The section *Pachylomidium* (genus Fissidens)

II. The species of Central America, temperate South America (including the High Andes), Australia, New Zealand and New Guinea

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Communicated by Prof. F. A. Stafleu at the meeting of June 17, 1978

ABSTRACT

Included in this revision are: *F. oediloma* C. Muell. ex Broth. subsp. *steyermarkii* (Bartr. in Grout) Brugg.-Nann. *nov. stat.* from Central America, the widespread southern temperate *F. rigidulus* subsp. *rigidulus* Hook. f. et Wils., *F. r.* subsp. *masatierrensis* Brugg.-Nann. *nov. subsp.* from the Juan Fernández Island Más á Tierra *F. r.* subsp. *novaguineensis* Brugg.-Nann. *nov. subsp.* from New Guinea and Guadalcanal, *F. dietrichiae* C. Muell. from Australia, New Caledonia and Lord Howe Island and *F. vanzanteni* Brugg.-Nann. *nov. spec.* from New Guinea.

As I have shown in "On the arbitrariness of the division in sections of the genus Fissidens" (in press) the section *Pachylomidium* is not sharply separated from some of the other ones. Consequently it was united with these sections. The resulting section is to be called *Fissidens*. Several objections could be raised against my still continuing a series of papers on the "section *Pachylomidium*". The above implicates that almost certainly synonyms will be overlooked and that it is possible that on occasion closely related species will, neither in the keys nor in the text, be compared. Moreover, it is, without including the complete section *Fissidens*, senseless to try to redivide it. Though the present series of papers can be no more than a rather arbitrary beginning of a monograph of the section *Fissidens*, I intend to complete the once undertaken task (cf. Bruggeman-Nannenga 1973). Of course I will try to meet the above objections by comparing the included species with those species from

other sections to which I know them to be closely related. However, I do not think it will be possible to trace all closely related species.

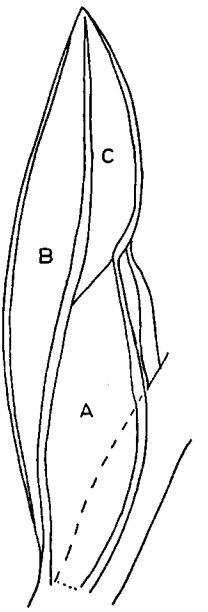
In this series of papers I will include all *Fissidens* species, that fit the diagnosis of the "section *Pachylomidium*" better than that of other "sections". Transitional species are included only when they traditionally belong to "*Pachylomidium*".

In my first *Pachylomidium* paper (Bruggeman-Nannenga, 1973) I neglected to discuss the terminology of the *Fissidens* leaf. As the leaf of the Fissidentaceae is rather different from that of other mosses, its description requires a special terminology. This is indicated below:

A: *lamina vera* (=sheath, lamina(e) vaginan(te)s, equitant leaves; Duplicatur (German); ailles (French)).

B: *lamina dorsalis* (=lamina inferior, inferior edge of the vertical lamina).

C: *lamina apicalis* (=lamina superior, superior part of the lamina verticalis; Fortsatz (German)).



The above is by no means a complete list of the terms that have been used to denominate the different parts. Such a list was not thought necessary as most of the not included indications speak for themselves and/or have been used once or twice only. The terms most commonly used in recent literature are printed in italics. The term "*lamina vera*" or "true leaf" originates from a theory to explain the aberrant shape of the *Fissidens* leaf. This theory and other ones are set out by Salmon (1899). A more recent paper on this matter is that of Robinson (1970).

According to this theory the duplicated part of the leaf is homologous with the leaf of other mosses. That is where its name derives from.

KEY

1a Cells small: 6–11 μm long and 4–7 μm wide 2
1b Cells larger 3

2a Leaves 1.7–2.7 mm long, archegonia 290–480 μm long, plants dioicous, monoicous or synoicous, in Central America only . . . . . 1b. *F. oediloma* subsp. *steyermarkii*

2b Leaves (2.0)2.4–3.4(4.2) mm long, archegonia usually longer: 440–760 μm, exclusively dioicous; not in Central America . . . . . 2. *F. rigidulus*

3a Leaves (2.0)2.4–3.4(4.2) mm long, rather narrow: L/W 3.5–7 . . . . . 2. *F. rigidulus*

3b Leaves less than 2.5 mm long, less narrow: L/W 1.75–4 4

4a Border rather narrow: 7–15(19) μm wide, spores 17–26 μm; Australia . . . . . 3. *F. dietrichiae*

4b Border wider: 15–22 μm wide, spores smaller: 13–17 μm; New Guinea . . . . . 4. *F. vanzanteni*

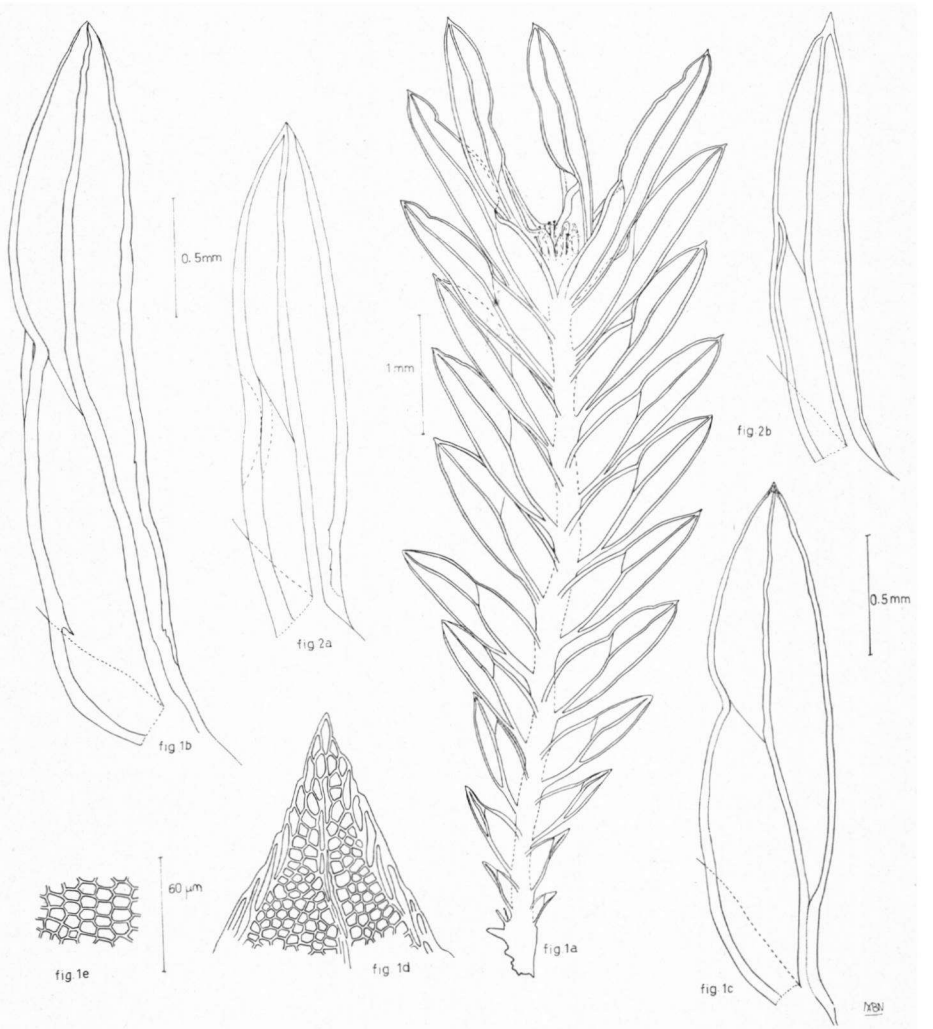


Fig. 1. *F. oediloma* subsp. *steyermarkii* (Bartr.) Brugg.-Nann. (type). a. habit; b. and c. leaves; d. leaf apex; e. cells from the middle of the dorsal lamina. Fig. 2. *F. oediloma* subsp. *oediloma* C. Muell. ex Broth. a. leaf (*Ule* 650). b. leaf (*Puiggari* 1809).

1. Fissidens oediloma C. Muell. ex Broth.

1a. subsp. oediloma C. Muell. ex Broth. has been discussed and figured in Bruggeman-Nannenga (1973: 186).

1b. subsp. steyermarkii (Bartr. in Grout) Brugg.-Nann., *nov. stat.* – *F. steyermarkii* Bartr. in Grout, 1943. N. Am. Fl. 15: 177, *3f 35–40*; Bartram (1949): 14, *f 5d–f*; Crum (1954): 257; Bowers (1970): 12, *pp*: not *Bowers* 847A (and 856B? not seen); Manuel (1972): 78, *pp*: not *Manuel* 689. – Type: *Steyermark* 36576 (F (holo-), FH, PAC). – **Fig. 1a–e.**

Though there are several differences (see table below) between the population of *F. oediloma* in southern Brazil (subsp. *oediloma*) and that in Central America (subsp. *steyermarkii*) it is impossible to draw a sharp line between the two on the basis of morphological characters.

In both regions many plants have short (up to 2.1 mm long), elliptical or, less often, ovate leaves with a relatively narrow border (up to 30 μm wide). Figs. 1c and 2b.

The most important difference between the two populations is the occurrence of plants with short leaves (up to 2.1 mm) and yet a very wide (up to 56 μm) border in Brazil; while in Central America leaves with a border that is more than 30 μm wide are usually longer (2.0–2.7 mm long).

Table showing the differences between subsp. *steyermarkii* and subsp. *oediloma*.

	subsp. *oediloma*	subsp. *steyermarkii*
border more than 30 μm wide	often	rarely
length of leaves with a border of 30 μm or more	never exceeding 2.1 mm	up to 2.7 mm
shape of leaves with a border of 30 μm or more	elliptical or ovate with a smooth outline (fig. 2a)	oblong or ovate, usually with an irregular outline (fig. 1b)
ecology	on stones in running water	often but not always in places outside the direct influence of running water
distribution	southern Brazil	Central America

F. oediloma subsp. *steyermarkii* is the only robust species with small smooth (not papillose or mammillose) cells, completely bordered leaves and terminal antheridia found in Central America.

Plants 0.7–1.5 cm long, *leaves* except for the very long ones (i.e. with a length of more than 2.0 mm, which are normally oblong or ovate with an obtuse tip), mostly elliptical, 1.7–2.7 mm long, 0.3–0.55 mm wide; L/W 4–7. Apex as a rule indistinctly or distinctly, and shortly, less often long acuminate, occasionally acuminately mucronate. Nerve and border

mostly almost reaching the apex. Lamina partly pluristratose. Width of the border 18–32.5 (52.5) μm. Cells 6–9 μm long and 4–7 μm wide. *Fertile plants*: archegonia and antheridia terminal; archegonia 290–480 μm long; antheridia 300–410 μm. Perichaetial leaves 2.3–3.6 mm long. *Sporophyte*: seta (3)5–9 mm long. Capsule erect or slightly oblique, 0.7–1.4 mm long, 0.4–0.8 mm wide; length of the operculum 0.45–0.5 mm; width of the peristomium teeth 37.5–63 μm. Spores 13–23 μm.

Distribution: Central America: Guatemala, Mexico and Costa Rica.

Examined specimens: GUATEMALA: *Steyermark* 33889 (F), 35310 (F), 36576 (F, PAC, FH). MEXICO: *Sharp* 3071 (MICH). COSTA RICA: *Bowers* 100-E-1 (TENN.). Somewhat aberrant sample: *Robinson* 105105 from Mexico (USNM).

Ecology: *F. oediloma* subsp. *steyermarkii* has been collected at altitudes ranging from 1200–3120 m. It grows in a variety of habitats on several kinds of substrates: it has been collected in moist ravines and on moist slopes, but also on stones near running water. It grows on soil as well as on rock.

Note 1: According to Bartram (in Grout, 1943) *F. oediloma* subsp. *steyermarkii* has faintly papillose cells. For this reason he described it in the section *Pycnothallia*. As I did not find any papillae, not even in sections of the leaf, it is here transferred to the section *Fissidens* (smooth cells).

Note 2: *F. oediloma* subsp. *steyermarkii* has been confused with what I consider to be a large form of *F. repandus* Wils. (Bowers (1970): 12, no 847A and Manuel (1972): 78, no 689). This *F. repandus* forma is different from *F. oediloma* subsp. *steyermarkii* by its distinctly mammillose cells. Mammillae are most numerous in the apical lamina and in the upper part of the dorsal lamina. They have a wide, flattened and thickened tip (fig. 3).

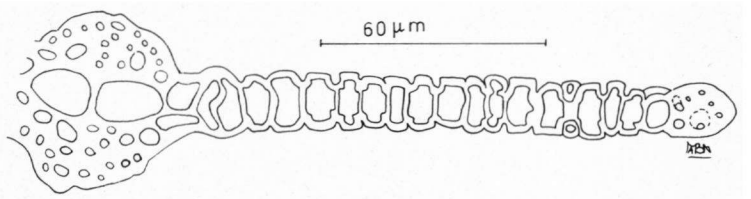


Fig. 3. Cross-section of dorsal lamina of *F. repandus* Wils. forma. (*Bues* 1074, Peru).

Note 3: Plants with long leaves (more than 2.0 mm long) can be confused with *F. rigidulus* Hook. f. et Wils. The two are compared in the key on p. 13.

2. F. rigidulus Hook. f. et Wils.

Key to the subspecies:

1a width of the border usually 30 μm or more 2
1b width of the border 15–30 (44) μm; widespread, but not in New Guinea, the Solomon Islands and Más á Tierra (Juan Fernández Islands) . . . . . 2a subsp. *rigidulus*

2a cells large: 7–17 μm long and 6–11 μm wide; Más á Tierra (Juan Fernández Islands) only . . . . . 2b subsp. *masatierrensis*

2b cells smaller: 6–10.5 μm long and 3–7.5 μm wide; New Guinea and the Solomon Islands . . . . . 2c subsp. *novaguineensis*

2a. F. rigidulus subsp. rigidulus Hook. f. et Wils. – *F. rigidulus* Hook. f. et Wils., 1854. Fl. Nov. Zel. 2: 61, *83, f 3*; Hooker (1860): 167, (1867): 407; Mitten (1883): 28; Mueller (1901): 60 and 67!; Sainsbury (1955): 49, *f 2*; Allison & Child (1971): 42+*fig.*; Bruggeman-Nannenga (1974): 141, *f 2* and *4*; Robinson (1975): 11 pp: the collections from Más á Tierra belong to subspecies *masatierrensis* (see below); Scott & Stone (1976): 10/10, *f 7*, *8* and *9*. – Type: *Lyall* 95 (BM(lecto-)). – *F. lechleri* Hampe ex C. Muell., 1864. Bot. Zeit. 22: 340; Mitten (1869): 602. – Type: *Lechler* 1460 (S(holo-), NY, L). – *F. tortuosus* Geh. & Hampe, 1881. Rev. Bryol. 8: 27, – *syn. nov.* – Type: *Beccari* 38 (GRO and probably (not seen) FI). – *F. macrostachys* Hampe ex Salm., 1899. Ann. Bot. 13: 125, *nom. inval. in synon. pro F. rigidulo.* – **Fig. 4a-g.**

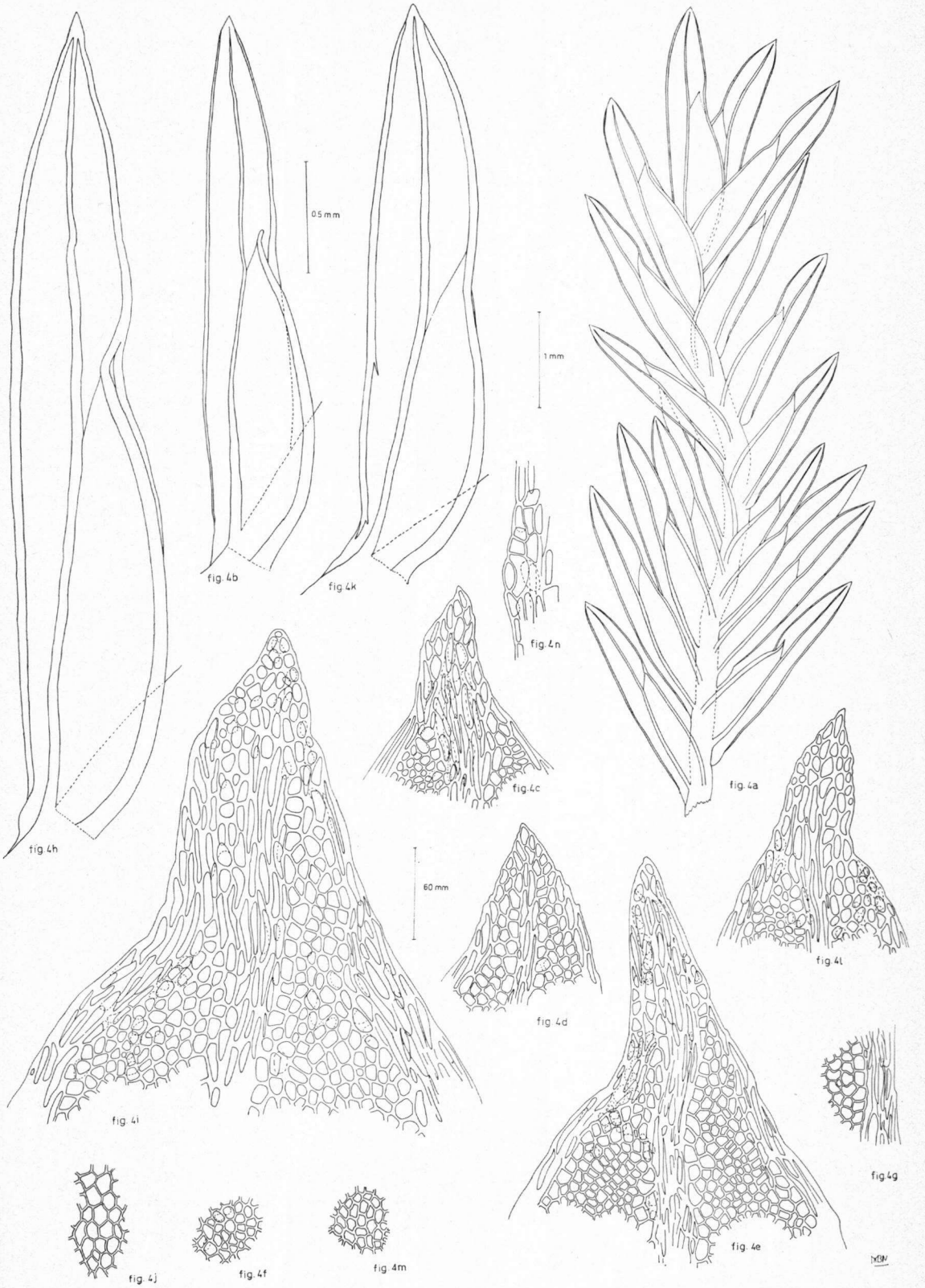
F. rigidulus subsp. *rigidulus* is the most variable taxon of the "section *Pachylomidium*". Yet it can easily be characterized, as 1) it is the only dioicous species known to me and 2) it has very long archegonia; the only other species with such long archegonia known to me is the European *F. crassipes* Wils. ex B.S.G.

In spite of its great variability *F. rigidulus* has rarely been confused with other species, probably because it is the only large *Fissidens* species with small, smooth cells and bordered leaves in the greater part of its area. In Australia and New Zealand it has been confused with large forms of *F. leptocladus* C. Muell. & Rodw. The two can be separated as follows:

	F. leptocladus	*F. rigidulus*
length of the leaves	1.5 (2.0) mm	(2.0) 2.4–3.4 (4.2) mm
width of the border	6–15 μm	15–30 (44) μm
width of the peristome teeth	44–56 μm	50–82 μm

South American plants with bordered leaves but with mammillose cells have sometimes be referred to *F. rigidulus* (Griffin, 1977: 182). These samples belong to the same taxon that on p. 15. I have indicated as *F. repandus* Wils. forma. The circumscription of *F. repandus* remains a subject for further study.

Fig. 4. *F. rigidulus* Hook. f. et Wils. – 4a–g: subsp. *rigidulus*. a and b. *Colenso* 4790. a. habit; b. leaf; c. leaf apex (*Allison* 123); d. leaf apex (*Gobby*, North Island); e. leaf apex (*Skottsberg* 1954/55, 100); f and g: *Berggren* 730B. f. cells in the middle of the dorsal lamina; g. border in the middle of the dorsal lamina. – h–j: subsp. *masatierrensis* Brugg.-Nann. (type). h. leaf; i. apex of the leaf; j. cells in the middle of the dorsal – lamina. k–n: subsp. *novaguineensis* Brugg.-Nann., k–m. (type), k. leaf; l. apex of the leaf; m. cells in the middle of the dorsal lamina; n. cluster of large cells in the leaf axil (*Van Zanten* 68–3693). Fig. 4c, d, e, f, g, i, j, l, m and n are drawn on the same scale; the same holds for 4b, h and k.


0.5 mm
1 mm
60 mm
fig. 4a
fig. 4b
fig. 4c
fig. 4d
fig. 4e
fig. 4f
fig. 4g
fig. 4h
fig. 4i
fig. 4j
fig. 4k
fig. 4l
fig. 4m
fig. 4n

Plants up to 5 cm, mostly 1.5–2 cm long, densely to rather thinly foliated with up to 32 leaf pairs. *Leaves* ovate with an acute or, less often, obtuse tip, (0.2) 2.4–3.4 (4.2) mm long and 0.4–0.8 (1.0) mm wide; ratio L/W 3.5–7; ratio L/V (1.25) 1.5–2.5 (3). Apex mostly acute to distinctly and shortly or long acuminate or acuminately mucronate; rarely complex, i.e. acuminate below and acute above. Except for the acuminate mucrones which often are asymmetrical, the apex is usually symmetrical. Nerve and border mostly ending before reaching the apex. The parts of the lamina alongside the nerve and that near the leaf insertion mostly are pluristratose; the rest of the lamina often is pluristratose. Nerve sometimes overgrown by lamina cells. Leaves more or less decurrent. Border reaching the insertion or not, often ending rather far above it, rarely still present on the decurrent part. Width of the border 15–30 (44) μm, border sometimes covered by lamina cells. Cells 6–11 μm long and 4–7 μm wide, occasionally larger (see note 4): (9) 11–15 μm long and (4) 6–9 μm wide. *Fertile plants* dioicous. Archegonia and antheridia terminal, this includes archegonia terminal on short axillary plants. Length of the archegonia 440–760 μm; length of the antheridia 290–570 μm. Perichaetial leaves 3.2–4.4 mm long, often with the lower half of the dorsal lamina over a large distance unbordered. *Sporophyte*: seta 5–11 mm long. Capsule erect or, less often slightly oblique; (0.7) 1.0–1.4 mm long and 0.45–0.9 mm wide; length of the operculum (0.45) 0.7–1.0 mm; width of the peristomium teeth 50–82 μm. Spores 13–22 (26) μm.

Distribution: Temperate parts of the southern hemisphere: southeastern Australia, New Zealand, southern South America and the high tropical Andes. Recently it has also been collected in the mountains of the Brazilian province of Rio de Janeiro.

Examined material: AUSTRALIA, CAPITAL TERRITORY: *Weber & McVean* B 29317 (GRO) – NEW SOUTH WALES: *Catchside* 5487 (DUKE); *Forsyth* 620 (H), 951 (H), Kiama (NSW); *Mueller*, Happy Valley River (MEL); *Watts* 2329 (H, BM), 8137 (H), 8746 (H); 8867 (H); Crypt. exs. Mus. Hist. Nat. Vindebon. 4680 (PC) – TASMANIA: *Archer*, Cheshunt (NY), Stackhouse Falls (NY); *Beccari* 25 (GRO); *Curtis*, Myrtle gally (PC); *Melville & Willis* 2385 (NSW); *Moore* 8 (BM, H); *Müller*, Snowy Mts (MEL); *Oldfield*, Mt Wellington (H), Tasmania (PC, NY), 250 (BM); *Stuart*, Tasmania (NY); *Walker*, Mt Wellington (BM); *Weber*, Blue Water Holes (PC); *Weymouth*, Guy Fawkes Falls (H, BM),Hobart Rivulet (H), Hobart (PC), Mt Wellington (L, PC, NY), Bower Creek (C), 780 (H, NSW), 780B (NY), 795 (H), 1152 (H), 1214 (H, PC, NY), 1821 (H, PC, BM, FH, NSW), 1881 (BM, H), 2158 (H), 2159 (L), 2160 (H, S), 2196 (H), 2333 (NY, H), 2855 (H); *?*, Arthur's Lake (NY) – VICTORIA: *Campbell*, Black spun (H); *Müller*, as *F. macrostachys* (BM, L, NY), Australian Alps (H), 145 (NY, H); *Thomas* 29 (MEL); *Willis*, Mirimbah (MEL), 7 (BM) – KING ISLAND: *Cameron* 55 (MEL).

NEW ZEALAND, NORTH ISLAND: *Allison* 123 (MEL); *Beckett*, Hawkes Bay (PC); *Berggren* 730 (H, S), 730 B (S, H), 731 (S, NY), 731 A (S), 732 C (S), 734 (H, S, DUKE); *Blackwell*, Kaipara (L, BM); *Gobby*, North Island (BM); *Gray*, Wararapa (BM), Mt Bruce (BM), 221 (PC); *Hodgon*, Makareki Str. (BM), 66 (MEL); *Kirk*, Auckland (NY); *Knight*, Auckland (H, S, PC); *Lyall* 95 (BM), 221 (NY, BM);

Sainsbury, Clydebank (NY), Wharerata (L, BM), Lac Makarique (Bizot): *Van Zanten* 73–140 (U); *Wilson & Hooker* (=*Sinclair?*) 3753 (BM, NY) – GREAT BARRIER ISLAND: *Gray*, Great Barrier Island (BM); *Hutton & Kirk*, Great Barrier Island (NY); *Filhol*, Great Barrier Island (PC) – SOUTH ISLAND: *Beckett*, Oxford Bush (BM, NSW), Waimati (1889) (FH, USNM, S), Waimati (1901) (C, S, NY, H, PC, MEL), 419 (DUKE, FH, S, PC, C, MEL, BM), 862 (NSW, H); *Bell*, Mt Earnslaw (H); *Berggren* 29 (FH, NY), 727 (S, NY, DUKE, C, H), 728 (NY, H), 729 (S, H), 730 B (S), 732 (C, S, USNM, NY, DUKE), 732 B (S, H), 732 D (S), 733 (DUKE, H); *Fleischer* B 94 (GRO, L), B 183 (L, GRO); *Gray*, Iararuas (BM); *Hector* 23 (NY, PC); *Meiekelejohn* 57 (S, BM), 58 (S), 61 (BM); *Petrie*, Kailangata (BM); *Van Zanten* 74–568 (U), 74–610 (U), 74–610 B (U) 74–717 (U) – NEW ZEALAND, island unknown: *Berggren* 29 (FH); *Bell*, Pina Hill (H), Diamond Lake (NY, H); *Brown*, Abouka River (BM), N.Z. (NY); *Colenso* 2899 (BM), 4790 (NY, PC, BM); *Hampe* 239 (BM); *Kirk*, Ngahauranga (NY, YU); *Knight*, N.Z. (NY, BM), 236 (BM); *Scott* 133 (DUKE); *Sinclair*, N.Z. (NY).

SOUTH AMERICA, ARGENTINA: *Arnow*, Jujuy (PAC); *Santeson* M 98 (S); *?*, Córdoba Mts (BM) – BOLIVIA: *Herzog* 2619 (H, S), 4062 (NY, FH, BM), 4393 (L, S), 4836 (FH, PC, L, S) – BRAZIL: *Griffin & Vital* 262 (PAC), 265 (PAC) – CHILI, mainland: *Bertho*, Los Gerales (FH, PC, Bizot); *Claude Joseph* 2188 (USNM, NY), 3422 (USNM); *Campo*, Rio Quino (PC); *Costes*, El Albánico (S, NY, PC, BM); *Dioriksen*, in humid. umbr. (C, H); *Dusén* 126 (NY, H), 232 (BR, NY, USNM, S, H, BM), 550 (H, S, NY, BM), 757 (H, FH, S, PC, NY, DUKE, BM); *Hollermayer*, Valdivia (S); *Lechler* 1460 (L, S, NY), 3422 (NY, USNM); *Mahu* 2770 (USNM); *Neger*, Valdivia (S); *Roivainen*, Ricinto (H, S); *Schwabe* 35 A (S); *Scott Elliot* 144 (H); *Sparre* 4503 (S), 4505 B (S); *Thaxter*, Corral (FH); *Wolffhügel*, Lago Todos los Santos (S) – CHILI, Mas Afuera (Juan Fernández Islands): *Hatcher & Engel* 356 (USNM, H, NY, DUKE); *Skottsberg* 1916/17, 28 (H, S), 99 (S); 1954/55, 95 (S), 100 (H), 200 (H, S), 297 (S) – COLOMBIA: *Cleef* 7562 (U), *Hermann* 25043 A (PAC), *Weir* 354 (BM, NY) – ECUADOR: *Crosby* 10498 (PAC) – FALKLAND ISLANDS: *Engel* 2920 (H), 2929 (H), 3284 (H), 3286 (H), 3287 (H, PC, S), 3462 (H); *Hamilton*, Beaver Island (BR, BM), Sea Island (BM) – PERU: *Cook & Gilbert* 670 (NY, USNM), *Hegewald* 5826 (PAC).

Three aberrant samples are: *Sainsbury*, nr Wairoa (S, PC, FH, Bizot), *Van Zanten & Hörmann* 1211 (GRO) and *Van Zanten* 1418 A (GRO). These samples have been collected near Hawke Bay (New Zealand) on calcareous soil. Most plants of these samples are encrusted with lime. Many of them differ from "normal" *F. rigidulus* by the more narrow border (11–19 μm wide) and by the leaves that are (almost) completely monostratose. Mixed with these grow "normal" *F. rigidulus* plants and intermediate ones.

Ecology: *F. rigidulus* is found in places with a temperate climate: between 0–30° S. lat. it has been collected at altitudes ranging from 2100–4200 m; between 30 and 50° S. lat. it grows from sealevel up to 1500 m.

Many labels accompanying collections of this species give no indication of the ecology. One gets, however, the impression that the species normally grows on rocks in or near running water, but is also occasionally found in humid places outside the direct influence of running water. So far collections that have certainly been collected outside the influence of running water are known from South America only.

In New Zealand *F. rigidulus* is always found epilithic in places that are

submerged or liable to frequent submergence in streams (Allison, 1932; Martin, 1946, 1949, 1951 and Craw, 1976).

F. rigidulus is tolerant of high concentrations of uranium (Whitehead & Brooks, 1969), copper (Brooks e.a., 1973 and Ward e.a., 1977), cadmium, lead, zinc and silver (Ward, Brooks & Roberts, 1977).

Note 1: *possible economic use.*

When growing in an environment with a high concentration of copper, cadmium, lead, zinc, silver and possible uranium too, *F. rigidulus* accumulates these substances in its tissues.

Therefore, it can be used for prospecting and also as an indicator of pollution (Whitehead & Brooks, 1969; Brooks e.a., 1973 and Ward e.a., 1977).

Note 2: *typification.*

F. rigidulus has three syntypes: East Cape, Dr *Sinclair*; Wellington, *Lyall* and Auckland, *Knight*. All of them fit the same species. I have chosen "New Zealand, 1850, Wellington, *Lyall* 95 (c. fr.)" as lectotype of *F. rigidulus* because 1) it is in the herbarium of one of the authors of this species, viz. *Wilson* (BM), 2) the label agrees with the originally published citation except for the addition of the number "95" and 3) on the label the remark has been added: "normal state of no 3753". No 3753 is another syntype, viz. *Sinclair*, East Cape.

Note 3: The leaves of South American plants are narrower than those of plants from Australia and New Zealand (significant at the level 0.0001, Wilcoxon test adapted for the occurrence of ties).

Note 4: As a rule cell size is a reliable feature in "*Pachylomidium*" species. Yet in *F. rigidulus* it is variable: though as a rule *F. rigidulus* plants have small cells (6–11 μm long and 4–7 μm wide), the plants of several collections (for instance: *Gray*, Wairarapa (New Zealand), *Weymouth* 780 and 2855 (Tasmania) etc.) have larger cells: (9) 11–15 μm long and (4) 6–9 μm wide.

Note 5: Individual collections are usually fairly homogeneous. The sample *Scott Elliott*, Concépcion, Chili, is an exception to this rule, and contains two very different kinds of plants. One of them has broad unbordered apices, the other one acuminate mucrones.

2b. subsp. masatierrensis Brugg.-Nann., *subsp. nov.* – Type: *Hatcher & Engel* 182 (NY(holo-), USNM, H, DUKE). – **Fig. 4 h-j.**

Subspecies haec a subspecie *rigidulo* limbo plerumque latiore, cellulis majoribus, foliis plerumque longioribus et insuper per distributionem restrictam ad insula Más á Tierra (Insulis Juan Fernández) differt.

Subspecies *rigidulus* and subsp. *masatierrensis* differ as follows:

	subsp. *rigidulus*	subsp. *masatierrensis*
width of the border	15–30 (44) μm	(26) 37–56 μm
length of the leaves	(2.0) 2.4–3.4 (4.2) mm	(2.7) 3.0–4.2 mm

length of the cells	6–11, less often (9) 11–15 μm long (see also note 4)	(6) 9–15 (19) μm long
distribution	southern hemisphere, not on Más á Tierra	found only on Más á Tierra

NB. Usually the apex of subsp. *rigidulus* is much smaller than that of subsp. *masatierrensis* (see fig. 4c and 4i).

Contrary to the other two subspecies of *F. rigidulus*, subsp. *masatierrensis* is a rather homogeneous taxon.

Plants up to 3 cm long. *Leaves* ovate, or less often elliptical, rarely oblong, (2.7) 3.0–4.2 mm long and 0.6–0.9 mm wide; ratio L/W (4) 4.5–7, ratio L/V 1.75–2.5. Apex indistinctly or distinctly and long to very long acuminate to acuminately mucronate, rarely acute. Mostly nerve and border towards the apex invisible under a cover of lamina cells, less often visibly fusing in the apex. Leaves pluristratose. Width of the border (26) 37–56 μm. Cells (6) 9–15 (19) μm long and 6–11 μm wide. *Fertile plants*: archegonia terminal, 500–610 μm long. Antheridia terminal, 550 μm long (only one fertile collection seen). Sporophyte unknown.

Distribution: Más á Tierra (Juan Fernández Islands).

Examined specimens: *Hatcher & Engel* 182 (H, USNM, NY, DUKE); *Imshaug* 37685 (NY, USNM, DUKE); *Jackson* 4712 B (NY); *Skottsberg* 1916–17, 63 (BM, USNM, NY, S, H), 64 (S, NY, BM), 65 (S); 1954–55, 19 (H, S), 44 (S, H). – Juan Fernández Islands, island not indicated *Tanz* 7 (PC, USNM).

Aberrant sample: *Skottsberg* 1916–17, 375 (H, S). These plants are smaller and have a less wide border than those of other samples of this subspecies. Moreover, the leaves are nearly to completely monostratose.

Ecology: in waterfalls and streams.

Note: the plants from the neighbouring island Mas Afuera are intermediate between subsp. *rigidulus* and subsp. *masatierrensis*. The greater part of the population of this island makes a uniform group that is, with regard to the size of the leaves and the apex (compare fig. 4c, 4e and 4i) remarkably like subsp. *masatierrensis*, but with regard to the width of the border and the size of the cells more like subsp. *rigidulus*. Moreover, one sample, viz. *Skottsberg* 1954/55, M200 contains typical Mas Afuera plants together with typical subsp. *rigidulus* plants, whereas another sample, viz. *Hatcher* and *Engel* 356 contains some plants with in the lower half "Mas Afuera leaves" and in the upper half subsp. *masatierrensis* leaves.

2c. subsp. novaguineensis Brugg.-Nann., *nov. subsp.* – Type: *Van Zanten* 68–341 (GRO(holo-), U). – *F. geppii* non Fleisch. sed Van Zanten, 1964. Nov. Guin. 16: 268. – **Fig. 4 k-n.**

Subspecies *novaguineensis* a subspecie *rigidulo* limbo latiore, a subspecie *masatierrensi* cellulis minoribus differt. A ambabus speciebus distributione geographica differt: subspecies *novaguineensis* in Nova Guinea et Guadalcanale tantum reperta est; subspecies *rigidulus* et subspecies *masatierrensis* ibi non inveniuntur.

Plants up to 4 cm long. *Leaves* ovate or oblong to elliptical, 2.4–4.0 mm long and 0.4–0.8 mm wide; ratio L/W 4–7 (9). Apex either unbordered and acute to indistinctly acuminate or, nearly or completely bordered and long and distinctly, less often indistinctly, acuminate or acuminately mucronate. Leaves more or less decurrent. Border (22.5) 30–48 μm wide, occasionally ending far above the insertion, normally reaching it; rarely still present on the decurrent part. Often lamina and border near the insertion fusing into a pluristratose mass of elongated cells with wide lumina. Cells 6–10.5 μm long and 3–7.5 μm wide. *Fertile plants*: archegonia and antheridia terminal, archegonia 440–640 μm long, antheridia 340–360 μm long. Perichaetial leaves 2.5–3.6 mm long. *Sporophyte*: seta 6.5–9 mm long; capsule erect or slightly oblique, 6.5–12 mm long and 0.4–0.7 mm wide, length of the operculum 0.6–0.7 mm; width of the peristomium teeth 44–77 μm. Spores 11–26 μm.

Distribution: New Guinea and Guadalcanal (Solomon Islands).

Examined material: NEW GUINEA, Eastern Highlands: *Van Zanten* 68–713A (GRO, U), 68–754 (GRO, U), 68–2845 (GRO, U), 68–2854B (GRO, U), 68–3660 (GRO, U); *Weber & McVean*, Mt Wilhelm (GRO, U). Owen Stanley Range: *Van Zanten* 68–3693 (GRO, U), 68–3721 (GRO, U). Star Mountains: *Van Zanten* 321A (GRO, L), 505C (GRO, L, NY). Surroundings Lae: *Van Zanten* 68–341 (GRO, U). Western Highlands: *Van Zanten* 68–3255 (GRO, U). – GUADALCANAL: *Van Zanten* 68–2580 (GRO, U). Aberrant sample: *Van Zanten* 68–3262A (GRO, U). This sample from the Western Highlands contains very small plants.

Ecology: subsp. *novaguineensis* is found from 1150–4000 m. It grows on stones in brooks and rivers. It has also been collected on a "dripping rocky loam-slope". It seems to prefer non-calcareous stones and shady places.

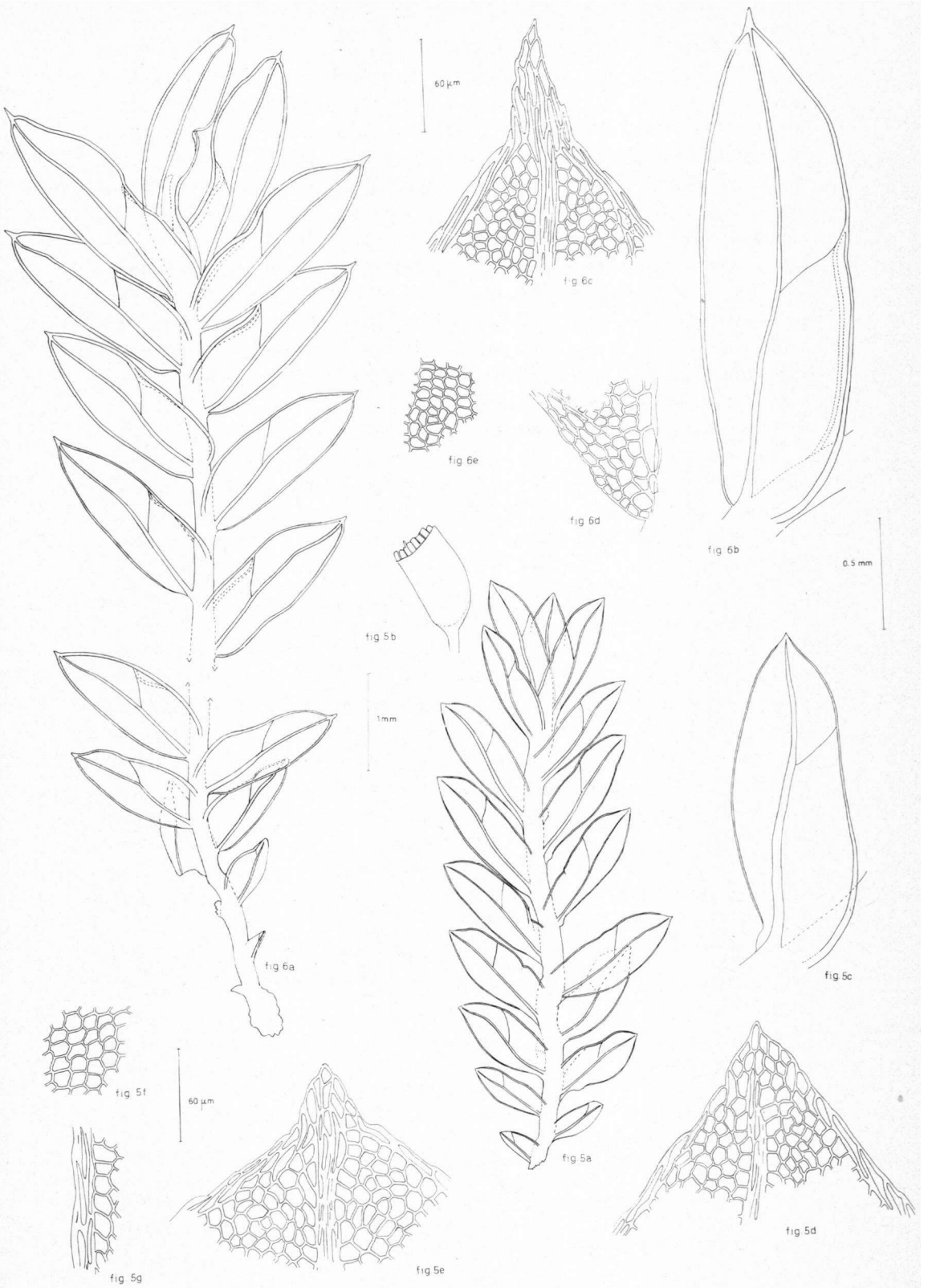
Note 1: whereas subsp. *rigidulus* at comparable latitudes, viz. in Peru and Colombia and even in places further away from the equator such as Bolivia, has been collected only above 2600 m, subsp. *novaguineensis* has been collected as low as 1150 m.

Note 2: as in young and poorly developed plants of subsp. *novaguineensis* the border is often less than 30 μm; the two subspecies are not sharply separated.

Note 3: in the sample *Van Zanten* 68–3693 I found enlarged cells in the axils of some leaves (fig. 4n). These are the "glandular structures", which are reported from the section *Crispidium* and by their presence differentiate that section from the section *Serridium* (fide Norkett, 1969). Apparently these structures can also be found in species of *Pachylomidium* (section *Fissidens*).

Fig. 5a–g. *F. dietrichiae* C. Muell. a. habit; b. capsule; c. leaf; d and e. leaf apices; f. cells in the middle of the dorsal lamina; g. border in the middle of the dorsal lamina. Fig. a, d and f: *Whitteron* 90; fig. b and c from *Möller*, Brisbane; fig. e and g: *Watts* NSW 5607.

Fig. 6. *F. vanzanteni* Brugg.-Nann. (type). a. habit; b. leaf; c. leaf apex; d. base of the dorsal lamina; e. cells in the middle of the dorsal lamina.


60 µm
fig 6c
fig 6e
fig 6d
fig 6b
0.5 mm
fig 5b
1mm
fig 6a
fig 5a
fig 5c
fig 5f
60 µm
fig 5d
fig 5g
fig 5e

3. **F. dietrichiae** C. Muell., 1872. Linnaea 37: 146. – Type: *Dietrich*, Brisbane (S(holo-), NY, BM, MEL). – *F. praemollis* Broth., 1916. Proc. Linn. Soc. N.S.W. 41: 578; Dixon (1948): 93; Willis (1955): 160. *nov. syn.* – Type: *Watts* NSW 5371 (H(holo-), NSW). – *F. undulatodecurrens* C. Muell. *nom. nud.*; Watts & Whitelegge (1902): 29; Willis (1955): 160. *syn. nov.* – *F. sydneyensis* Geh. *nom. nud.*; Watts & Whitelegge (1902): 29; Willis (1955): 160. – *F. crassipes* non Wils. ex B.S.G. sed Willis, 1955. Vict. Nat. 71: 160; Scott & Stone (1976): 10/12. – **Fig. 5a-g.**

F. dietrichiae is intermediate between the former sections *Pachylomidium* and *Bryoidium*. Its ecology usually is that of a "*Pachylomidium*" species, the border, however, normally is monostratose. This species has been included in the present paper because it has been associated with the European "*Pachylomidium*" species *F. crassipes* Wils. ex B.S.G.

Even at low magnification (40×) *F. dietrichiae* is easily recognized by its large cells and its short, wide leaves.

Vegetative plants up to 3 cm long, mostly 0.5–1.5 cm long, rather thinly foliated with up to 33 leaf pairs. The often flaccid leaves oblong, broadly elliptical (with an obtuse tip), obovate or, less often, ovate with an obtuse tip or elliptical with an acute tip; 1.1–2.0 mm long and 0.3–0.7 mm wide; ratio L/W (1.75) 2.25–4; ratio L/V (1.25) 1.5–2.5. Apex mostly either acute to indistinctly and shortly acuminate or distinctly and more or less long acuminate or acuminately mucronate. Nerve becoming indistinct in the apex or, less often, reaching it. Border mostly vanishing just before reaching the apex, or fusing with the nerve at the apex. Leaves decurrent or not, border mostly nearly or completely reaching the insertion, rarely ending far above it. Width of the border 7–15 (19) μm. Cells large: 7–19, mostly 11–15 μm long and 6–15, mostly 7–11 μm wide. *Fertile plants*: antheridia and archegonia terminal, often synoicous. Length of the archegonia 350–569 μm; length of the antheridia 292–365 μm. Perichaetial leaves (1.5) 1.9–3.0 mm long. *Sporophyte*: seta 4–8.5 mm long; capsules slightly oblique or, less often, erect, 0.5–1.5 mm long and 0.35–0.8 mm wide; length of the operculum 0.3–0.7 mm; width of the peristomium teeth 48–81 (91) μm. Spores 17–26 μm.

Distribution: Eastern and north-east Australia: Victoria, New South Wales and Queensland; also found on New Caledonia and Lord Howe Island.

Examined material: NEW SOUTH WALES: *Watts* NSW 653 (H), 654 (NSW, S, H), 847 (H), 1206 (NSW, H), 1550 (H, NSW), 2242 (H), 2774 (NSW), 2977 (H, NSW), 4124 (H), 4917 (BM), 5167 (H), 5324 (NSW), 5327 (NSW, H), 5371 (NSW, H, MEL), 5554 (NSW), 5607 (NSW), 5612 (BM), 5662 (NSW), 5670 (NSW), 6282 (NSW), 8083 (H), 8088 (NSW, S, H). QUEENSLAND: *Bailey* 225 (H), 235 (H), 492 (H); *Dietrich* 444 (MEL), Queensland (S, NY, BM); *Keys*, Burnett River (PC); *Möller*, Brisbane (S, NY); *Scortechini* 655 (H); *Watts* Q 135 (H), 465 (NSW, H); *Whitteron* 87 (H), 88 (H), 90 (H, S), 147 (H), 173 (H), 233 (H), 257 (H); *Wild*, Ashgrove (FH, NSW). VICTORIA: *Willis* 154 (BM). LORD HOWE ISLAND: *Watts* LHI 98 (H), 193 (H). NEW CALEDONIA: *de Roc*, ravin de Mayenta (OSLO).

Aberrant collections: *Watts* NSW 2976 (H, S, NSW, BM). The plants of this sample are extremely large in all respects; *Dietrich* 444 represents a poor form in which the border often is incomplete.

Ecology: on rocks and wood in rivers and on loamy banks of rivers. Also, but less frequently on road banks or on stones outside the influence of running water.

Note 1: Norkett (see Willis, 1955) expressed the view that some specimens of *F. dietrichiae* belong to the European *F. crassipes* Wils. ex B.S.G. Both species are distinct. They differ for instance by the shape of the leaves: leaves of *F. crassipes* have a ratio L/W of 3.5–5.5, those of *F. dietrichiae* are wider, with a ratio L/W of (1.75) 2.25–4. They also differ in the leaf apex, which in *F. crassipes* is unbordered over a long distance, and in *F. dietrichiae* as a rule is almost completely bordered.

Note 2: *F. sydneyensis* Geh. *nom. nud.*, which is a synonym of *F. dietrichiae* should not be confused with *Forsyth* 669, which collection is labeled *F. sydneyensis* Broth. (nom. nud.). This collection is the type of *F. rigidiusculus* Broth. (=*F. leptocladus* C. Muell. & Rodw.). NB this is not *F. rigidiusculus* Broth. in Bruehl. ex Gang. (1971) (hom. illeg.).

4. F. vanzanteni Brugg.-Nann. *nov. spec.* – Type: *Van Zanten* 68–191 (GRO(holo-), U). – *F. schmidii* non C. Muell. sed Van Zanten (1964): 268. – *F. schmidii* var. *irrigatus* non (Fleisch.) Fleisch. sed Van Zanten (1964): 268. – **Fig. 6a-e.**

Species foliis latis plerumque oblongis, limbo lato crassoque et apice plerumque acuminate mucronato. A *Fissidente dietrichiae* limbo latiore crassioreque et a *Fissidente schmidii* cellulis majoribus differt.

F. vanzanteni is easily recognized by the wide leaves, the stout border, the mucronately acuminate, less often acuminate apex and the rather large cells. It has been named after its collector Dr B. O. van Zanten. In spite of Recommendation 73 C of the International Code of Botanical Nomenclature I have chosen the latinization *vanzanteni* instead of *vanzantenii* to retain the stress on the syllable "zant".

Plants 0.7–1.3 cm long, rather thinly, rarely rather densely foliated with up to 20 leaf pairs. *Leaves* oblong, rarely elliptical or ovate with an obtuse tip; 1.4–2.5 mm long, 0.5–0.7 mm wide; ratio L/W 2.5–3.75; ratio L/V 2–2.5. Apex symmetrical or asymmetrical, distinctly and long (rarely distinctly and shortly or indistinctly and long) mucronately acuminate or acuminate. Nerve and border fusing at the apex or shading off into a tissue of cells that are too wide for nerve or border cells and too long for lamina cells. Leaves usually not decurrent, dorsal lamina often more or less rounded near the insertion. Border mostly reaching the insertion. Width of the border 15–22 μm. Cells 7.5–13.5 μm long and 6–10.5 μm wide. *Fertile plants*: archegonia and antheridia terminal. In one case antheridia in buds. These buds were situated terminal, and in the axils of the upper-

most leaves. Length of the archegonia 350–482 μm; length of the antheridia 248–438 μm. Length of the perichaetial leaves 2.25–3.2 mm. *Sporophyte* (only two seen): Seta 6.5 mm long. Capsule erect, 0.7–1.0 mm long and 0.5 mm wide; width of the peristomium teeth 48–80 μm. Spores 13–17 μm.

Distribution: New Guinea.

Examined materials: Star Mountains: *Van Zanten* (1959) 312A (L, GRO), 505C (L, NY, GRO), 514A (L, GRO), and 560E (L, GRO), 577B (L, GRO). Wau: *Van Zanten* 68–190 (GRO, U), 68–191 (GRO, U). Eastern Highlands: *Van Zanten* 68–2854 (GRO, U).

Ecology: *F. vanzanteni* is found between 800 and 2600 m altitude. It has been collected on stones, wood and earth in and near running water, on earth and wood in humid places and at the dry base of a tree.

Note: *F. vanzanteni* has been confused with *F. schmidii* C. Muell. and *F. schmidii* var. *irrigatus* (Fleisch.) Fleisch. (Van Zanten, 1964). From *F. schmidii* it differs as follows:

	F. schmidii	*F. vanzanteni*
length of the cells	4–7.5 μm	7.5–13.5 μm
width of the cells	3–6 μm	6–10.5 μm
width of the border	9–15 μm	15–22 μm

F. schmidii var. *irrigatus* is polytypic. Neither of the components is identical with *F. vanzanteni*. I will go into the matter of typification of *F. schmidii* var. *irrigatus* in a future paper.

ACKNOWLEDGEMENTS

I am indebted to the Netherlands Organization for the Advancement of Pure Research (Z.W.O.) for awarding me a grant which enabled me to make a working visit to France.

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