

THE SECTION PACHYLOMIDIUM (GENUS FISSIDENS). I
THE SPECIES OF TROPICAL AND SUBTROPICAL SOUTH AMERICA

BY

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The present paper is intended to be the first of a series on the species of *Pachylomidium* from all over the world. It has been prepared under supervision of Dr. P. A. Florschütz (Instituut voor Systematische Plantkunde, Heidelberglaan 2, Utrecht).

The species of *Pachylomidium* are characterised by leaves which are completely or nearly completely bordered, with a nerve which nearly or completely reaches the apex, smooth cells and a pluristratose border. The species of this section grow exclusively near running water and are inundated during part of the year. Unfortunately there are some species which are more or less transitional between this section and other ones. I will deal with these problems more extensively in a following paper.

Two of the South American species included by BROTHERUS (1924) in this section have been excluded. One of them, viz. *F. luteolimbatus* Broth. has been removed to the section *Pycnothallia*, because of its very small and papillose cells. This species may be a synonym of *F. weirii* Mitt. The other one, viz. *F. protracticaulis* Broth. has been transferred to the section *Bryoidium*. This has been done on account of its thin, mostly unistratose border and because of its strong resemblance to the *Bryoidium* species *F. anguste-limbatus* Mitt. *F. protracticaulis* differs from that species by its erect capsules.

In this paper for the first time a key to the South American *Pachylomidium* species is published. As far as possible figures and comparable descriptions of all species are supplied. Moreover, each description is preceded by a summary of its most characteristic features. One new species is described; of one species a synonym is rejected and one of the names which so far have been accepted is reduced to a synonym. Unfortunately five from the eight species with which this paper deals are known from their type only. Therefore it is impossible to know the variability of their characters. Nevertheless all but one species have been included in the key and have been provided with a summary of their most characteristic features. Naturally, in these cases mainly those characters have been used which, on account of my experience with other *Pachylomidium* species, were considered to be reliable, but apart from these some characters have

been used, which are striking, but of which it is not yet known whether they really are constant.

ABBREVIATIONS

- d.l. dorsal lamina
 L length of the leaf
 V length of the sheathing part of the leaf
 W width of the leaf

USED CHARACTERS

I. The next list circumscribes the terms which have been used throughout this paper, in a narrower sense than they usually are, and explains the way in which some measurements were made.

cells: cells in the middle of the d.l. of the leaves halfway up the stem of a sterile plant, unless stated otherwise

insertion: place of insertion of the leaf

leaves: leaves halfway up the stem of a sterile plant, unless stated otherwise

length of the sheathing part of the leaf: this length can be measured from the base to either the point at which the sheath ends on the border or the point at which it ends on the nerve. In this paper the last has been done

width of the border: width in the middle of the d.l. of the leaves halfway up the stem of a sterile plant

width of the leaves: greatest width

width of the peristomium teeth: width at the base of the latter

spores, size of: always the length of the axis is given.

II. *form of leaves*

N.B. In the descriptions no difference has been made between narrowly, normally and broadly elliptical, oblong or ovate leaves. Instead of this the ratio L/W has been given.

Elliptical leaves reach their greatest width in the middle and have an acute tip.

In oblong leaves the width is about equal throughout the leaf; the tip is obtuse.

Ovate leaves reach their greatest width below the middle. Their tips may be acute as well as obtuse.

REMARK. Acute as well as obtuse tips may have acuminate, apiculate or mucronate apices.

III. *form of the apex*

Acute is used for apices bounded by two straight lines converging at an angle of less than 90° .

Acuminate apices are bounded by lines which change from straight or convex to concave and converge gradually into a meeting point. To describe the variation within the acuminate form the term acuminate is preceded by two adverbs: the first indicates the degree of concavity of

the acumen, the second the degree in which the tip projects beyond the point at which one would expect it when the course of the margins would not have changed. The kind of acuminate apex in which the tip is situated at or below the point on which one would expect to find it has not been met in the South American *Pachylomidium* species (but see acuminate mucrones). An acumen is always composed of lamina tissue, or lamina tissue together with nerve and/or border tissue.

Apiculate and mucronate apices are abruptly narrowed to a point. This point is bounded by parallel sides (only at the extreme base of a mucro or apiculus the sides may be somewhat converging, while broad ones may have an acute or acuminate tip). Apiculate and mucronate apices differ by their structure. Apiculi are composed of lamina tissue or of lamina tissue together with nerve and/or border tissue. **Mucrones** are formed either entirely by nerve tissue or by nerve and border tissue. **Acuminate mucrones** have the same structure as mucrones, but they differ by their form which is acuminate. However in acuminate mucrones the tip may be below the point at which one would have expected to find it when the course of the margins would not have changed. This difference has been left out of consideration in the descriptions.

Obtuse apices are rounded, with a tip large enough for an angle of 90° to be placed in it.

SOME CHARACTERS WHICH HAVE NOT BEEN USED

The length of the peristomium teeth has not been used because the width is just as reliable and because it is often still measurable when the length is not, e.g. in broken teeth.

I do not use the distinction between dioicious, rhizautoicious, autoicious or synoicious, because most species may occur in all these forms, even in one sample. Therefore in my opinion these differences have no taxonomic value in *Pachylomidium*. Nevertheless, there is one species, *F. rigidulus*, which seems to be exclusively dioicious.

I do not mention the number of setae. Generally *Pachylomidium* species have one seta per gynoicium or gynandroicium, but occasionally there may be two or three of them. Therefore, although the species seem to be somewhat different with regard to the frequency with which more than one setae occur, in my opinion this character too has little taxonomic value.

KEY

If this key does not give a decisive answer, it may be useful to compare the following characters of the plant one wishes to identify with those given in the descriptions: the length of the archeogonia, the terminal or axillary position of the antheridia, the size of the cells and the width of the peristomium teeth. I have found all these characters to be very reliable and often very differentiating, not only in South American *Pachylomidium* species but in other ones as well.

In species with axillary antheridia sometimes also terminal ones occur, but I have never seen a sample of such a species with exclusively or even mainly terminal antheridia. Anyhow, if there is some doubt about the position of the antheridia, their length may be decisive. For as a rule two species of about equal size will have about equally long antheridia, but if one has terminal and the other mainly axillary antheridia, the antheridia of the latter (even if terminally placed) will be much shorter. There is on the other hand no difference in length between terminal and axillary antheridia of one species.

N.B. Those terms which have been marked with an asterisk should be looked up in the list of used terminology.

- 1a Length of the leaves* 2.0–3.4 (3.8) mm; length of archegonia 458–759 μ ; plants from regions with a moderate climate *F. rigidulus* Hook. f. et Wils.

(This species will be dealt with in a following paper, as it does not occur in tropical or subtropical South America. It has been included in the key since it lives in the Andes. Furthermore it occurs in southern South America, in Australia and in New Zealand.)

- 1b Length of the leaves up to 2.1 mm; length of archegonia up to 438 μ ; plants from warmer regions 2
- 2a Border* very narrow, up to 7 μ wide and ending distinctly below the apex; apex acute; leaves flaccid; cells* rather large: 7–15 μ long, 7–11 μ wide . . . 1. *F. smaragdinus* Lor. et C. Muell.
- 2b One or more of these characters is different 3
- 3a Cells* very small: 7–11 μ , mostly 7 μ long; 4–7 μ wide 8. *F. oediloma* C. Muell. ex Broth.
- 3b Cells larger 4
- 4a Border* reaches the insertion* and is even at the insertion formed by true border cells (i.e. long and narrow cells which are pointed at both ends); antheridia in axillary buds 5
- 4b Border only very rarely reaching the insertion; however, sometimes the true border cells are near the insertion replaced by cells which are long, but not very narrow and not pointed at the ends; such a "border" may reach the insertion. Antheridia terminal in *F. crenulatulus*, unknown in the other two species 6
- 5a Capsules horizontal, curved; setae long and slender: 6.5–10 mm; spores* small, circa 11 μ , globose. . 3. *F. capillisetus* Broth.
- 5b Capsules erect; setae 5 mm long; spores large: 19–26 μ , prolate to subglobose 2. *F. capillisetoides* Brugg.-Nann.
- 6a Border* rather wide: (11) 19–26 (33) μ (if wider than 33 μ , see *F. oediloma*); leaves never flaccid; sheath in most leaves half as long as the leaf or less 7. *F. crenulatulus* C. Muell. ex Broth. (but see also 6. *F. variabilis*)
- 6b Border less wide: 7–11 μ ; leaves flaccid in *F. pennula* (*F. goebelii* is only known from the type specimens, which do not have

- flaccid leaves); sheath half as long as the leaf or, more often, more than half as long as the leaf 7
- 7a Leaf* length 1.4–1.8 mm; cells* rather large: 11–19 μ long, 7–9 μ wide 5. *F. goebelii* C. Muell.
(but see also 6. *F. variabilis*)
- 7b Leaf length 0.9–1.5 mm; cells smaller: (4) 7–11 μ long, 4–7 μ wide 4. *F. pennula* Broth.
(but see also 6. *F. variabilis*)

REMARK: Of one species, 6. *F. variabilis* Brugg.-Nann. the only available plants (the type material) are so variable that it is impossible to tell which of their features are characteristic. When using the key one might confuse this species with *F. crenulatulus*, *pennula* and *goebelii*. For differences between these species and *F. variabilis* see the description of that species.

1. *F. smaragdinus* (Lor. et C. Muell.) Broth. Nat. Pfl. 1 (3): 355. 1901. – *Conomitrium smaragdinum* Lor. et C. Muell. Linnaea 42: 248. 1879. – Type: Lorentz, Córdoba (S-PA, H, NY). – Fig. 1a-d.

This species can be recognized at once by the characters mentioned in the key, to which may be added that the ratio L/V is 1.5–2.

Plants up to 2 cm long, thinly to densely foliated, with up to 42 leaf pairs. Leaves ovate with an acute tip; 0.8–1.4 mm long and 0.2–0.4 mm wide; ratio L/W 3–5; ratio L/V 1.5–2. Apex acute, border ending distinctly below the apex and nerve vanishing in or below the apex, occasionally even rather far below the apex, which is unusual for a *Pachylomidium* species. Leaves not or slightly decurrent; border ending distinctly above the insertion. Width of the border 7 μ . Cells 7–15 μ long, 7–11 μ wide; walls thin and colourless. Neither sexual organs nor sporogones have been collected.

Distribution: Argentina.

Examined specimens: ARGENTINA, Lorentz, Córdoba (S-PA, H, NY).

Ecology: The plants have been found near a cataract.

Remark: This species is the only one of the South American species which seems to belong to the same group as the European *F. crassipes* Wils. and *F. rufulus* B. S. G. All species of this group have leaves with an acute apex and a border which ends distinctly below the apex. *F. smaragdinus* differs from the other species of this group by its thin border and flaccid leaves.

The next two species, *F. capillisetoides* and *F. capillisetus*, both have axillary antheridial buds, in addition to which terminal ones may occur, completely bordered leaves, often with an acuminate, asymmetric mucro.

2. *F. capillisetoides* Brugg.-Nann. nov. spec. – Type: Lindberg, Caldas (L(holo-), H). – Fig. 2a-d.

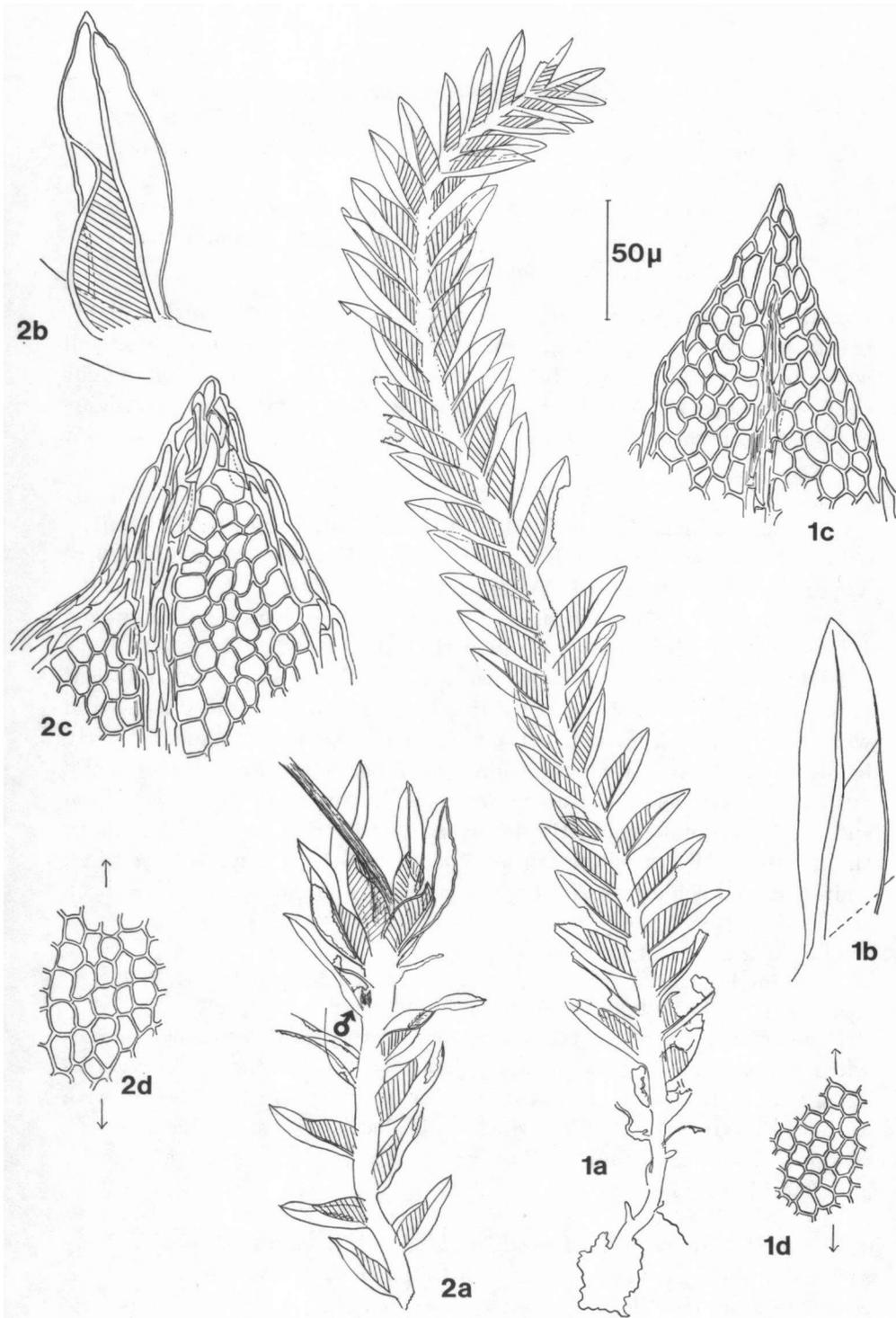


Fig. 1. *F. smaragdinus* Lor. et C. Muell. (type). **a:** Habit (length 2.0 cm); **b:** leaf (length 1.4 mm); **c:** leaf apex; **d:** cells from the middle of the d.l. – **Fig. 2.** *F. capillisetoides* Brugg.-Nann. (holotype). **a:** Habit (length 0.5 cm); **b:** leaf (length 1.5 mm); **c:** leaf apex; **d:** cells from the middle of the d.l. – The enlargement supplied between the figures applies to fig. 1c–d and 2c–d. The arrows in fig. 1d and 2d show the orientation of the leaf axis.

Plantae usque ad 1.5 cm longae, sparsius foliatae, paribus foliorum usque ad 23 instructae. *Folia* 1.0–1.7 mm longa, 0.35–0.5 mm lata, anguste ovata, apice nunc acuta, nunc acuminata mucronata vel mucronata, ubique limbata, limbo (11) 15 (19) μ lato. *Archegonia* terminalia; *antheridia* lateralia. *Setae* circa 5 mm longae. *Thecae* erectae, symmetricae, 0.6–1.0 mm longae, 0.4–0.6 mm latae, dentibus peristomii 41–61 μ latis, sporis 19–26 μ longis.

Species differt a *F. capillisetos* sporis multo longioribus, setis multo brevioribus et thecis erectis.

Of this species only six stems are known. These have been found scattered in the type of *F. variabilis* and are old, crisped and weathered. Nevertheless it is clear that this species is different from all other representatives of *Pachylomidium*. Most of all it resembles *F. capillisetos*, hence its name. *F. capillisetoides* differs from this species by its shorter, less thin setae, its erect capsules and its much larger spores.

Plants up to 1.5 cm long, rather thinly foliated with up to 23 leaf pairs. The following description of the leaves is not, as usual, based on leaves from sterile plants, but on leaves from either fertile plants, or from plants of which we may assume that they are young fertile plants. *Leaves* ovate, with an acute tip, 1.0–1.7 mm long, 0.35–0.5 mm wide; ratio L/W 2.5–3.5; ratio L/V 1.5–2 (2.5). Apex either acute, acuminately mucronate or mucronate, often asymmetrical; nerve and border fusing at the apex or vanishing in it. Border reaching the base of the d.l., the latter not always reaching the insertion; in such cases the border may be decurrent on the nerve. Width of the border (11) 15 (19) μ . Cells 11–15 μ long, 7–11 μ wide; however, the cell size may vary in the different leaves. *Fertile plants*: archegonia terminal; antheridia axillary (archegonia and antheridia too old to measure their length). Perichaetal leaves about 2.0 mm long. *Sporophyte*: Setae 5 mm. Capsules erect and asymmetrical; length of capsules 0.6–1.0 mm; width 0.4–0.6 mm; width of peristomium teeth 41–61 μ . Spores 19–26 μ , prolate to subglobose, finely papillose.

Distribution: Brazil, province Minas Geraës.

Examined specimens: BRAZIL: Lindberg, Caldas (H, L).

Ecology: The plants have been found among stems of *F. variabilis*, which was found near a river.

3. *F. capillisetos* Broth. Bih. K. Svensk. Vet. Ak. Handl. 21, 3 (3): 17. 1895. – Type: Puiggari 409 (H(holo-), NY, S-PA, K, PC). – Fig. 3a-f.

An easily distinguishable species recognizable by the long slender plants, the narrow leaves, the long setae, the horizontal, curved capsules and the small, globose and smooth spores. Beside the above mentioned long and slender plants, which are mostly sterile but which may bear terminal antheridia or archegonia, short female plants with broader leaves occur.

Plants 0.7–1.2 cm long, thinly foliated with up to 23 leaves. *Leaves* elliptical, circa 1.2 mm long, circa 0.2 mm wide; ratio L/W about 6; ratio L/V 2–3. Nerve and border fusing to form an often asymmetrical acuminately mucronate apex. Leaves not decurrent; border reaching the

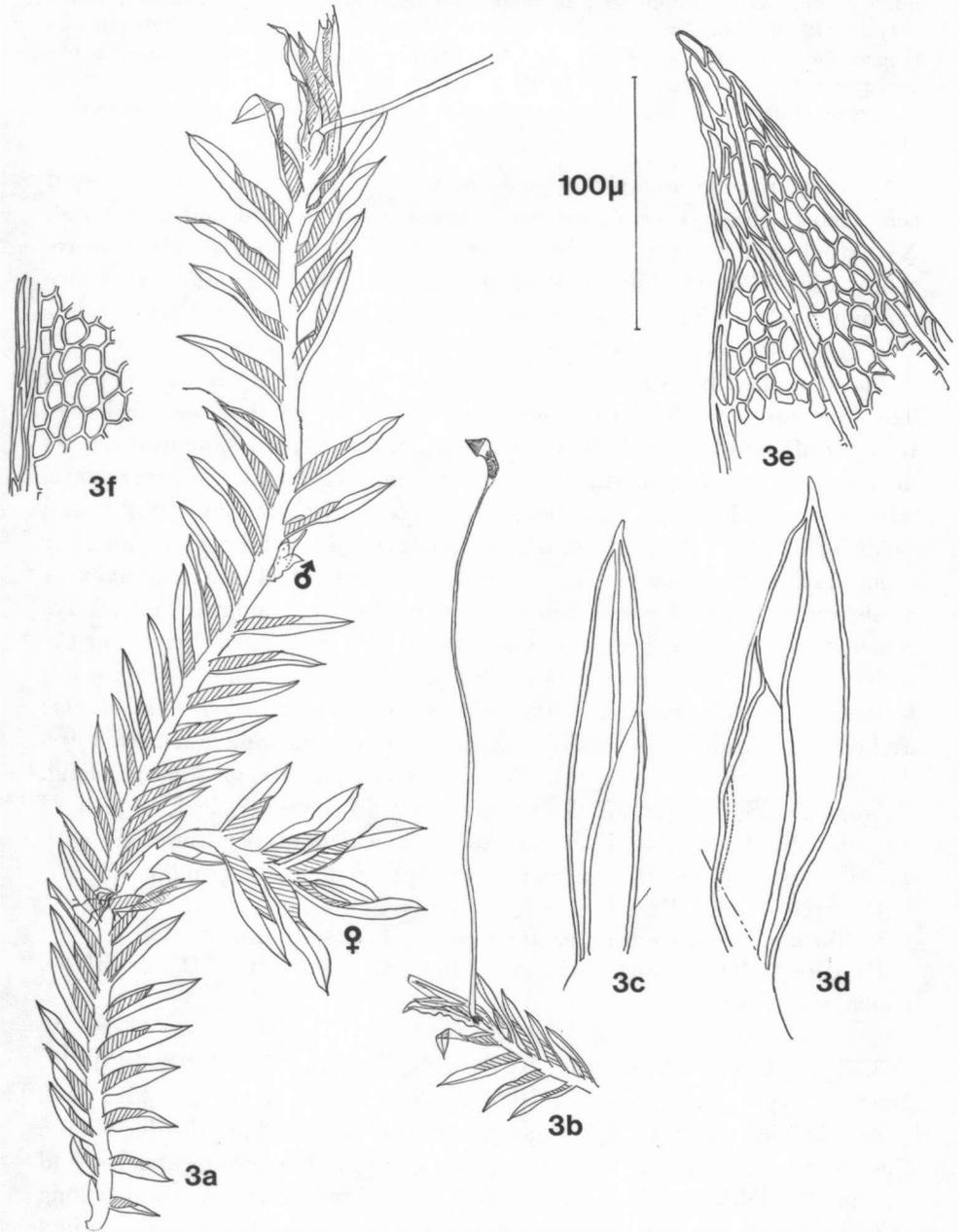


Fig. 3. *F. capillisetus* Broth. (holotype). **a:** Habit (length 1.2 cm); **b:** sporophyte (length seta 9.0 mm); **c:** leaf from sterile plant (length 1.2 mm); **d:** leaf from short female plant (length 1.4 mm); **e:** leaf apex; **f:** cells near the border from the middle of the d.l. — The enlargement supplied between the figures applies to fig. 3e-f.

insertion. Width of the border circa $11\ \mu$. Cells (7) 11 (15) μ long, circa $7\ \mu$ wide; walls thin. *Fertile plants*: Archegonia terminal. Female plants either not different from sterile ones or shorter (with 4–5 leaf pairs); in the latter case the leaves are, when compared with those of sterile plants, rather large and broad (length 1.5 mm; width 0.3 mm). Antheridia in axillary buds or terminal on very short to rather long axillary stems or branches (branches differ from stems in having no radicles). Length of archegonia circa $292\ \mu$; length of antheridia 146 – $190\ \mu$. Perichaetal leaves 1.4 – 1.8 mm long. *Sporophyte*: Setae 6.5 – 10.0 mostly about 8 mm long. Capsules horizontal, curved asymmetrical, 0.6 (0.7) mm long, 0.2 – 0.3 (0.4) mm wide; length of operculum 0.4 mm; width of peristomium teeth 48 – $52\ \mu$. Spores $11\ \mu$, globose and smooth.

Distribution: Brazil, province São Paulo.

Examined specimens: BRAZIL: *Puiggari* 409 (H, NY, K, S-PA, PC).

Ecology: The label of the type material says: *agua limpa in loco arenoso*, by which is probably meant "on sandy place in clear water".

4. *F. pennula* Broth. Bih. K. Svensk. Vet. Ak. Handl. 26, 3 (7): 13. 1900. – Type: *Lindman* 535 (H(holo-), S-PA). – *F. mattogrossensis* Broth. Bih. K. Svensk. Vet. Ak. Handl. 26, 3 (7): 14. 1900. – Type: *Lindman* 351 (H(holo-), S-PA, BM). – Fig. 4a-f.

F. pennula is not *F. falcatus* Lindb. (see FLORSCHÜTZ, 1964). For differences between these two species see 6. *F. variabilis*.

According to BROTHERUS (1900) *F. mattogrossensis* differs from *F. pennula* by being more slender and having more flaccid leaves. Besides, the type of *F. mattogrossensis* appears to differ from the type of *F. pennula* by having leaves with a more narrowly acute apex. Except for these differences the resemblance of these two species is striking. Moreover the samples from Surinam show all kinds of intermediate forms. For these reasons in my opinion the two are conspecific.

This species is easily recognizable by its broad, flaccid leaves, with small, thin walled cells and by the ratio L/V , which is generally 2 or less. However, none of these features is completely constant, and one sample (Steyermark 8769) even seems to be intermediate between this species and the next. The differences between both species are nevertheless rather persuasive:

	<i>F. goebelii</i>	<i>F. pennula</i>
length of cells	11 – $19\ \mu$	(4) 7 – $11\ \mu$
width of cells	7 – $11\ \mu$	4 – $7\ \mu$
length of stems	up to 3.5 cm	up to 1.5 cm
length of leaves	1.4 – 1.8 mm	0.9 – 1.5 (1.7) mm

Besides *F. goebelii* differs from *F. pennula* by its narrower, not flaccid leaves, by the form of the leaf apices which are slightly, but long acuminate and have a more distinctly excurrent nerve.

The above mentioned Steyermark 8769 has narrow, not flaccid leaves with a slightly, but long acuminate apex and a distinctly excurrent nerve.

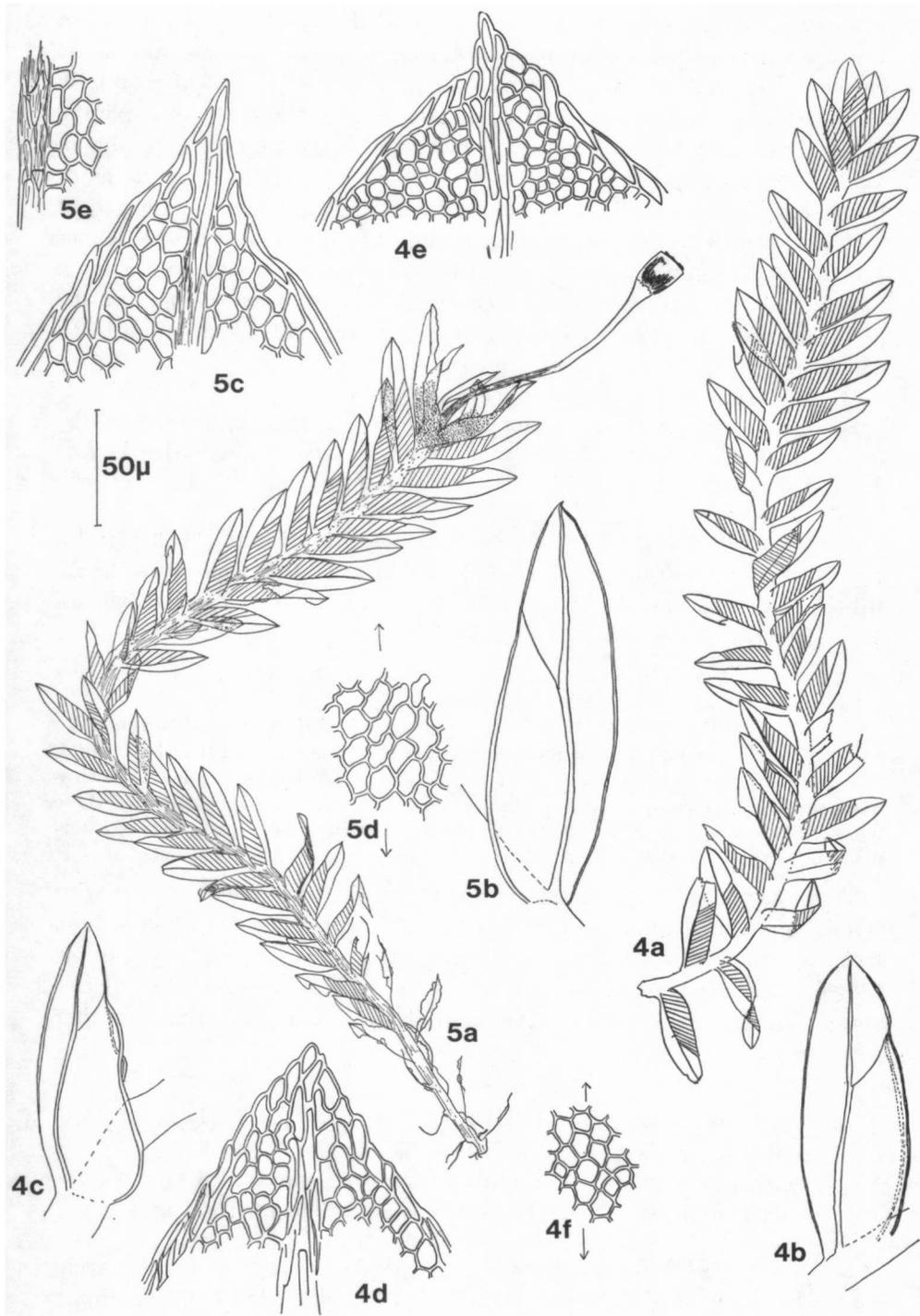


Fig. 4. *F. pennula* Broth. a: Habit (length 1.1 cm); b: leaf (length 1.4 mm); c: leaf (length 1.2 mm); d, e: leaf apices; f: cells from the middle of the d.l. (a: Huber, Igarapá; b: Lindman 535; c-d: Lindman 351; e-f: Florschütz 2173). - Fig. 5. *F. goebelii* C. Muell. (type). a: Habit (length without seta 1.8 cm); b: leaf (length 1.4 mm); c: leaf apex; d: cells from the middle of the d.l.; e: border in the middle of the d.l. - The enlargement given between the figures applies to fig. 4d-f and 5c-e. The arrows in fig. 4f and 5d show the orientation of the leaf axis.

Due to these features its general aspect is strikingly like that of *F. goebelii*, even though some leaves are rather broad for this species. Besides, like the type of *F. goebelii*, Steyermark 8769 was collected in Venezuela. As for its other characters Steyermark 8769 is more like *F. pennula*.

Generally the size of the cells is a rather reliable character, but in this case there is some doubt about its value, because the cells of some young plants of *F. goebelii* are not different from those of *F. pennula*. Nevertheless, the cell size together with the above mentioned occurrence of broad leaves has convinced me that Steyermark 8769 is best referred to *F. pennula*.

From the above it will be clear that *F. goebelii* and *F. pennula* may be only two forms of one species. On the other hand it is not impossible that both species will turn out to be not at all narrowly related. A comparison of the width of the peristomium teeth, the position of the antheridia and the size of the spores (those of *F. goebelii* are strikingly large) might be conclusive. Anyhow, to find a reasonable solution for these problems more material, especially in Venezuela, will have to be collected.

Plants up to 1.5 cm long, but mostly shorter, densely to rather thinly foliated, with up to 27 leaf pairs; often with ill defined "annual rings", which differ from each other in the length and shape of the leaves, in the density of foliation or in some combination of these characters; however, within a ring the leaf length increases from the base upwards and decreases once more towards the top, this brings on that the rings shade off into each other. *Leaves* ovate with an acute tip, less often elliptical or even oblong; 0.9–1.5 (1.7) mm long and 0.3–0.5 mm wide; ratio L/W 2–3.5; ratio L/V 1.5–2 (2.5). Apex acute or, less often, obtuse with or without a mucro or apiculus, rarely slightly and briefly acuminate (mostly it is difficult to see the form of the apex in a slide, because it is nearly impossible to get the leaves of this species completely flat; the same holds for recognizing the details of the base of the d.l.); nerve reaching the apex, often excurrent with a single cell; border reaching the apex or vanishing below it. Leaves generally not decurrent; border mostly not reaching the insertion. Width of the border 7–11 μ . Cells (4) 7–11 μ long, 4–7 μ wide; walls mostly very thin and colourless. *Fertile plants*: Archegonia terminal; length of archegonia 219–307 μ . Antheridia not seen. Perichaetal leaves 1.7–1.9 mm long. *Sporophytes* not seen.

Distribution: Surinam, Venezuela, Brazil (provinces Pará and Mato Grosso).

Examined specimens: SURINAM, *Florschütz* 256, 262, 489, 1172, 2173, 2226 (U); *Lanjouw & Lindeman* 2011 (U); *Lindeman*, Herminadorp (U); BRAZIL: *Lindeman* 535 (H, S-PA), 351 (H, BM, S-PA); *Huber*, Igarapá (H); VENEZUELA: Steyermark 8769 (NY).

Ecology: On clayey banks and on stones in running water.

5. *F. goebelii* C. Muell. *Flora* 83: 327. 1897 (non *F. (Weberiopsis) goebelii* (C. Muell.) Broth. 1901). – Type: *Goebel*, Tovar (H). – Fig. 5a-d.

This species can be recognized by its long plants, its rather long, ovate

leaves and its large cells. For differences between this species and *F. pennula* see 4. *F. pennula*.

Plants up to 3.5 cm, rather densely foliated with up to 37 leaf pairs. *Leaves* ovate with an acute tip, less often elliptical; 1.4–1.8 mm long and 0.35–0.6 mm wide; ratio L/W 3–4; ratio L/V 1.5–2. Apex often slightly but long acuminate, rarely acute; nerve reaching the apex, excurrent or percurrent; border reaching the apex or vanishing just below it, only in leaves of badly developed plants the border may stop distinctly below the apex. Leaves not or slightly decurrent; border vanishing some cells above the insertion. Width of the border 7–11 μ . Cells 11–19 μ long, (6) 7–9 μ wide; walls often coloured. *Fertile plants*: Antheridia not seen. Archegonia terminal; length of archegonia 292–307 μ . Perichaetal leaves 2.0–2.5 mm long. *Sporophyte*: Setae 3–5 mm. Capsules erect and symmetrical, 0.6–0.8 mm long and 0.3–0.5 mm wide. Width of peristomium teeth 74–81 μ . Spores 19–26 μ , prolate to subglobose, finely papillose.

Distribution: Venezuela.

Examined specimens: VENEZUELA: Goebel, Tovar (H).

Ecology: MUELLER (1897) says *forsan in humidis* and nothing else is known about it.

6. *F. variabilis* Brugg.-Nann. (*nom. nov.*). – *F. falcatus* Lind. ex Ångstr. Oefv. K. Svensk. Vet. Ak. Foerh. 33 (4): 49, 1876 *hom. illeg.* (non Wils. 1854). – Type: Lindberg, Caldas (H(holo-), S-PA, NY, L, BM, U). – Fig. 6a-c.

The available material of this species is so variable, crisped, old and weathered, that it is impossible to tell which features are characteristic. Therefore instead of giving a diagnosis I give a list of differences between this species and those with which confusion is possible when we rely exclusively on the key.

This species differs in the following points from *F. pennula*: 1. The shape of the leaves. In *F. pennula* the ventral periphery always forms a flowing line, which is not or but slightly influenced by the transition of sheath in the lamina apicalis; while the leaves of *F. variabilis* always show a distinct incurvation at this place. 2. The leaf length (*F. variabilis*: (1.0) 1.4–1.7 (1.9) mm; *F. pennula*: 0.9–1.5 mm). 3. The thicker cell walls and broader border of *F. variabilis* (width of the border 11–19 μ in *F. variabilis*, 7–11 μ in *F. pennula*).

F. goebelii and *F. variabilis* resemble each other but very slightly. They differ by: 1. The form of their leaves (see fig. 5b, c and 6a, b). 2. The width of their peristomium teeth (*F. variabilis*: 48–70 μ ; *F. goebelii*: 74–81 μ). 3. The size of the spores (*F. variabilis*: 15–19 μ ; *F. goebelii*: 19–26 μ).

F. crenulatulus and *F. variabilis* too are rather different from each other. They differ by: 1. The form of their leaves which is nearly always ovate in *F. variabilis* and oblong or elliptical in *F. crenulatulus*. 2. The

base of their d.l., which in *F. crenulatulus* is mostly pluristratose and consists of strikingly large cells, while in *F. variabilis* it is always formed by one layer of cells in the middle of the d.l. 3. The width of the border (*F. variabilis*: 11–19 μ ; *F. crenulatulus*: (11) 19–26 (33) μ).

Plants up to 2.5 cm, thinly foliated, with up to 27 leaf pairs. *Leaves* ovate, mostly with an obtuse, less often with an acute tip; (1.0) 1.4–1.7 (1.9) mm long, (0.4) 0.5–0.7 mm wide; ratio L/W 2–3; ratio L/V 1.5–2. Apex either apiculate, mucronate, indistinctly and briefly acuminate or acute; nerve and border reaching the apex or stopping below it. Leaves decurrent or not; border reaching the insertion or ending some distance above it. Width of border 11–19 μ . Cells 7–11, mostly 7 μ long and 6–7 μ wide; walls thin to rather thick. *Fertile plants*: Archegonia and antheridia either terminal – this may be on the main stem for archegonia, and for archegonia as well as antheridia on very short to rather long lateral branches – or in the axils of leaves or branches.

Leaves enveloping axillary archegonia and antheridia are wanting. Such naked caulogenous archegonia occasionally occur in other *Pachylomidium* species too, but only as an abnormality. So probably for *F. variabilis* caulogenous, naked archegonia are not normal either.

Length of the archegonia 292–321 μ ; length of the antheridia 117–248 μ . Perichaetal leaves 1.5–2.4 mm long. *Sporophyte*: Setae 2.5–5 mm long, terminal or axillary. Capsules erect or occasionally somewhat oblique, symmetrical or asymmetrical, 0.7–1.2 mm long and 0.3–0.6 mm wide; operculum 0.4 mm long; width of peristomium teeth (37) 48–70 μ . Spores 15–19 μ , prolate to subglobose, finely papillose.

Distribution: Brazil, province Minas Geraës.

Examined specimens: BRAZIL, Lindberg, Caldas (H, S-PA, NY, L, U, BM).

Ecology: The plants have been collected near a river.

The next two species, *F. crenulatulus* and *F. oediloma*, have terminal archegonia and antheridia, leaves with a stout border and a base of the d.l. which is often pluristratose and composed of cells which are rather large when compared with other lamina cells.

7. *F. crenulatulus* C. Muell. ex Broth. Bih. K. Svensk. Vet. Ak. 21, 3 (3): 16. 1895. – Type: *Mosén* 5 (H (holo-), S-PA, U, NY). – *F. mucronifolius* Besch. et Geh. 1901. *pro syn.* (nom. nud.) pp. – Fig. 7a-d.

N.B. *F. crenulatulus* C. Muell. ex Broth. should not be confused with *F. crenulatus* Mitt. 1859.

This species can be recognized by the size of its cells, its mostly oblong leaves and its terminal antheridia. For differences between this species and *F. oediloma* see the diagnosis of the latter.

Plants up to 1.5 cm, mostly circa 1 cm long; more or less densely foliated, with up to 22 leaf pairs; in long plants usually two or three “annual rings” occur; with the exception of the lowest ones all leaves

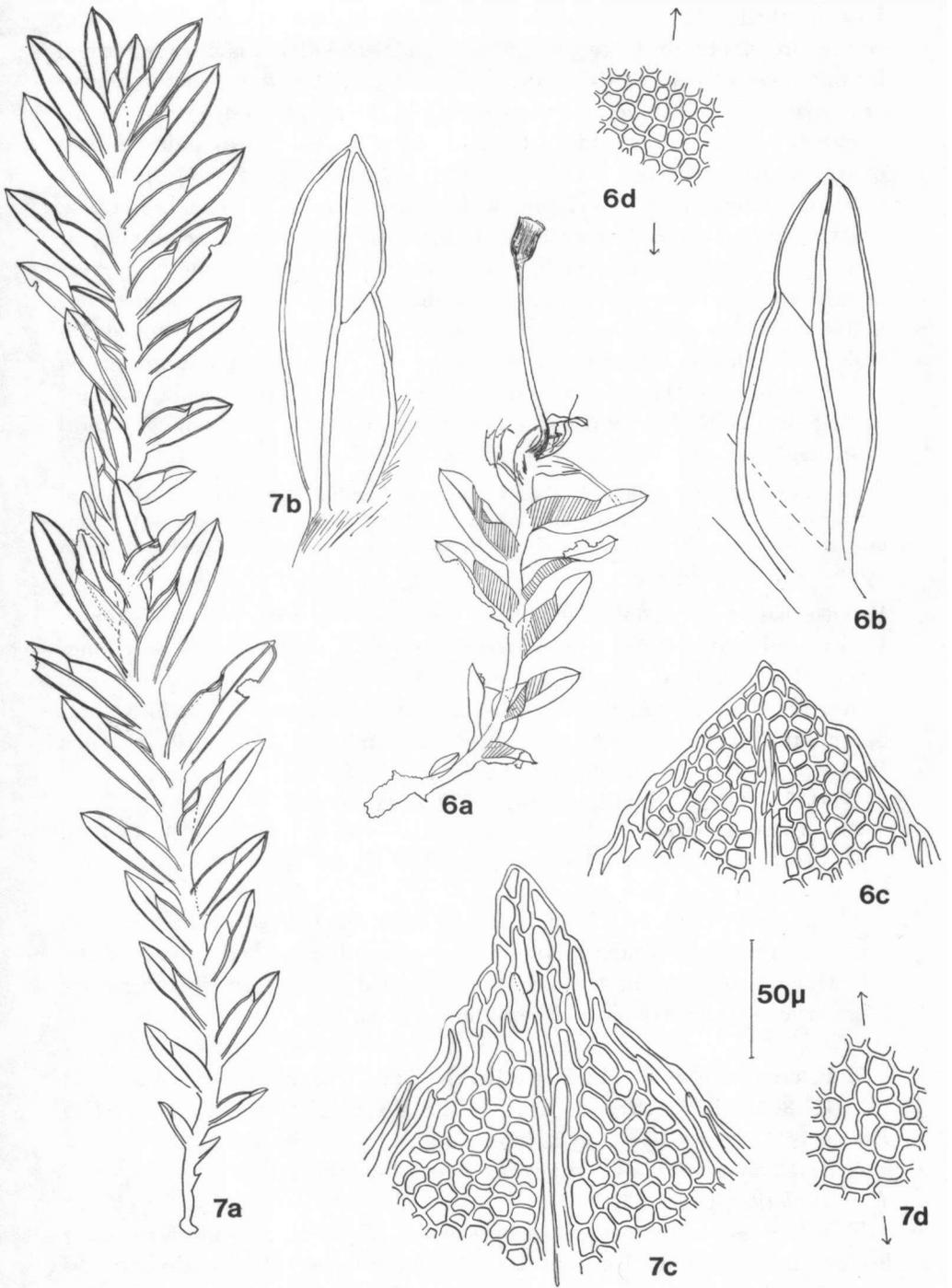


Fig. 6. *F. variabilis* Brugg.-Nann. (type). **a:** Plant (length without seta 0.8 cm); **b:** leaf (length 1.9 mm); **c:** leaf apex; **d:** cells from the middle of the d.l. – **Fig. 7.** *F. crenulatulus* C. Muell. ex Broth. (*Mosén* 128). **a:** Habit (length 2.3 cm); **b:** leaf (length 1.7 mm); **c:** leaf apex; **d:** cells from the middle of the d.l. – The enlargement given between the figures applies to fig. 6c–d and 7c–d. The arrows in fig. 6d and 7d show the orientation of the leaf axis.

of such a ring are about equally long. *Leaves* oblong to elliptical, often with a distinct incurvation at the transition of the sheath into the apical lamina; leaf length (1.2) 1.5–1.9 mm, width (0.3) 0.4–0.5 mm; ratio L/W 3–4 (7); ratio L/V (1.5) 2–3. Apex variable, often slightly asymmetrical; it may be broadly and long apiculate, acuminately mucronate, slightly and long (rarely briefly) acuminate or, less often, mucronate or acute; the first four possibilities shade off into each other; acute apices only occur in young and not well developed plants; generally both nerve and border vanish just before reaching the apex, less often they fuse at the apex or stop distinctly below it. Leaves not or indistinctly decurrent; border not reaching the insertion. Border (11) 19–26 (33) μ wide. Cells 7–15 (22), mostly 11 μ long, 4–9, mostly 7 μ wide; walls often coloured. *Fertile plants*: Archegonia and antheridia terminal; length of the archegonia 307–438 μ ; length of the antheridia 219–292 μ . Perichaetal leaves 1.7–2.4 mm long. *Sporophyte*: Setae 3.0–5.5 mm long. Capsules mostly somewhat oblique and asymmetrical, but sometimes erect and symmetrical, (0.4) 0.6–1.1 mm long, 0.2–0.6 mm wide; length of the operculum 0.35–0.45 mm; width of the peristomium teeth 41–63 μ . Spores 11–28, often 20–22 μ , prolate to subglobose, finely papillose.

Distribution: Brazil, provinces Minas Geraës and São Paulo.

Examined specimens: MINAS GERAËS: *Mosén* 5 (H, S-PA, NY, U), 128 (S-PA, G, H), 129 (NY, H, S-PA); *Regnell*, Pl. Braz. III, 85 (H). SAO PAULO: *Puiggari* (H, BM).

Ecology: On stones in running water.

8. *F. oediloma* C. Muell. ex Broth. Bih. K. Svensk. Vet. Ak. Handl. 21, 3 (3): 15. 1895. – Type: *Ule* 49 (H (lecto-), G, K, S-PA, NY, BR, L, C, U). – *F. mucronifolius* Besch. et Geh. 1901. *pro syn.* (nom. nud.) pp. – Fig. 8a-f.

In well developed form this species can be recognized at once by the narrow leaves with their thick and wide border and their small cells. Nevertheless, this species might be confused with *F. crenulatulus*. For instance when, as occasionally happens in leaves with a very thick border, the row of large cells alongside the nerve changes gradually and not abruptly into the much smaller cells of the rest of the lamina. If in such a case the leaves are narrow, the middle cells of the lamina may be so near to the nerve that they are still rather large. In this case the two species can be distinguished by the width of the border and that of the leaves, but certainly not by the size of the spores, as BROTHERUS (1895) wrote.

Plants 0.5–1.7, mostly about 1 cm long, from rather thin to densely foliated, with up to 23 leaf pairs. *Leaves* ovate with an acute tip, elliptical or, rarely, obovate; (1.0) 1.5–2.1 mm long and 0.3–0.4 (0.5) mm wide; ratio L/W (3) 4–7; ratio L/V (1.5) 2–3.5. Apex often asymmetrical, mostly acute, but often either distinctly (less often indistinctly) and long acuminate, or mucronate; nerve and border mostly reaching the apex and

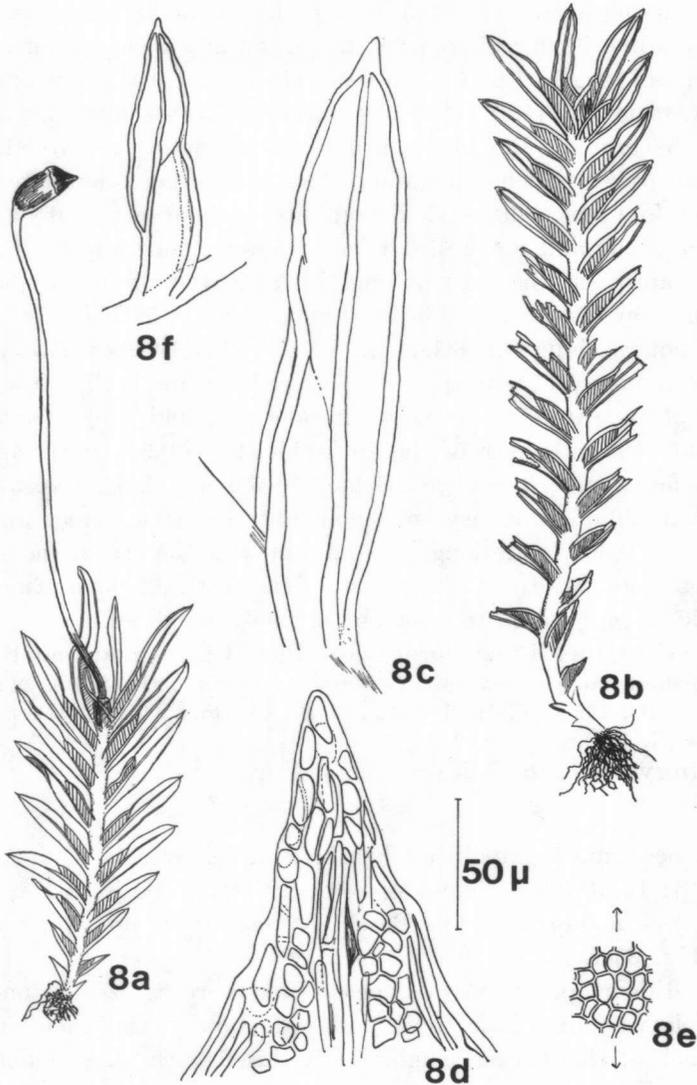


Fig. 8. *F. oediloma* C. Muell. ex Broth. **a**: Female plant with rather thin borders (length including sporophyte 1.4 cm); **b**: male plant with thick borders (length 1.2 cm); **c**: leaf (length 1.9 mm); **d**: leaf apex; **e**: cells from the middle of the d.l.; **f**: leaf from *Puiggari* 305 (1882) (length 2.1 mm). (**a**: *Puiggari* 1809; **b**–**e**: *Bornmüller* 6128). – The enlargement given between the figures applies to fig. **d**–**e**. The arrows in fig. **e** indicate the orientation of the leaf axis.

often fusing at the apex. The apex, the base of the d.l. and the parts of the lamina near the nerve and near the border often are pluristratose. Leaves not or indistinctly decurrent; border reaching the insertion or not; in leaves with a very thick border it often is impossible to see whether the border reaches the insertion or not, since in these leaves the tissues of nerve, lamina and border shade off into each other near the insertion.

Width of the border (11) 22–56 μ . In plants with very thick borders nerve and border are often surfaced with short, wide cells. Cells 6–11, mostly 7 μ long and 4–7 μ wide; walls mostly colourless. *Fertile plants*: Archegonia and antheridia terminal; length of the archegonia 292–438 μ ; length of the antheridia 219–423 μ . Perichaetal leaves 1.7–3.0 mm long. *Sporophyte*: Setae 3.5–8.5 mm long. Capsules mostly somewhat oblique and asymmetrical, sometimes erect and symmetrical; 0.6–1.2 mm long and 0.3–0.6 mm wide; length of operculum 0.4–0.7 mm; width of peristomium teeth 41–63 (74) μ . Spores 11–22 μ , prolate to subglobose, finely papillose.

REMARK: *Puiggari* 305 (1882) from the herbarium of Helsinki differs strikingly from all other samples of *F. oediloma* by the decurrence of the border of the d.l. on the nerve (see fig. 8 f) and by its cells, which are very small (circa 4 μ long) and neatly arranged in rows. As in other species with small cells, e.g. the species of the section *Pycnothallia*, the border is ramified and extends into the lamina.

Distribution: Brazil, provinces Minas Geraës, São Paulo, Santa Catarina and Rio Grande do Sul.

Examined specimens: SAO PAULO: *Mosén* 151 (H), 432 (H); *Puiggari* 26 (H, BM), 294 (H), 305 (1897) (H), 305 (1882) (H), 307 (H, BM), 309 (BM), 321 (H, BM), 409 (H, BM), 914 (H), 1809 (H), 2007 (H). MINAS GERAËS: *Mosén* 126 (H, S-PA), 129 pp (NY, S-PA, H). SANTA CATARINA: *Ule* 49 (H, G, K, S-PA, NY, BR, L, U, C), 239 (H), 241 (H), 650 (PC), 805 (H). RIO GRANDE DO SUL: *Bornmüller*, Crypt. Bras. 6128 (H).

Ecology: On stones in running water, often (always?) in forests.

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