the vaginant lamina, reaching the insertion, limbidium cells firm walled, unistratose, marginal; *vaginant lamina* 3/5–7/10 the leaf length, half open to closed, unistratose; *dorsal lamina* slightly to distinctly rounded at the insertion, mostly reaching the insertion, not to slightly decurrent, *dorsal* and *apical laminae* unistratose; *costa* percurrent; mid dorsal *laminal cells*

hexagonal, plane, smooth, firm-walled, 5.0–13.5 × 5.0–9.5 μm; mid vaginant laminal cells 8.0–13.0 × 6.5–8.0 μm.

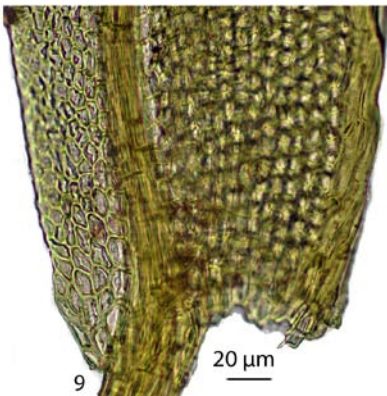
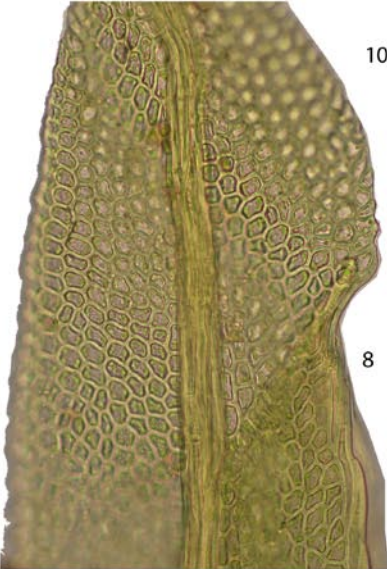
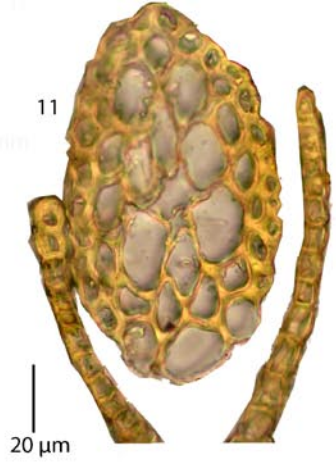
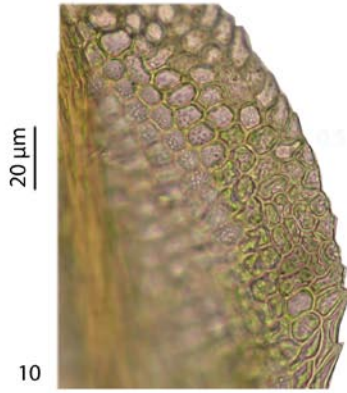
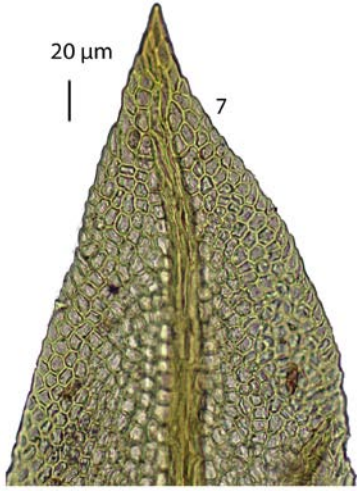
*Fertile parts* often lacking, *perigonia* not seen, *perichaetia* terminal on long to very short stems or long branches; *perichaetial leaves* 1.0–1.5 mm long, *archegonia* 220–350 μm long; *sporophyte* not seen.

*Fissidens rotereaui* is a rather constant species characterized by strong, unistratose limbidia that typically reach the complete length of the vaginant lamina and sometimes extend slightly onto the apical lamina; limbidia present on the vaginant laminae of all leaves of both vegetative and perichaetial stems; firm cell walls [limbidial (Fig. 15: 11) as well as laminal]; and percurrent costae. Its leaves are often notched just before the termination of the vaginant laminae (Fig. 15: 8). Like *F. curvatus* it can have (pseudo) papillae (Fig. 15: 10). It can be confused with other partly limbate species. Of these *F. taylorii* has vegetative stem leaves that are elimbate or weakly limbate on the basal part of the vaginant lamina and costae that 1–4 cells below the apex. Moreover, the latter species is heterocaulous.

NOTE. In 1997 (Bruggeman-Nannenga 1997) I reduced with some hesitation *F. rotereaui* to *F. bogosicus*. Later, it became more and more clear that *F. rotereaui* is a distinct taxon (Bruggeman-Nannenga in O’Shea *et al.* 2001; Bruggeman-Nannenga & Arts 2010). It is here reinstated as a species. *Fissidens bogosicus* differs in that limbidia are mostly restricted to the upper and mid leaves, and the costae are shorter.

HABITAT. In forests (montane rainforest 2×, mesic montane rainforest, mossy montane evergreen, evergreen forest, bamboo forest), bushes (subalpine *Erica-Hypericum* bush) and roadside bank, Tanzania: *Hagenia-Podocarpus* forest.

←  
**Fig. 14.** *Fissidens robynianus* P. de la Varde 1 – vegetative stem; 2 – perichaetial stem; 3 & 4 – leaves; 5 & 6 – leaf apices; 7 – margin mid dorsal lamina with intramarginal limbidium; 8 – midleaf; 9 – rheomorphic, limbidium of apical lamina confluent with the costa in mid leaf, scale not available; 10 – basal part of leaf with limbidoid dorsal lamina; 11 – basal part of leaf; 12 – trans section of basal part of leaf; 13 & 14: trans sections of leaves near the termination of the vaginant lamina; 1 & 14 from *Pócs, Kungu, Szabo 9211/AW* (L); 2–4 & 11 from *Pócs 6716/J* (L); 8, 10, 12 & 13 from *Wesche 9107* (private herbarium Bruggeman-Nannenga); 5–7 from *Kis & Pócs 9145/S* (L); 9 from holotype *Demaret 5257* (BR).



**SUBSTRATE.** Mostly on rocks, also on soil, rarely lignicolous; Tanzanian collections from soil.

**ALTITUDE.** 1340–2890 m.

**DISTRIBUTION.** East tropical Africa (Kenya, Tanzania); south tropical Africa (Malawi); and western Indian Ocean (Madagascar, La Réunion). New to Tanzania.

**SPECIMENS EXAMINED:** TANZANIA, Kilimanjaro, Kilimanjaro Mts, *Pócs & Ochyra 88122/BP, BQ* (EGR, private herbarium Bruggeman-Nannenga); Morogoro, S Uluguru Mts, *Van Zanten & Pócs 86.08.665* (GRO a few stems only). – KENYA, S. Nyeri District, Mt. Kenya, *Townsend 85/163* a few in mixture (E). – MADAGASCAR, Central Madagascar, *Pócs 9481/DC* (EGR, L). – MALAWI, Mulanje Mt, *Wigginton 1257a* (E, private herbarium Bruggeman-Nannenga), *Magombo 4297A* (E, private herbarium Bruggeman-Nannenga); Zomba, *Pócs 9171/BD* (EGR, L). – LA RÉUNION, la Caverne de la Glacière, *Arts 13/04* (BR, private herbarium Bruggeman-Nannenga); Forêt de Bébour, *Bruggeman-Nannenga 11001* (L, REU) and Hellbourg, *Müller R 93* and *R 621* (both: DRE, private herbarium Bruggeman-Nannenga).

**ILLUSTRATIONS:** Bruggeman-Nannenga & Arts (2010: fig. 13 as *F. bogosicus*); Potier de la Varde (1938: 63, fig. 1; 1953: fig. 3 as *F. schelpei*).

17. *Fissidens rufescens* Hornsch. Fig. 16

Linnaea **15**: 153. 1841. – LECTOTYPE (designated by Bruggeman-Nannenga & Pursell 1995): South Africa, Cape, Greenkloof, *Breutel s.n.* (BM).

*Fissidens marginatus* Schimp. ex Müll. Hal., Bot. Zeitung (Berlin) **16**: 154. 1858. – HOLOTYPE: South Africa, Cape, *Ecklon s.n.* (BM).

*Fissidens breutelii* Schimp. ex Müll. Hal., Bot Zeitung (Berlin) **17**: 198. 1859. – LECTOTYPE (designated by Magill 1981): South Africa, Cape, Gnadenthal, *Kuhn s.n.* (BM).

NOTE. *Fissidens rufescens* sensu Magill (1981) is *Fis-*

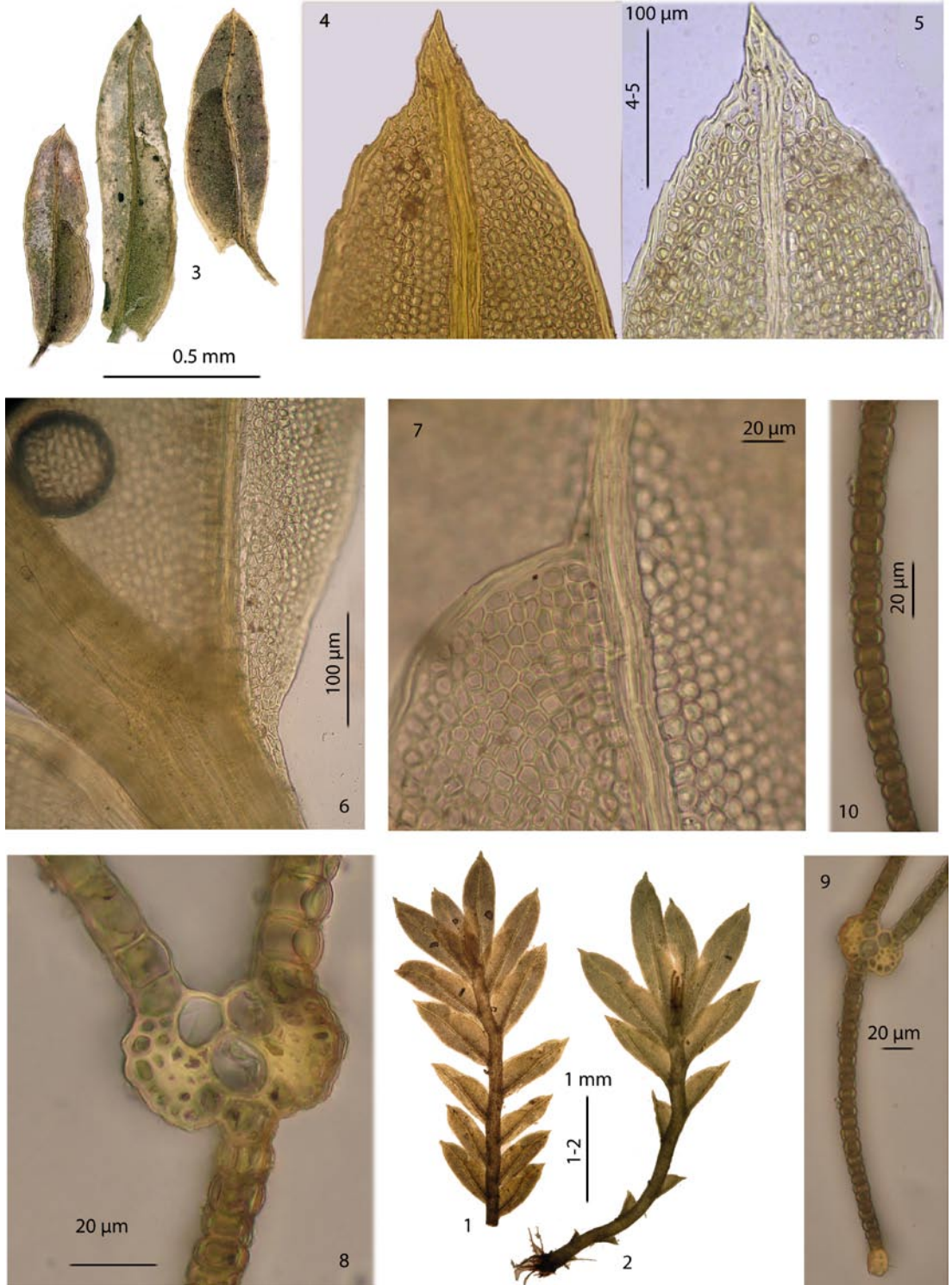
*sidens megalotis* Schimp. ex Müll. Hal. subsp. *megalotis* (Bruggeman-Nannenga & Pursell 1995).

Growing scattered or in loose tufts or mats; stem with central strand, mostly unbranched, 4.0–8.0 × 0.7–1.8 mm; rhizoids basal a few axillary, brown, faintly papillose; axillary nodules weakly differentiated; leaves green, mid and upper leaves close to distant, basal pairs distant, 5–12 pairs, crispate when dry often difficult to flatten, obscure, lanceolate to oblong-lanceolate, acute, broadly acute or obtuse, apiculate to mucronate, 0.6–2.0 × 0.2–0.5 mm, L/W 3–5; margin limbate; limbidium on all laminae of all leaves, reaching the leaf apex, confluent with the costa or ending just below; reaching the insertion of the vaginant lamina, limbidium of lesser lamella confluent with the costa; ± reaching the insertion of the dorsal lamina not present on the decurrent part, on mid of dorsal lamina 7.5–16.0 µm wide, 1–2 strato-se; on vaginant laminae 1–2 strato-se, marginal; vaginant lamina 1/2–2/3 the leaf length, open, smaller lamella distally rounded to rounded truncate, unistratose sometimes bistratose alongside the costa; dorsal lamina, mostly tapering towards the insertion, straight to slightly rounded below, short to long decurrent, in the basal 5 leaf pairs ending far above the insertion, dorsal and apical laminae unistratose; costa per- to excurrent; mid dorsal laminal cells obscure, roundish-hexagonal to oblong with convex, thickened walls, 5–13 × 5–8 µm; mid vaginant laminal cells clear, plane or convex, 8–21 × 5–11 µm.

Fertile parts, perigonia (only one seen) terminal on short, 0.75 mm long, bud-like stems; antheridia 350 µm long; perichaetial stems not markedly different from vegetative stems; perichaetia terminal, perichaetial leaves 1.8–2.7 mm long with rounded mucronate apex; archegonia 450–500 µm long. Sporophytes rare, not observed in Tanzanian material; seta 6–7 mm long, smooth;

←  
**Fig. 15.** *Fissidens rotareau* P. de la Varde 1 & 2 – vegetative stems; 3 – perichaetial stem; 4, 5 & 6 – leaves; 7 – leaf apex; 8 – mid leaf; 9 – basal part of leaf; 10 – apical lamina with (pseudo?) papillae; 11 – trans section of stem and limbate margins of vaginant lamina; 1, 2, 4, 5 & 8 from *Bruggeman-Nannenga 11001* (private herbarium Bruggeman-Nannenga); 3 & 10 from *Arts RÉU 13/04* (private herbarium Bruggeman-Nannenga); 6, 7, 9, & 11 from *Pócs & Ochyra 88122/BQ* (private herbarium Bruggeman-Nannenga).







*capsules* inclined to curved to almost horizontal, 1.0–1.5 × 0.4–0.9 mm, with 50–60 files of oblong, exothecial cells; *peristome* bryoides type, teeth 49.5–54.5 µm wide at base; *operculum* not seen; *calyptra* not seen; *spores* 13.0–16.5 mm long, smooth to faintly papillose.

This species is easily recognized by its open vaginant laminae, obscure leaves with strongly convex dorsal and apical laminal cells, stout limbidia on all laminae and inclined to horizontal capsules. *Fissidens beckettii* also has open vaginant laminae and strongly inclined capsules, but has larger, not convex cells. *Fissidens artsii* and *F. megalotis* also often have convex, lenticularly thickened cell walls. *Fissidens megalotis* subsp. *helictocaulos*, however, has almost closed and *Fissidens artsii* completely closed vaginant laminae, whereas *F. megalotis* subsp. *megalotis* can be distinguished by its intramarginal limbidia.

**HABITAT.** In forests, stream sides, road banks, near cascades, in gardens and, less often, in grasslands.

**SUBSTRATE.** Mostly on soil, also saxicolous; in Tanzania on a lava cliff.

**ALTITUDE.** 0–3540 m.

**DISTRIBUTION.** Northeast tropical Africa (Djibouti); east tropical Africa (Kenya, Tanzania); south tropical Africa (Malawi, Zimbabwe); southern Africa (Botswana, Lesotho, Namibia, South Africa); and western Indian Ocean (Madagascar, La Réunion). Rare in Tanzania.

**SPECIMENS EXAMINED:** TANZANIA, Mt. Kilimanjaro, *Sharp et al. 7431/E* (EGR, L). – MALAWI, *Kungu 3237y* (E). – SOUTH AFRICA, Cape Province, *Ecklon s.n.* (BM); *Lübenau SA 15R* (private herbarium Bruggeman-Nannenga); *Van Zanten 76.08.43* (GRO) and *76.08.44* (GRO); *Ecklon s.n.* (BM).

**ILLUSTRATIONS.** Bruggeman-Nannenga & Arts (2010: fig. 17), Magill (1981: fig. 10: 17–24 as *F. marginatus*).



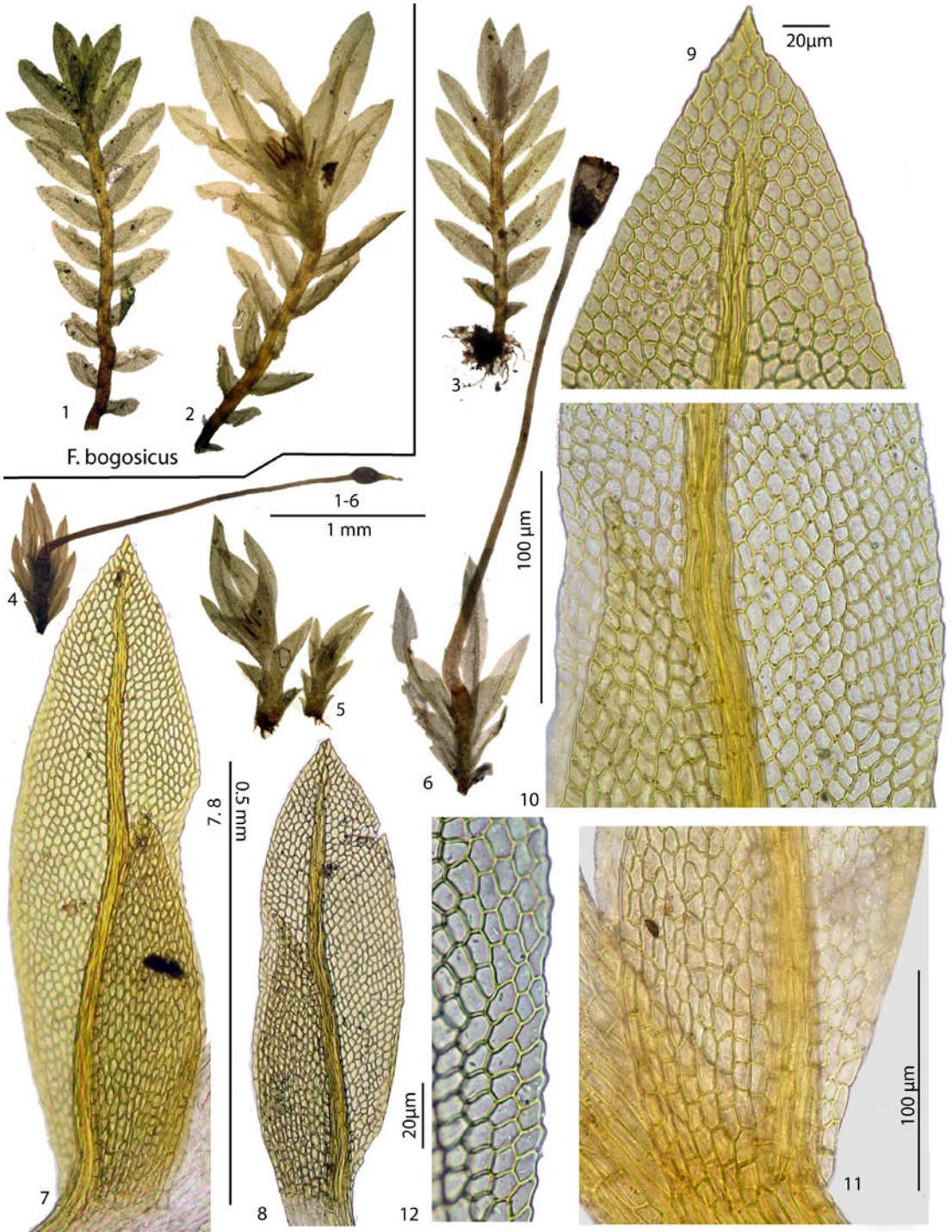
**Fig. 16.** *Fissidens rufescens* Hornsch. 1 – vegetative stem; 2 – perichaetial stem; 3 – leaves; 4 & 5 – leaf apices; 6 – leaf insertion; 7 – mid leaf; 8 – detail of 9; 9 – trans section leaf; 10 – trans section dorsal lamina showing the lenticularly thickened walls; 1, 2, 4 & 6 from *Van Zanten 76.08.44* (GRO); 3, 8–10 from *Lübenau SA 123* (private herbarium Bruggeman-Nannenga); 5 & 7 from *Sharp et al. 7431/E* (L).

18. *Fissidens taylorii* Müll. Hal. Fig. 17

Syn. Musc. Frond. 1: 65. 1848. – TYPE: Australia, Swan River, *J. Drummond s.n.* (HOLOTYPE: FH; ISOLECTOTYPES: BM, FH) (not seen).

Growing scattered between other mosses. *Stems* heterocaulous, with central strand; *rhizoids* basal, pale brown to hyaline, smooth; *axillary* cells hardly differentiated; *vegetative stems* unbranched, pinnate, 1.10–2.00 × 0.65–1.00 mm; *leaves* pale green, distant, 5–12 pairs, hardly crispate (flexuose) when dry, elliptical to elliptico-lanceolate, acute, 0.37–1.40 × 0.11–0.40 mm, L/W 3–4, margin subentire, elimbate, weak limbidium of a few thin-walled oblong cells on the basal part of vaginant laminae sometimes present; vaginant lamina 3/5–7/10 the leaf length, slightly to half open, unistratose; dorsal lamina tapering and straight towards the insertion, reaching the insertion, not decurrent, dorsal and *apical lamina* unistratose; costa ending 1–5 cells below the leaf apex, bryoides type; mid dorsal *laminal cells* clear, hexagonal, smooth, plane, 9.0–16.0 × 6–11 µm; mid vaginant laminal cells 8–18 × 5–8 µm; vaginant laminal cells of perichaetial leaves often oblong, 24–35 µm long.

**Fertile parts.** *Perigonia* terminal, male stems 0.5–1.0 mm long, antheridia 170–200 µm long; *perichaetial stems* unbranched, 1.3 × 1.0 mm, frondiform; *leaves* crowded to slightly distant, 5–6 pairs that differ much in shape and size; upper and mid leaves of perichaetial stems limbate, limbidia present on all laminae or restricted to the vaginant laminae, extension variable, ending well below the leaf apex, reaching the insertion of the dorsal lamina or not, frequently restricted to (part of) the vaginant laminae, marginal or intramarginal, unistratose; *perichaetia* terminal; perichaetial leaves narrowly acute with percurrent costa, 1.1–1.5 mm long; archegonia 300 µm long. *Sporophyte*, *seta* 3–4 mm long, smooth, 1 per perichaetium; *capsule* symmetrical, 0.55 × 0.30 mm,



± 58 columns of oblong exothecial cells; *peristome* bryoides type, teeth 35–40 µm wide at base; *operculum* not seen; *calyptra* mitrate, smooth, 0.45–0.50 mm long; *spores* 14–27 µm long, papillose.

This rare species is usually found in small quantities mixed with other species. It is characterized by heterocaulous stems, i.e., pinnate vegetative stems with characteristic elliptico-lanceolate leaves (Fig. 17: 3, 7, 8) and short, relatively large, frondose perichaetial stems; limbidia are typically restricted to the vaginant laminae of upper and mid leaves of perichaetial stems, but can be present on all laminae. It has costae that end 1–5 cells below the apex and bryoides type peristomes.

It is most likely to be confused with other partly limbate, heterocaulous species. Of these, *F. pygmaeus* Hornsch. (not known from Tanzania) can be distinguished by its completely open vaginant laminae and the typically recurved leaf apices on infertile stems. *Fissidens bogosicus* has similar vegetative stems, but is less distinctly heterocaulous. It has longer, pinnate perichaetial stems with distant leaves that except for the upper leaves do not differ from vegetative stems. The vegetative stems of these two species are compared in Fig. 17: 1 and 3, and the perichaetial stems in Fig. 17: 2 and 4–6. In vegetative state these species can not be separated with certainty. *Fissidens roteraeui* has limbate vaginant laminae on all or most leaves of both vegetative and perichaetial stems, firm limbidia that typically reach the apex of the vaginant laminae and percurrent costae. The leaves of the semiaquatic *F. obscurifrons* are obscure and attenuated towards the insertion (Fig. 12: 2–5); furthermore this species typically has limbate vaginant laminae on all leaves of both vegetative and perichaetial stems and limbidia that may extend up to 150 µm onto the apical laminae. *Fissidens curvatus* is equally heterocaulous, but has limbidia

on all laminae of all leaves that are confluent at the leaf apex and excurrent costae.

**HABITAT.** Insufficiently known: rainforest, montane rainforest, dry evergreen gully forest.

**SUBSTRATE.** On stone and soil.

**ALTITUDE.** 930–2400 m.

**DISTRIBUTION.** Pantropical. USA, neotropics, Australia, New Zealand and St Helena. In Africa known from Tanzania (Arusha and Tanga) and Uganda. New to Africa.

**SPECIMENS EXAMINED:** TANZANIA, Arusha, Arusha National Park, *Sharp 8871* (PC cited by Bizot *et al.*, 1979 as *F. stellenboschianus*); Arusha region, S slope of Longido Hill, *Pócs et al. 87165/AC p.p.* mixed with several other *Fissidens* species (EGR, L); Tanga, East Usambara, *Brago & Vollesen s.n.* (PC, cited by Bizot *et al.* 1978 as *F. stellenboschianus*). – UGANDA, Rukungiri, Bwindi NP, *Hodgetts U 4596A* (E). – NEW ZEALAND, Wellington, Lyell's Bay, *Roper s.n.* (BM). – ST HELENA, *Wigginton 05/287A* and *Wigginton 05/364A* (both: E, private herbarium Bruggeman-Nannenga).

**SELECTED ILLUSTRATIONS:** Beever *et al.* (2002: 68), Pursell (1997: figs 1–7; 2007: 101, fig. 49D), Stone & Beever (1996: fig. 1–2); Bruggeman-Nannenga & Wigginton (2012: fig. 2: 3–7).

#### EXCLUDED SPECIES

*Fissidens linearilimbatus* Müll. Hal., *Flora* **73**: 471. 1890. – TYPE: Afr. or. trop., Leikipia in regione occid. montis Kenia, inter *Trichostomum* Leikipiae m. vigen, *L. Höhnel* in Exped. Telekiana 1887. I have not been able to locate a type specimen.

*Fissidens menyharti* Müll. Hal., *Hedwigia* **38**: 54. 1899 – TYPE: Ad flumen Zambesi medium circa Borome, Dec. 1890, *Menyhárt*, HB. Vindebonense mis. 1893 (= ?*F. androgynus* fide Sim 1926: 199). Sim did not see the type specimen. I too have been unable to locate a type.

←  
**Fig. 17.** *Fissidens bogosicus* Müll. Hal. (1 & 2). 1 – vegetative stem; 2 – archegonial stem. *Fissidens taylorii* Müll. Hal. (3–12). 3 – vegetative stem; 5 – archegonial stems; 4 & 6 – sporophytic stems; 7 & 8 – leaves; 9 – leaf apex; 10 – mid leaf; 11 – basal part of leaf; 12 – mid margin dorsal lamina; 1 & 2 from *Pócs & Magombo 9176/O* (L); 3, 6, 8–11 from *Pócs et al. 87165/AC* (L); 4 from *Brago & Vollesen s.n.* (PC), 5 & 12 from *Hodgetts U4596A* (private herbarium Bruggeman-Nannenga); 7 from *Pócs 8663/N* (L).

ACKNOWLEDGEMENTS. I am grateful to the curators of BM, BR, EGR, H, K, L, MO, NY, PC and PRE for the loan of specimens, to Nicolien Sol and Gerard Thijssse (L) for practical support, Iris and Henk Wevers for help with organizing the geographical date, and to Dr. Ron Pursell and Dr. Jessica Beever for helpful comments.

## REFERENCES

- ARTS T. 1998. A contribution to the moss flora of the Cape Provinces (South Africa). *J. Bryol.* **20**: 429–447.
- BEEVER J. E., MALCOLM B. & MALCOLM N. 2002. The moss genus *Fissidens* in New Zealand an illustrated key. Micro-Optics Press. Nelson N.Z.
- BIZOT M., 1963. *Nanobryum gladiolum* (Mitt.) Biz. comb. nov. *Rev. Bryol. Lichénol.* **32**: 82–83.
- BIZOT M. & PÓCS T. 1979. East African bryophytes III. *Acta Bot. Acad. Sci. Hung.* **25**: 223–261.
- BIZOT M., DURY M. N. & PÓCS T. 1976. East African Bryophytes, II. Collections made by L. Ryvarde in Malawi, SE Africa. *Acta Bot. Acad. Sci. Hung.* **22**(1–2): 1–8.
- BIZOT M., PÓCS T. & SHARP A. J. 1979. Results of a bryogeographical expedition to east Africa in 1968. II. *J. Hattori Bot. Lab.* **45**: 145–165.
- BIZOT M., FRIIS I., LEWINSKY J. & PÓCS T. 1978. East African bryophytes IV. Danish collections. *Lindbergia* **4**: 259–284.
- BRUGGEMAN-NANNENGA M. A. 1993. Taxonomic Results of the BRYOTROP expedition to Rwanda and Zaire. 15. Fissidentaceae. *Trop. Bryol.* **8**: 141–148.
- BRUGGEMAN-NANNENGA M. A. 1997. Notes on *Fissidens* VI. New synonyms, new combinations and validation of some names. *J. Hattori Bot. Lab.* **81**: 155–173.
- BRUGGEMAN-NANNENGA M. A. 1999. Notes on Seychelles mosses. 2 A revision of Fissidentaceae. *Bryobrothera* **5**: 65–75.
- BRUGGEMAN-NANNENGA M. A. 2005. Two new species of *Fissidens* (Fissidentaceae, Musci) from Africa, *Fissidens haringtonii* and *Fissidens artsii*. *Trop. Bryol.* **26**: 13–17.
- BRUGGEMAN-NANNENGA M. A. 2006a. Bryophyte flora of Uganda. 6. Fissidentaceae (Part 1). *J. Bryol.* **28**: 53–62.
- BRUGGEMAN-NANNENGA M. A. 2006b. Bryophyte Flora of Uganda 6 Fissidentaceae (Part 2). *J. Bryol.* **28**: 139–148.
- BRUGGEMAN-NANNENGA M. A. 2009. Notes on *Fissidens* VII–IX. *J. Bryol.* **31**: 106–116.
- BRUGGEMAN-NANNENGA M. A. 2013a. *Fissidens tamaspocsii* and *F. magnicellulatus* spp. nov. from eastern Africa and validation of *F. cyatheicola*. *Lindbergia* **36**: 9–14.
- BRUGGEMAN-NANNENGA M. A. 2013b. Two new *Fissidens* species (Fissidentaceae) from tropical eastern Africa and *Fissidens bessouensis* Corb., a remarkable species with fimbriate leaves and multicellular spores. *Polish Bot. J.* **58**(1): 117–125.
- BRUGGEMAN-NANNENGA M. A. & ARTS T. 2010. A revision of the Fissidentaceae (Musci) of La Réunion (including all species known from Mauritius and Rodriguez). *J. Bryol.* **32**: 170–207.
- BRUGGEMAN-NANNENGA M. A. & PURSELL R. A. 1995. Notes on *Fissidens* V. *Lindbergia* **20**: 49–55.
- BRUGGEMAN-NANNENGA M. A. & WIGGINTON M. J. 2012. Bryophytes of St Helena, South Atlantic Ocean. 5. *Fissidens* Lindb. (Fissidentaceae), including a description of *F. translucens* sp. nov. and *Fissidens curvatus* Hornsch. subsp. *sanctae-helenae* subsp. nov. *J. Bryol.* **34**: 212–230.
- CHUAH-PETIOT M. S. 2003. Mosses, liverworts and hornworts of Kenya. An illustrated guide with descriptions and figures of over 300 species and keys for identification. Chuah-Petiot, Nairobi.
- DEMARET F. & LEROY V. 1944. Exploration du Parc National Albert. Mission J. Lebrun (1937–1938) fascicule 6. Mousses: 1–65. Imprimerie M. Hayez, Brussels.
- DEMARET F. & POTIER DE LA VARDE R. 1957. Trois *Fissidens* et un *Philonotis* nouveaux du Ruwenzori. *Bull. Jard. Bot. État Bruxelles* **27**: 755–762.
- DIXON H. N. 1922. Some new genera of mosses. *J. Bot.* **60**: 101–110, pl. 564.
- IWATSUKI Z. & PURSELL R. A. 1980. Axillary nodules in *Fissidens* (Fissidentaceae). *J. Hattori Bot. Lab.* **48**: 329–335.
- IWATSUKI Z. & SUZUKI T. 1982. A taxonomic revision of the Japanese species of *Fissidens* (Musci). *J. Hattori Bot. Lab.* **51**: 329–508.
- KIS G. 1985. Mosses of South-East Tropical Africa. Vácátót, Hungary.
- KÜRSCHNER H. 1999. New moss records for Socotra and Yemen mainland. Studies in Arabian bryophytes 24. *Nova Hedwigia* **69**: 399–405.
- MAGILL R. E. 1981. Bryophyta. Part 1. Mosses. Fascicle I. Sphagnaceae – Grimmiaceae In: O. A. LEISTNER (ed.), *Flora of Southern Africa*. Botanical research Institute, Department of Agriculture and Fisheries, Republic of South Africa.
- MÜLLER C. 1900. Genera Muscorum Frondosorum. E. Kummer. Leipzig.
- O'SHEA B. J. 2006. Checklist of the mosses of sub-Saharan Africa (version 5, 12/06). *Tropical Bryology Research Reports* **6**: 1–152.
- O'SHEA B. J., WIGGINTON M. J., BRUGGEMAN-NANNENGA M. A., HODGETTS N. G. & PORLEY R. D. 2001. British Bryological Society Expedition to Mulanje Mountain, Malawi. 13. New and other unpublished records. *Trop. Bryol.* **20**: 1–26.



- O'SHEA B. J., WIGGINTON M. J., BRUGGEMAN-NANNENGA M. A., HEDENÁS L., MATCHAM H. W., FRAHM J.-P., PORLEY R. D., ELLIS L. T., WATLING M. C., BATES, J. E. & VAÑA J. 2003. Bryophytes of Uganda, 6. New and additional records, 3. *Trop. Bryol.* **24**: 161–168.
- POTIER DE LA VARDE R. 1926. Mousses nouvelles de l'Afrique tropicale française. Quatrième note. *Bull. Soc. Bot. France* **73**: 377–386.
- POTIER DE LA VARDE R. 1928. Mousses de l'Oubangui. *Arch. Bot. Mém.* **3**: 1–152, pl. 1–4.
- POTIER DE LA VARDE R. 1929. Etudes préliminaires de quelques espèces africaines du genre *Fissidens*. *Ann. Cryptog. Exot.* **2**: 272–290.
- POTIER DE LA VARDE R. 1932. Récoltes bryologiques aux environs de Bozoum. *Rev. Bryol. Lichénol.* **5**: 83–90.
- POTIER DE LA VARDE R. 1936. Herborisations dans la région de Bocaranga (Oubangui). *Rev. Bryol. Lichénol.* **9**: 194–209.
- POTIER DE LA VARDE R. 1938. Sur une collection de Mousses malgaches. *Mémoires de la Société Nationale des Sciences Naturelles et Mathématiques de Cherbourg* **43**: 63–69.
- POTIER DE LA VARDE R. 1943. Mousses nouvelles recoltées aux Iles du Cap Verts par. M. Aug. Chevalier en 1934. *Bull. Mus. Hist. Nat. (Paris)* **15**: 239–243.
- POTIER DE LA VARDE R. 1953. Contribution à la flore bryologique africaine (cinquième article). *Rev. Bryol. Lichénol.* **22**: 6–15.
- PURSELL R. A. 1994. *Fissidentales*. In: A. J. SHARP, H. CRUM & P. M. ECKEL (eds), *The Moss Flora of Mexico. Part one*. The New York Botanical Garden, New York.
- PURSELL R. A. 1997 [1998]. *Fissidens taylorii*, new to North America north of Mexico. *Bryologist* **100**: 525–528.
- PURSELL R. A. 2007. Fissidentaceae. Flora Neotropica Monograph 101. The New York Botanical Garden Press, New York.
- PURSELL R. A. & BRUGGEMAN-NANNENGA M. A. 2004. A revision of the infrageneric taxa of *Fissidens*. *Bryologist* **107**: 1–20.
- PURSELL R. A. & REESE W. D. 1980. The taxonomic status of the Nanobryaceae (Bryopsida). *Bryologist* **83**: 559–562.
- RENAULD F. 1909. Essai sur les Leucoloma et Supplément au Prodrome de la Flore Bryologique de Madagascar, des Mascareignes et des Comores. Monaco.
- SHEVOCK J., PURSELL R. A., GARCIA C., BRUGGEMAN-NANNENGA M. A. & SÉRGIO C. 2013. The genus *Fissidens* in the Republic of São Tomé and Príncipe, Gulf of Guinea, West Africa. *J. Bryol.* **35**: 197–205.
- SMITH A. J. E. 1978. The Moss Flora of Britain and Ireland. Cambridge University Press, Cambridge.
- STONE I. G. & BEEVER J. E. 1996. Studies of the Australian moss *Fissidens taylorii* C. Muell. *J. Bryol.* **19**: 49–64.
- TONGIORGI E. 1938. Schaedulaceae bryologicae Africae orientalis Italicae. 1. *Fissidens badoglioi* n. sp. *Nuovo Giorn. Bot. Ital.* **45**: 219–220.

Received 1 September 2013