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A NOTE ON ANOTRICHIUM TENUE (C. AG.) NÄG. (CERAMIACEAE, RHODOPHYTA) IN SOUTHERN AFRICA[1]

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SUMMARY

The red algal species *Anotrichium tenue* (C. Ag.) Näg. is reported from localities on the South African and Transkeian coasts. From this area the species has originally been described as *Griffithsia secunda* Harvey ex J. Ag. From morphological study it is concluded that the Cape material can be distinguished at varietal level, as *Anotrichium tenue* var. *secundum* (Harvey ex J. Ag.) nov. comb., nov. stat. It differs from the typical variety by its broader filaments, broader and less branched trichoblasts, and whorls with more numerous spermatangial clusters and tetrasporangia.

1. INTRODUCTION

The genus *Anotrichium* Näg. was reinstated (BALDOCK 1976) for a group of species usually considered to belong to *Griffithsia* C. Ag. Discriminating characters are the strongly inflated hypogenous cell of the female reproductive structure, developing a whorl of unicellular involucral branches around the carposporophyte, and tetrasporangia and spermatangial clusters developing in a number of only one per pedicel.

Anotrichium tenue (C. Ag.) Näg. is a species of world-wide tropical and subtropical (to temperate) distribution. It was recorded from a.o. the Mediterranean (FELDMANN-MAZOYER 1940; COPPEJANS 1983), the Caribbean (BØRGESEN 1920; NORRIS & BUCHER 1982), East Africa (JAASUND 1976), Japan (ITONO 1977) and Australia (BALDOCK 1976). The hereby reported recent finds of this species in Southern Africa made it possible to study its vegetative and reproductive morphology in some detail, and make a comparison with earlier descriptions.

2. MATERIALS

Fresh material of *Anotrichium tenue* was collected at:
CAPE PENINSULA: 5-XI-1983, St James, lower intertidal
[permanent slides Stegenga *nos* 333 (male), 339 (female)];
21-XI-1983, Glencairn, lower intertidal

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[Stegenga *no* 348 (tetrasporophyte)];
2-II-1984, Buffels Bay, lower intertidal
[Stegenga *no* 477 (tetrasporophyte)].
TRANSKEI: 24/26-VI-1983, Hluleka Nature Reserve, lower intertidal [Stegenga *nos* T138, T242 (male), T141 (female), T203 (tetrasporophyte)].

On all occasions plants were growing in a low algal turf, exposition to wave action at the collecting sites moderate to heavy. All material has been deposited in the Bolus Herbarium at Cape Town (BOL).

Preserved material examined of *Griffithsia secunda*, as deposited in BM:
CAPE PENINSULA: Dec. 1835, Muysenberg (TYPE, tetrasporangial); undated, Sea Point (Tyson *no* 94, female and tetrasporangial).
EAST CAPE PROVINCE:
undated, Cape Morgan (Flanagan *nos* 61 (sterile), 337 (female));
undated, Kei Mouth (Flanagan *no* 221, tetrasporangial);
undated, "British Kaffraria" (Flanagan *no* 254, sterile).

3. RESULTS

3.1. Description of Cape material

Main filaments procumbent, up to *c.* 10 cm long, apparently of indefinite growth, the apex ascending (*fig. 1*). Filaments attached by unicellular rhizoids; creeping filaments with secund rows of erect laterals bearing the reproductive structures, laterals arising from the proximal end of the cells. Filaments 300–350 (–400) μm in diameter, cells cylindrical, up to 1200 μm long; apical cells semiglobose or lens-shaped, 50–70 μm in diameter. Cells near the apices of the plants each with one or two subapical whorls of deciduous trichoblasts, numbering 20–30 per cell. Trichoblasts two-celled and unbranched or three-celled and with one dichotomy, attaining a diameter of *c.* 40 μm before being shed.

Tetrasporangia in one or two whorls on a number of successive subapical cells of the erect axes (*fig. 2*), apparently substituting trichoblasts. Total number of tetrasporangia per cell 20–30. Tetrasporangia pedicellate, terminal on the pedicel, but sometimes subterminal/adaxial by distortion of the shape of the pedicel; pedicels up to 120 μm long. Tetrasporangia at maturity globose, *c.* 65 μm in diameter, tetrahedrally divided.

Spermatangial clusters arranged in whorls on a number of subapical cells of the erect axes, substituting trichoblasts (*figs. 5, 11, 12*). Total number of clusters up to 16 per cell. Each cluster with a single stalk cell and a central axis, which at first is two-celled, but may later on develop to *c.* seven cells. Each of the cells of this axis bearing several repeatedly branching small-celled filaments which terminally bear the spermatangia. Mature spermatangial clusters pyramidal, up to 500 μm long and 300 μm in diameter. Pedicel up to 250 μm long; by distortion of the latter's shape spermatangial clusters subterminal/adaxial.

Female fertile axis three-celled (*figs. 3, 4, 13*), formed terminally on the erect axis, but soon pushed aside by a newly developing apical cell; by repetition of this process a secund row of fertile axes may be formed on a number of successive

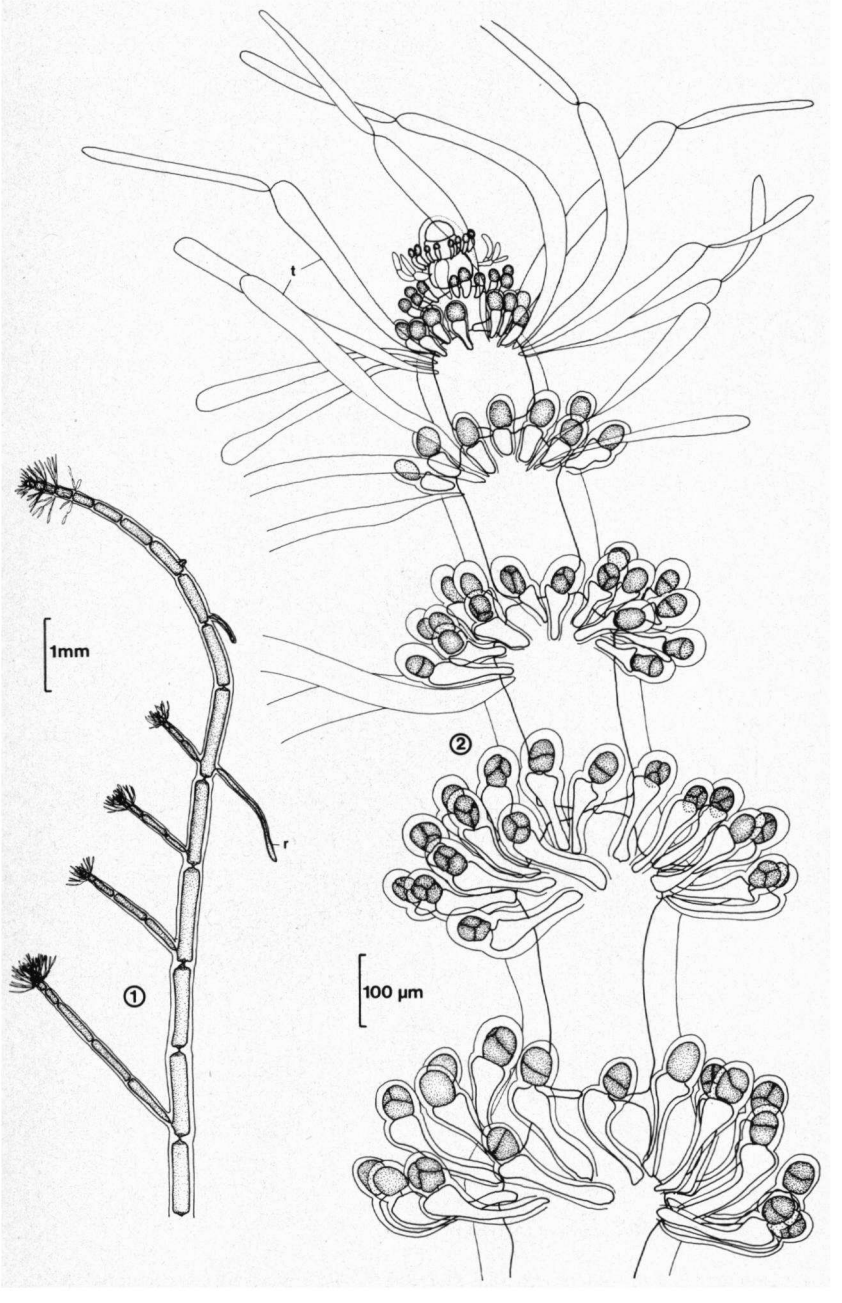
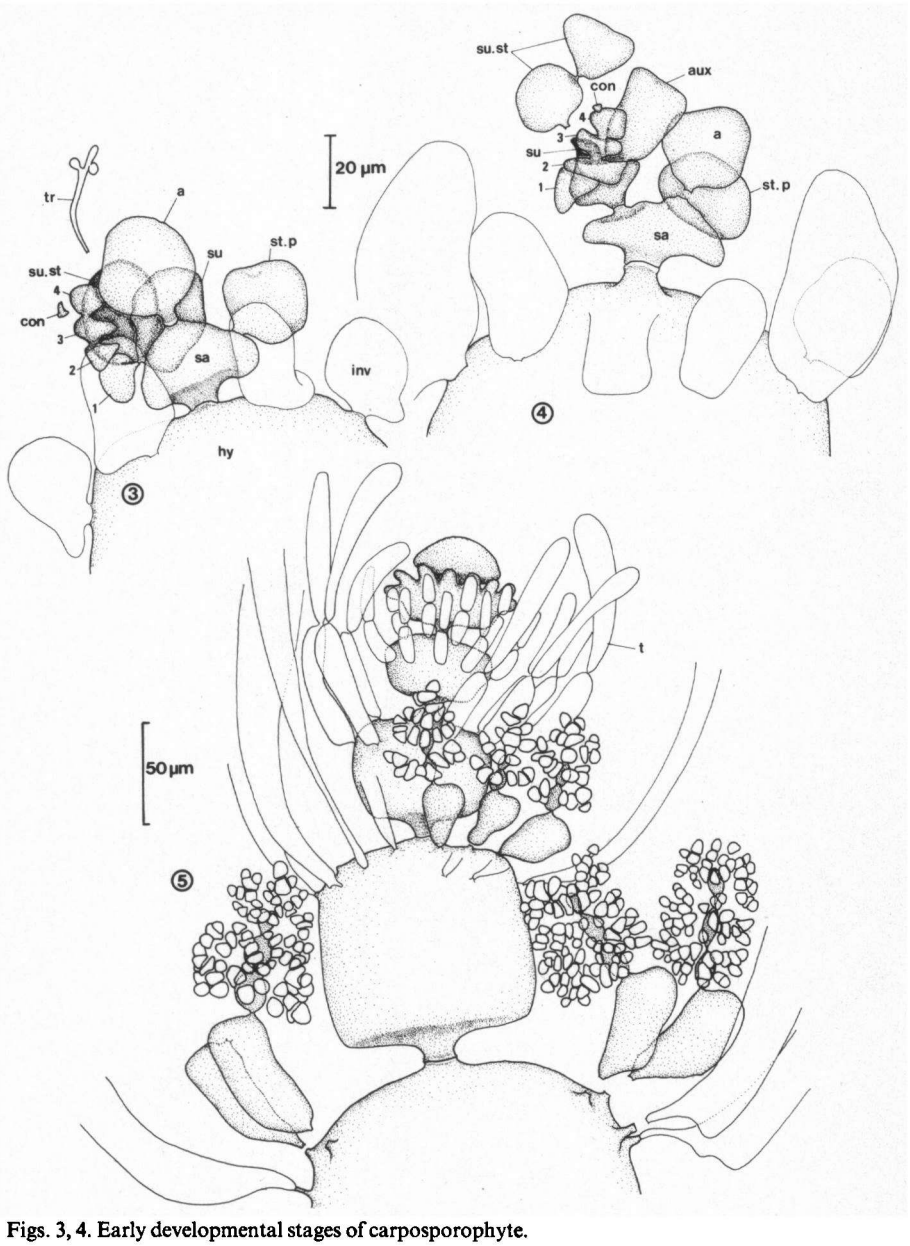


Fig. 1. Habit of creeping filament with erect axes and rhizoids (r). Fig. 2. Apex of tetrasporangia-bearing axis (t = trichoblast). Both figures from Cape material.



Figs. 3, 4. Early developmental stages of carposporophyte.

Fig. 5. Apex of male axis with young spermatangial clusters. All figures from Cape material. Abbreviations: a = apical cell of fertile axis; aux = auxiliary cell; con = connecting cell; hy = hypogenous cell of fertile axis; inv = involucral cell; sa = subapical cell of fertile axis; st.p = sterile pericentral cell; su = supporting cell; su.st = sterile cell (or two-celled filament) on supporting cell; t = trichoblast; tr = trichogyne; 1–4 = cells of carpogonial filament.

vegetative cells, which in addition bear one or two whorls of trichoblasts. Fertile axis consisting of an apical cell, subapical cell and hypogenous cell (*figs. 3, 4*). Subapical cell with two pericentral cells, one sterile, the other functioning as supporting cell. Supporting cell bearing one sterile cell or a "filament" (*fig. 4*) of two sterile cells, and a four-celled carpogonial branch. After fertilization an auxiliary cell develops from the supporting cell and probably fuses with a connecting cell from the carpogonium; no actual observations were made of this stage, but a second connecting cell is visible in some procarps (*figs. 3, 4-con*). In the Cape material no stages further than the formation of an auxiliary cell have been observed. As fertilization occurs, the hypogenous cell inflates and develops a subapical whorl of unicellular involucral branches (*figs. 3, 4*) around the growing carposporophyte. A number of 10 involucral cells was observed, but more may develop at a later stage.

As aberrant developmental stages four-celled female axes were seen, the sterile and fertile pericentral cells developing on the third cell from the apex. Two fully developed carpogonial filaments on one supporting cell were found once.

3.2. Observations on Transkei material

The overall morphology of Transkeian material is in agreement with the description above; only the points of difference will be briefly stated (see also table 1).

Filaments are up to 200 μm in diameter, cells generally not longer than 600 μm. Trichoblasts in whorls of up to 20 per cell, once or twice dichotomously or trichotomously branched, attaining a length of up to four cells and a maximum diameter of 7 μm before being shed.

Tetrasporangia in whorls of up to 15, rarely 25; individual tetrasporangia *c.* 85 μm in diameter.

Spermatangial clusters in whorls of up to 10; individual clusters measuring *c.* 200 × 180 μm.

Development of female fertile structure not deviating from the Cape material, except for the fact that cell dimensions are smaller in all parts. After the first stages of development of procarp and carposporophyte, which proceed as described for the Cape material (*figs. 6–9*), three gonimolobes are produced from the apex of the auxiliary cell in quick succession (*fig. 10*); more gonimolobes are developed as the first gonimolobes are shed (*figs. 14, 15*). Subapical cell of the fertile axis, supporting cell and auxiliary cell form a fusion cell (*fig. 10-arrow*). The involucral cells elongate and curve over the developing carposporophyte (*figs. 10, 14, 15*). Nearly all cells of the gonimolobes develop into carposporangia; mature carposporangia measure *c.* 40 μm in diameter. Involucral filaments, numbering up to 14 per whorl, measure *c.* 400 × 80 μm.

3.3. Type and other material of Griffithsia secunda

Griffithsia secunda Harvey ex J. Ag. 1851 was described from the Cape of Good Hope. The type is in BM, a tetrasporangium bearing plant collected Dec. 1835 at Muizenberg (Cape Peninsula). From the branching type (laterals arising from

Table 1. Comparison of Southern African material of *Anotrichium tenue* with some earlier descriptions.

	Cape Peninsula (own material)	Transkei (own material)	Cape Peninsula (*Griffithsia secunda* – type and other material)	Eastern Cape (*Griffithsia secunda*)	Australia (BALDOCK 1976)	Japan (ITONO 1977)	Mediterranean (FELDM.-MAZOYER 1940)	Caribbean (BØRGESEN 1920)
filament diameter (µm)	–350(–400)	–200	300–400	200–260	100–200	88–110	150–200	200
cell length (µm)	–1200	–600	–1500	–1200	500–1100	5 × width	3–5 × width	4–6 × width
n° of trichoblasts per cell	20–30	–20	?	?	8–12	"numerous"	?	"several rows"
trichoblast diameter (µm)	–40	–7	–	–	(in fig. –20)	(in fig. few µm)	–	?
branching of trichoblasts	one dichotomy at most	di-/trichotomous	–	–	di-/polychotomous	trichotomous	repeatedly dichotomous	di-/trichotomous
n° of tetrasporangia per cell	–30	–25	–45(–50)	–40	8–10(–12)	–15	5–8	15
n° of spermatangial clusters per cell	–16	–10	?	?	4(–6)	–	–	–

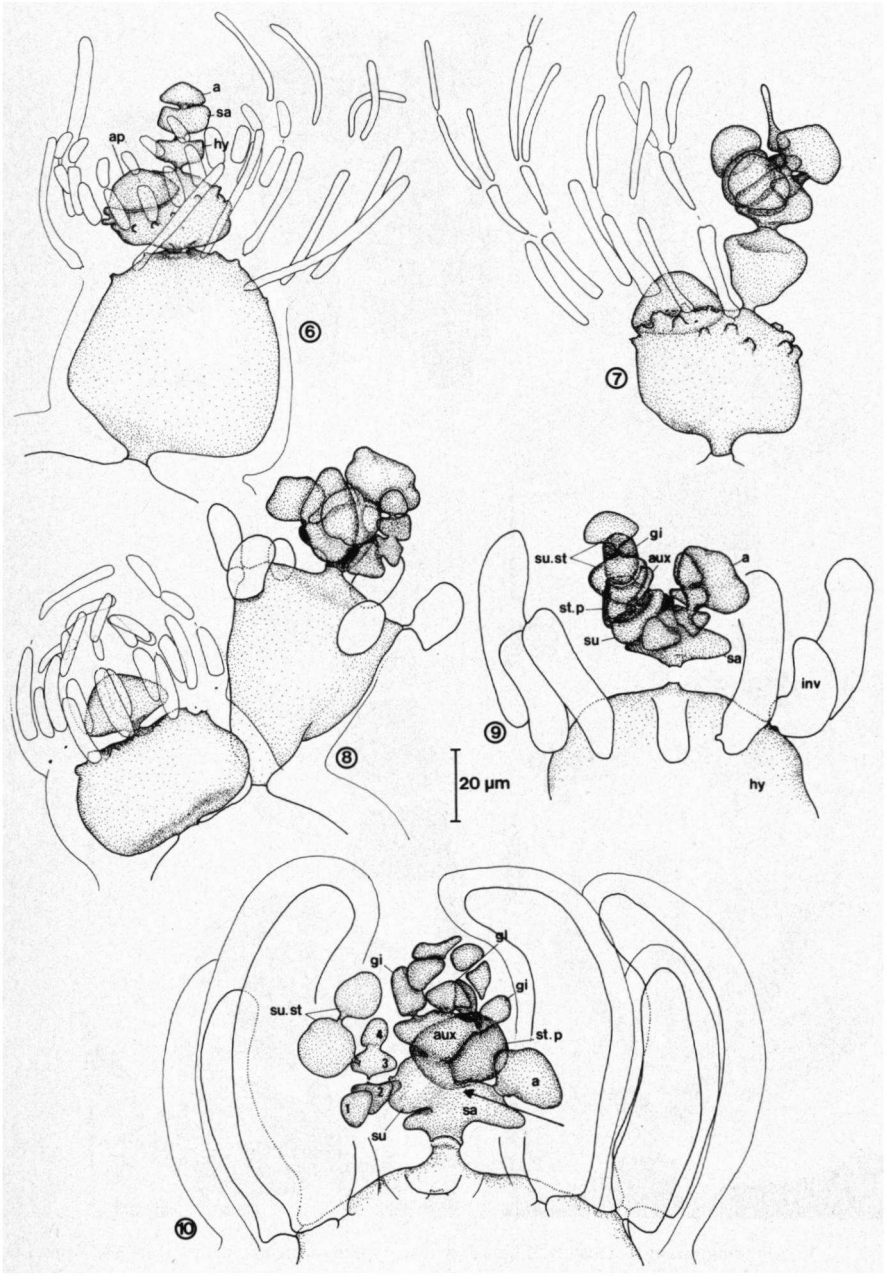


Fig. 6–10. Developmental stages of fertile axis and carposporophyte. All figures from Transkeian material. Abbreviations as in *figs. 3* and *4*, in addition: ap = apical cell of vegetative filament; gi = gonimolobe initials.

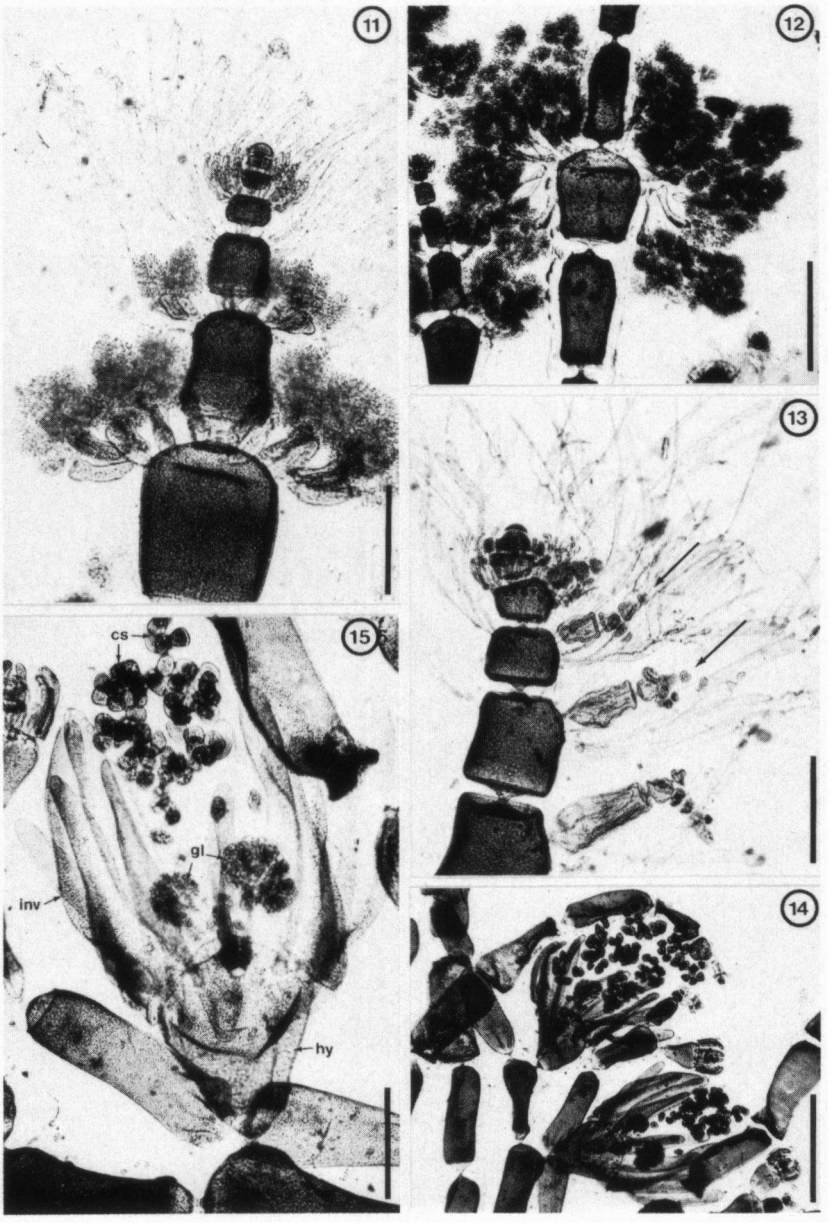


Fig. 11. Young spermatangial clusters. Fig. 12. Mature spermatangial clusters. Fig. 13. Apex of female plant with several fertile filaments, but without fertilized carpogonia (arrows indicate four-celled fertile filaments). Fig. 14. Carposporophytes at various stages of development. Fig. 15. Mature carposporophyte, the first-formed gonimolobe being shed (cs = carpospores; gl = gonimolobe; hy = hypogenous cell; inv = involucral cell). *Figs. 11–13* from Cape material, *figs. 14, 15* from Transkei material. Scale bar in *figs. 11, 13, 15* = 200 μm, in *figs. 12, 14* = 500 μm.

the proximal end of the cells) and the tetrasporangial arrangement (tetrasporangia pedicellate, organized in subapical whorls) it is clear that this material fits the description of *Anotrichium tenue* and hence, that *Griffithsia secunda* is a synonym. Material of *Anotrichium tenue* recently collected near the Cape, and described above, is in good agreement with this type. Main filaments in the type are over 300 μm in diameter, individual cells up to 1500 μm long. The state of preservation of the material does not permit close observations on the trichoblasts or on numbers of tetrasporangia.

Other, earlier collected material from the Cape Peninsula (Seapoint, Tyson 94) is in agreement with the type of *G. secunda* and with our collections of *Anotrichium tenue* from the Cape Peninsula: main filaments are 300–400 μm in diameter, tetrasporangia occur in whorls of up to 45(–50) per vegetative axis cell; this material also contains mature carposporophytes.

The other material of *G. secunda* in BM includes various specimens collected near the present Cape Province–Transkei border. The filaments are in general narrower than in the Cape Peninsula material: up to 200–260 μm in diameter, but cells are longer than in our own Transkeian material of *Anotrichium tenue*: up to 1200 μm. In the only tetrasporangial specimen tetrasporangia occur in whorls of up to 40 per cell.

4. DISCUSSION

Anotrichium tenue from the Cape Peninsula differs from earlier descriptions of this species in a number of aspects (see also *table 1*). The most complete description of this species to date was given by BALDOCK (1976), and the latter description will serve as a basis for comparison:

– vegetative cells reach diameters of 300–400 μm, compared with only 200 μm in earlier descriptions (but only 110 μm in Japanese material – ITONO 1977).

– trichoblasts appear to be more numerous than in earlier reports: 20 trichoblasts in one whorl or 30 in two whorls per cell are of common occurrence, as opposed to 8–12 in Australian material (BALDOCK 1976).

– trichoblasts are simple or with one dichotomy as opposed to polychotomous trichoblasts (BALDOCK 1976) or repeatedly dichotomous trichoblasts (e.g. BØRGESEN 1920, COPPEJANS 1983); the trichoblast cells are also wider than in earlier reports: up to 40 μm, sizes in the literature not usually given, but in various figures not exceeding 20 μm.

– tetrasporangia occur in whorls of up to 30 per vegetative cell – this is far more than in any other report (*table 1*); tetrasporangial sizes are not aberrant.

– spermatangial clusters are more numerous: although they are seldom reported, BALDOCK (1976) mentioned a number of 4–6 per vegetative axis cell, in the present material there are up to 16 per whorl. They may be formed on a number of successive subterminal cells, or may skip a number of cells, but are not placed with regularity every other cell as in BALDOCK's material. Spermatangial cluster size is at least twice that of Australian material; 500 × 300 μm as opposed to 140 μm diameter. Also the pedicel reaches about twice the size of Australian

material (250 μm vs 140 μm). Moreover, in BALDOCK's material the spermatangial clusters had a three-celled axis (including the pedicel); in Cape material this axis is three-celled at first, but it may develop to a length of seven cells as spermatangial clusters continue growth. Consequently the shape of the spermatangial clusters is pyramidal rather than globose.

– in the development of the procarp there is little deviation from the report of BALDOCK (1976), however the supporting cell may bear either one sterile cell or a two-celled sterile filament, whereas BALDOCK reports only a single sterile cell in this position. In contrast to BALDOCK's report, the S. African material has fully developed whorls of trichoblasts on the subhypogenous cell; this seems to be the case in Mediterranean plants as well (COPPEJANS 1983, PL. 181, fig. 2).

– although few measurements on developing female structures have been published, an interesting difference if found between the Cape Peninsula material and the Transkeian specimens (compare *figs. 3, 4* and *figs. 8, 9*). The Cape material reaches larger sizes in all parts: in comparative stages the cells of the fertile axis and involucral cells are about 1.5 times as large in the Cape material as in the Transkeian plants.

It appears that, in comparison with the Cape Peninsula material, the Transkeian material is more in agreement with the earlier descriptions of *Anotrichium tenue* as regards cell dimensions and trichoblast morphology, but less so with respect to numbers of reproductive organs, i.c. tetrasporangia and spermatangial clusters.

From the examination of the type specimen of *Griffithsia secunda* it appears that *G. secunda* is a synonym of *Anotrichium tenue*. BØRGESEN (1945) came to the same conclusion with regard to material from Mauritius, earlier identified as *G. secunda*, but he did not formally synonymize the two. BALDOCK (1976) included in *A. tenue Callithamnion thyrsigera* Thwaites ex Harvey and *Stephanocomium adriaticum* Kützing.

The type specimen of *Griffithsia secunda* and the recent material of *Anotrichium tenue* from the Cape Peninsula are indistinguishable. Thus, although apparently belonging to *Anotrichium tenue*, all Cape material differs in a number of aspects from earlier descriptions of the species, as outlined above. It is therefore proposed that the Cape material be distinguished as a variety of *Anotrichium tenue*, which in accordance with Recommendation 61A.2 of the International Code should be called *Anotrichium tenue* var. *secundum* (Harvey ex J. Ag.) nov. comb., nov. stat. (basionym: *Griffithsia secunda* Harvey ex J. Ag. – AGARDH 1851). This variety is typified by the type specimen of *Griffithsia secunda* (in BM).

With respect to recent collections of Transkeian material, I am inclined to assign this to the typical variety of *A. tenue*, but like the older material of *Griffithsia secunda* from the Eastern Cape Province, it is in some aspects intermediate between the Cape Peninsula plants and *Anotrichium tenue* as it occurs elsewhere. A clinal variation of various characters in this species along the S. African coast can therefore not be excluded.

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