

**NOTES ON CERAMIACEAE (RHODOPHYTA) FROM THE EASTERN
CAPE PROVINCE, SOUTH AFRICA. I.
NEW RECORDS AND REMARKS ON MORPHOLOGY**

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SUMMARY

Eleven species of Ceramiaceae are reported from the coast of the eastern Cape Province, South Africa, for the first time; five of these also represent new records for southern Africa as a whole.

New details on reproductive morphology of *Anotrichium furcellatum*, *Callithamniella capensis*, *Griffithsia subbiconica* and *Laurenciophila minima* are presented. A key to the East Cape species of *Callithamnion* is provided.

INTRODUCTION

Our present state of knowledge on eastern Cape seaweeds is summarised by Seagrief (1988). A total of 276 species is listed and illustrated in that publication, among them 28 species belonging to the family Ceramiaceae.

In an earlier study (Stegenga, 1986) an account was given of representatives of the Ceramiaceae occurring on the West Cape coast: 38 species were mentioned, not including the genus *Ceramium*.

While working on the East Cape seaweeds, it soon became apparent to me that this coast is in all probability as rich as, or richer in species than the West Cape. Including unpublished data, a total of about 65 species (including *Ceramium*) has been found to date in the coastal area between Plettenberg Bay and East London, several of them new to South Africa; in a number of cases the identity of species has not yet been established. (Note: Although the area surveyed during the present study extends slightly beyond Cape St. Francis, the western boundary of the East Cape coast as used by Seagrief (1988), this has not resulted in the discovery of any species not found to the east of Cape St. Francis.)

The present publication deals with a number of records, either new to the whole of South Africa, or to the East Cape. In some cases additional information on vegetative and reproductive morphology of earlier recorded species is given.

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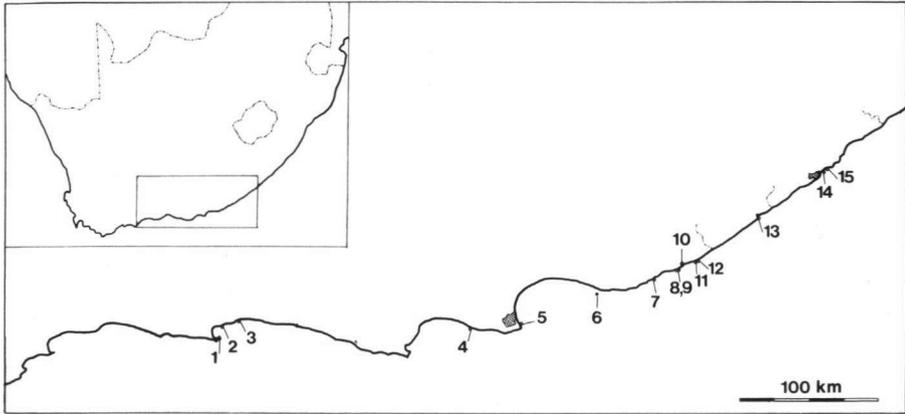


Fig. 1. The East Cape coast: localities mentioned in the text: 1. Robberg; 2. Keurboomstrand; 3. Nature's Valley; 4. Kini Bay; 5. Port Elizabeth, Summerstrand; 6. Bird Island; 7. Kenton on Sea; 8. Port Alfred, Piano Rocks; 9. Port Alfred, Sharks Bay; 10. Kowie Estuary; 11. Three Sisters; 12. Kleinemonde; 13. Hamburg, Ciskei; 14. East London, East Beach; 15. East London, Bat's Cave.

MATERIAL AND METHODS

During the year 1987 material was collected on several localities between Plettenberg Bay and East London (fig. 1). Material was collected in the intertidal and sublittoral fringe, supplemented with diving samples from Robberg and Bird Island; in some cases drift material, possibly of subtidal origin, was included.

Plants were preserved in 5% formalin in seawater. For microscopic study specimens were stained in FCF fast green and embedded in KARO corn syrup. Drawings were made with the aid of a camera lucida. Voucher specimens of most species are in the herbarium of Rhodes University (RUH); permanent slides are for the time being in the personal collection of the author.

For a number of species additional material was studied, belonging to the M. A. Pocock collection, kept in the Albany Museum, Grahamstown (GRA).

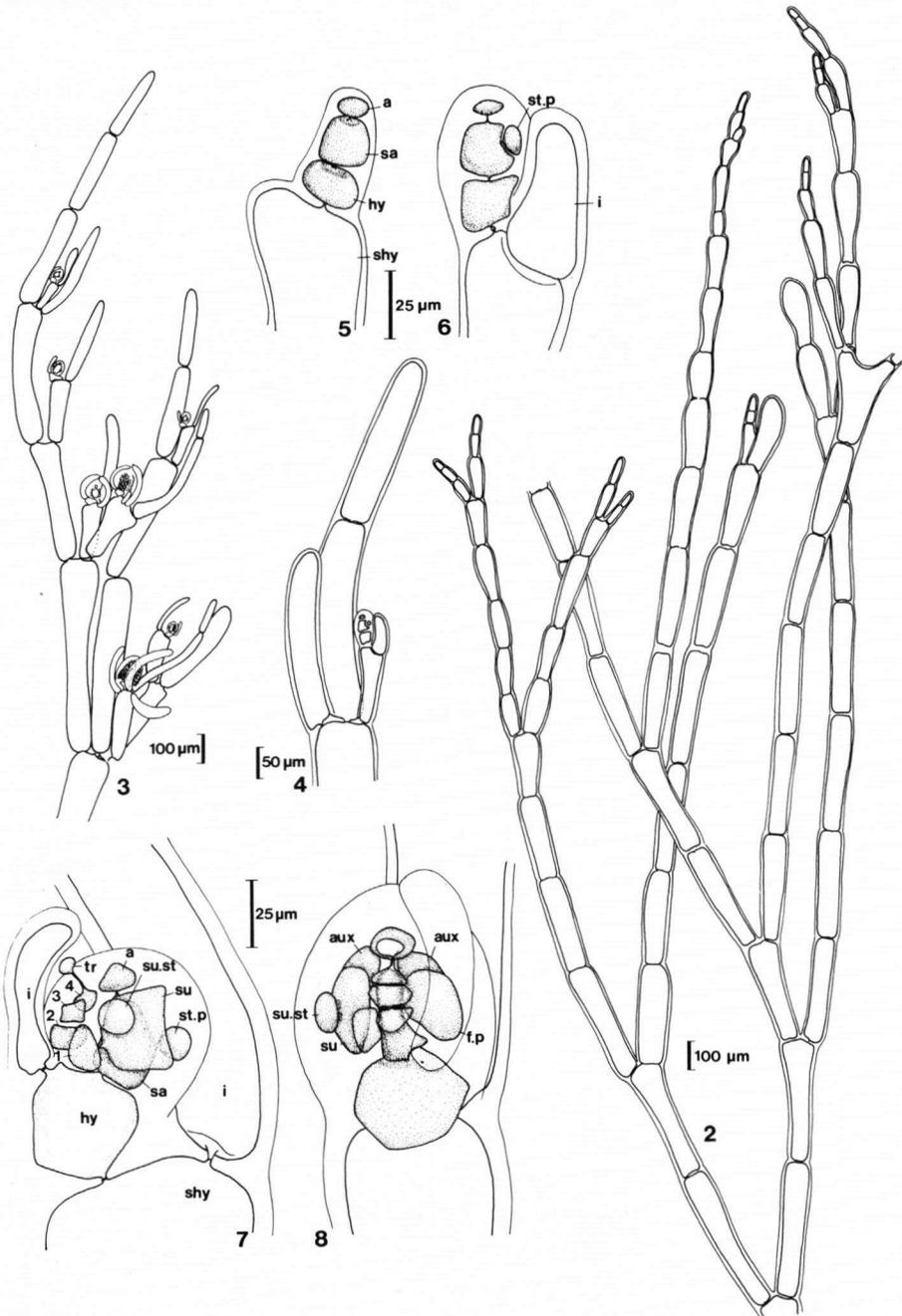
In the text, specimens are referred to as: Sa-numbers (herbarium material, collected by the author), EC-numbers (permanent slides, material collected by the author), MAP-numbers (collector's numbers in the M. A. Pocock collection).

OBSERVATIONS AND DISCUSSION

Anotrichium furcellatum (J. Agardh) Baldock (Figs. 2–12)

This species, not reported from South Africa before, was found in abundance in one of the shallow lagoons of the Kowie estuary.

Plants form bright red fluffy pompons of up to 200 mm in diameter, at first



Figs. 2–8. *Anotrichium furcellatum*. – 2: Apical part of sterile thallus (EC 34). – 3 & 4: Apical sections of female plant with procarp and carposporophytes (MAP 4127). – 5–8: Developmental stages of procarp (MAP 4127). – See further legend under figs. 9–12.

attached to hard substrates, but later also found free floating. Plants consist of uncorticated filaments, many times subdichotomously branched. The filament diameter, up to 200 μm basally, decreases to 25–30 μm in the apical cells; cells are cylindrical, 2–10 times longer than broad, the longest cells, up to 2 mm, occurring in the proximal parts of the thallus.

An inspection of the M. A. Pocock collection revealed that this species had been collected along the south coast of the Cape Province, especially in False Bay; in one collection of relatively small attached plants from the Kowie estuary female reproductive organs were found, otherwise rarely reported and incompletely described. It is, however, with some hesitation that I present here my findings on the morphology of procarp and post-fertilization structures: In detailed morphology and cell sizes the female plants were similar to *A. furcellatum*, but the plants were smaller, up to about 50 mm tall; the frequent occurrence of larger, but sterile plants could indicate that this species is only fertile in an early growth phase. A more serious problem is that major deviations from an earlier report on the female reproductive structure (L'Hardy Halos, 1968) were found.

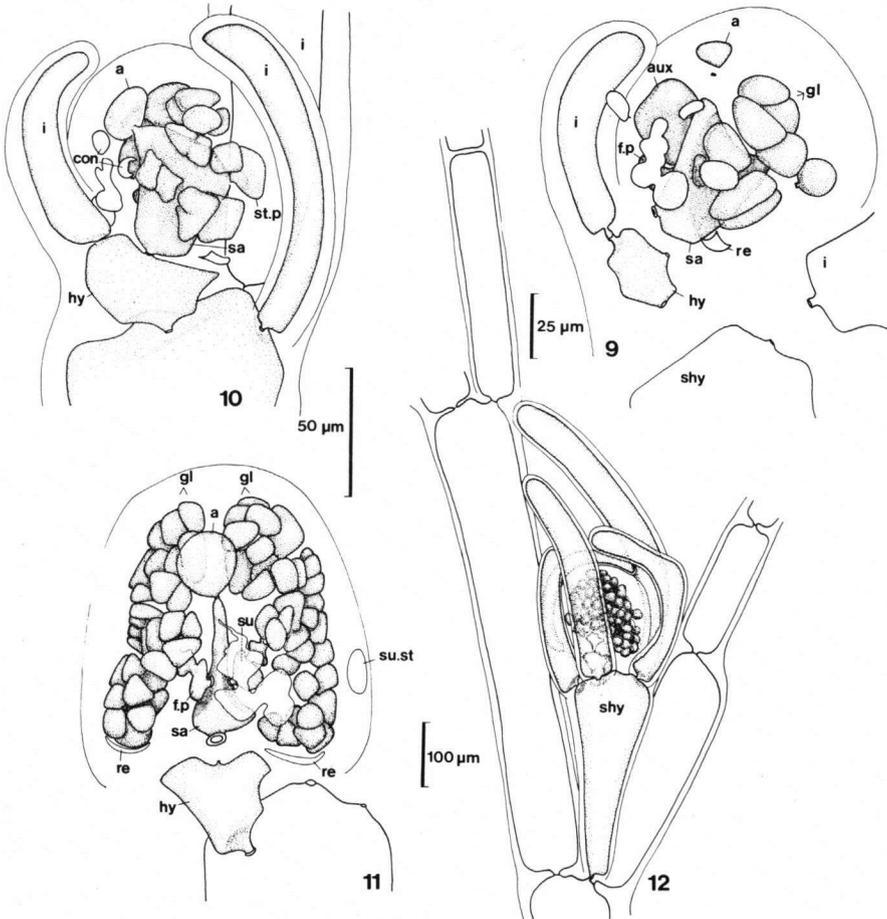
Female fertile filaments consist of four cells: apical, subapical, hypogenous and subhypogenous cell (fig. 5); the subhypogenous cell is large, not much different from vegetative cells, and laterally inserted on the filament; the fertile filament is often formed in addition to a normal vegetative lateral. The subapical cell cuts off three pericentral cells, first a sterile cell, then two fertile cells. At the time the sterile pericentral cell is cut off, the subhypogenous cell emits a single involucre cell at the abaxial side of the fertile filament (as related to the vegetative axis); the sterile pericentral cell is cut off on the same side as this involucre cell (fig. 6). The fertile pericentral cells are cut off to the right and left of the sterile pericentral, in opposite positions; both are much larger than the sterile pericentral cell. One fertile pericentral cell functions as a supporting cell, bearing a sterile cell and a four-celled carpogonial filament; carpogonia have a short bulbous trichogyne. As the procarp develops, and thus prior to fertilization, a second involucre cell is formed, now from the hypogenous cell, and in a position alternating with the first involucre cell (fig. 7). The supporting cell and the other fertile pericentral cell each cut off an auxiliary cell. Auxiliary cells are (supposedly) diploidized by the fertilized carpogonium via a connecting cell (fig. 10), and subsequently give rise to a gonimolobe each. The two gonimolobes develop into a spherical or slightly ovoid carposporophyte, completely immersed in mucilage. Nearly all cells of the gonimolobes develop into carposporangia simultaneously. No significant cell fusions take place in the carposporophyte. Mature carposporophytes are up to 300 μm in diameter, individual carpospores are rounded angular, c. 50 μm in diameter. As post-fertilization development progresses, a ring of additional involucre cells is formed from the subhypogenous cell, usually four to six (fig. 12).

MATERIAL EXAMINED: Kowie Estuary (lagoon), 5-iii-1987 (Sa 1009, eC 34); Idem, 27-vii-1987 (Sa 1557).

Material seen in the M. A. Pocock collection: Muizenberg, 4-i-1939 (MAP 204); Idem, 23-vi-1944 (MAP 8172); Idem, 30-xii-1945 (MAP 8573); Idem, 15-vii-1958 (MAP 12590 – attached); Strandfontein, 24-x-1938 (MAP 840); Idem, 24-xi-1938 (MAP 1093); Idem, 15-xi-1941 (MAP

4714); Idem, 3-i-1942 (MAP 4868); Idem, 13-viii-1942 (MAP 6809); Idem, 17-ix-1955 (MAP 10944 – attached); Kowie, Salt Vlei, 29-iii-1953 (MAP 10782); Kowie River, 23-ii-1941, 'on barrels supporting cove mansions' (MAP 4127 – female).

The structure of the female apparatus as described here differs considerably from the report of L'Hardy Halos (1968) on this species. Differences (with regard to pre-fertilization stages only) include:



Figs. 9–12. *Anotrichium furcellatum*, development of carposporophyte (N.B.: in fig. 9 cells slightly dislocated). – Legend: a = apical cell of fertile filament, aux = auxiliary cell, con = connecting cell, f.p. = fertile pericentral cell, gl = gonimolobe, hy = hypogenous cell, i = involucral cell, re = rest cell, sa = subapical cell of fertile filament, shy = subhypogenous cell, st.p. = sterile pericentral cell, su = supporting cell, su.st = sterile cell on supporting cell, tr = trichogyne, 1, 2, 3, 4 = cells of carpogonial filament (4 = carpogonium). – All material: MAP 4127.

- a three-celled fertile filament, with a long hypogenous cell; in our material a four-celled fertile filament with a short hypogenous cell and a long subhypogenous cell;
- possession of two pericentral cells on the subapical cell; in our material three pericentral cells;
- no development of involuclal cells prior to fertilization; in our material two involuclal cells, one from the subhypogenous cell, one from the hypogenous cell.

L'Hardy Halos (l.c.), on the evidence available to her, concluded that this species should be returned to the genus *Griffithsia*. It is interesting that in a footnote she comments that her findings were very different from those of Funk (1961); in Funk's publication no detailed description is given of the procarpic structure, but two elements in that paper seem to be important in the present context: the first is that female reproductive structures were found on dwarf plants, in short a condition comparable with our observations on the East Cape material. Secondly, Funk's (1961) figures 3 and 4 strongly suggest that a four-celled filament is present, both the subhypogenous and the hypogenous cell bearing an involuclal cell prior to fertilization; also a bulbous trichogyne can be recognized, although no details of pericentral cells or carpogonial filament. The observed structures again are completely in agreement with the East Cape material.

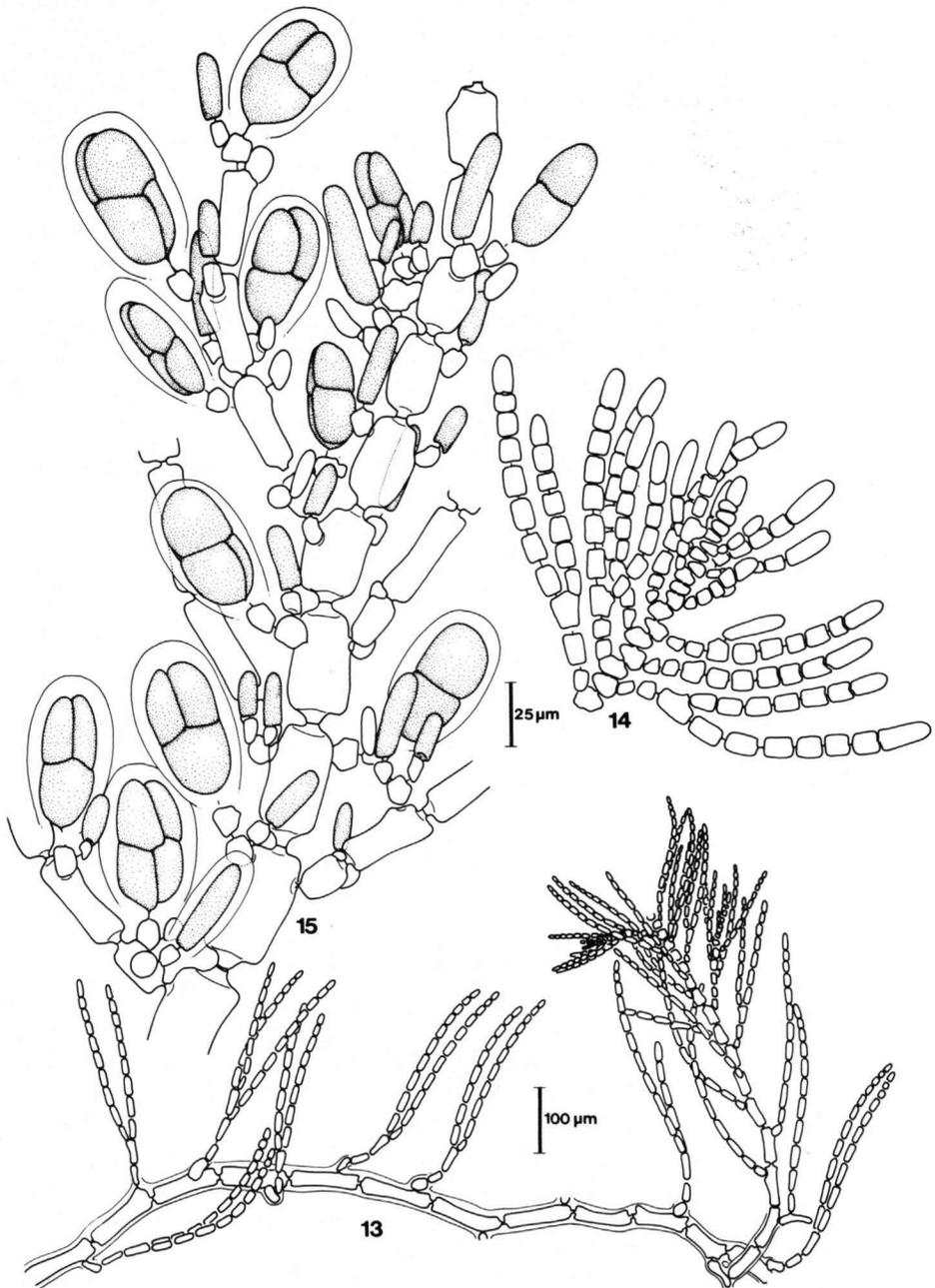
From the above described pre- and post-fertilization structure it is clear that *A. furcellatum* cannot be maintained in the tribe Griffithsieae, although it best fits there in terms of vegetative morphology; in the Griffithsieae two pericentral cells are present on the subapical cell of the female fertile filament, one sterile, the other a supporting cell; consequently only one auxiliary cell is formed. In addition our species specifically differs from *Anotrichium* by the development of the involuclal cells from the subhypogenous cell mainly; in *Anotrichium* the formation of a whorl of involuclal cells from the hypogenous cell is considered a generic character.

Certain elements, i.e. the three pericentral cells, and the two auxiliary cells link this species to the tribe Spermotamnidae. On the other hand, the simultaneous development of all gonimolobe cells into carpospores is more in line with the Griffithsieae again.

In conclusion, tribal assignment of *A. furcellatum* is unsatisfactory and must remain so until definitions of these tribes are amended. At present it is deemed impractical to reassign *A. furcellatum* generically until more is known on sexual reproduction in probably related genera such as *Monosporus* and *Anisoschizus* (cf. Huisman & Kraft, 1982).

Callithamniella capensis Simons (Figs. 13–15 & 40)

In the western Cape this species is found most abundantly on the stipes of the kelp *Ecklonia maxima* (Osbeck) Papenfuss (Stegenga, 1986). While *E. maxima* has an eastward extension about as far as Cape Agulhas, *Callithamniella capensis* is found along the whole of the Cape south coast. Some of the East Cape specimens deviate morphologically from the West Cape material. Also, female specimens were



Figs. 13–15. *Callithamniella capensis*. – 13: Habit of plant with forked laterals (EC 148). – 14: Apex of indeterminate erect axis (EC 148). – 15: Clustered tetrasporangia (EC 246).

found for the first time, although unfortunately no post-fertilization stages. Nevertheless, a taxonomic affinity of this species with the tribe Heterothamnieae can be made acceptable.

Morphological peculiarities include:

- The occurrence of forked determinate laterals (figs. 13, 14); these laterals were 10–15 cells long, in the West Cape material laterals were up to 25(–35) cells. These plants also had smaller cell sizes: prostrate axes 25–35 μm in diameter (40–50 μm in West Cape plants), determinate laterals c. 12 μm in diameter (15–20 μm in West Cape material). The forking is usually from the third cell of the lateral.
- Tetrasporangia, normally borne on a single stalk cell on the indeterminate erect axes, were found to occur in small clusters (fig. 15), often consisting of a three-celled forked branchlet with terminal sporangia. These clusters occurred both directly on the indeterminate axes and (sometimes in pairs) on the proximal cells of the determinate laterals.

Female plants were found on one occasion: Carpogonial filaments are borne on the basal cell of a two-celled branchlet (fig. 40). Such branchlets are borne at short intervals in the apical region of the indeterminate erect axes. No further developments were observed. Apparently, in case of non-fertilisation, the two-celled branchlet may develop into a normal determinate lateral. In female plants the determinate laterals were sometimes found to be terminated by a unicellular hair.

MATERIAL EXAMINED: Robberg, 11-vi-1987 (EC 246), on *Pyura* (male, tetrasporangial); Keurboomstrand, 11-vi-1987 (EC 284), on mussels; Bird Island, 20-viii-1987 (EC 397), at 1–3 m depth; Port Elizabeth, Summerstrand, 31-iii-1987 (EC 148), on *Sargassum* sp.; Kenton on Sea, 2-xii-1987 (Sa 1944), on *Patella cochlear*; Port Alfred, Sharks Bay, 17-iii-1987, on *Caulerpa holmesiana* Murray, washed ashore; East London, East Beach, 19-xi-1987 (EC 445, 446), on *Pyura* (tetrasporangial, female); East London, Bat's Cave, 9-ix-1987 (EC 351), on *Pyura* (tetrasporangial).

The morphology and position of the female fertile structure of this species are similar to that in the Heterothamnieae, the reduced fertile whorl branchlet being typical of that tribe (Wollaston, 1968). It is probably most closely related to *Antithamnonella*, although in that genus so far no representatives with only one determinate lateral per segment are known; *A. spirographidis* (Schiffner) Wollaston has occasionally one, usually two ramuli per segment.

A relationship to the genus *Grallatoria* (see e.g. Abbott, 1976) is discredited by the present evidence. *Grallatoria* is thought to have taxonomic affinities with the Wrangelieae (Wynne & Ballantine, 1985).

As the above-mentioned morphological deviations show, *C. capensis* exhibits a large variation. Much of the East Cape material was however not aberrant from earlier descriptions (Simons, 1970; Stegenga, 1986), and at the moment there seems to be no reason to distinguish more than one species or subspecific category on the South African coast; but it must be mentioned that the plants with forked ramuli and smaller cell sizes are remarkably similar to *C. tingitana* (Schousboe) G. Feldmann, as described from the Mediterranean (Feldmann-Mazoyer, 1940).

The area of distribution of *C. capensis* is now known to extend along the whole of the south coast of the Cape Province. Two collections of this species were found

in the M.A. Pocock collection, both originating from False Bay. In the East Cape animals, especially molluscs and *Pyura*, are favoured as substrates.

These records present an extension of the genus *Callithamniella* into the Indian Ocean. The other species, *C. tingitana* and *C. flexilis* Baardseth are known from the northern and southern Atlantic Ocean respectively. *Callithamniella* appears to be a genus of (warm-)temperate environments (see however Lawson & John, 1982); the earlier mentioned *Grallatoria* is known from the Caribbean and southern Japan: apparently *Antithamnion tanakae* Itono (e.g. Itono, 1977), described from the latter locality, belongs to *Grallatoria*, and probably to *G. reptans* Howe.

Callithamnion

The genus *Callithamnion* was known to be represented by only one species in the East Cape so far (Seagrief, 1988). This species, *C. stuposum* Suhr, is indeed very common in the lower intertidal and in shallow tidal pools. Its spongy habit and often vivid green iridescence make it easily recognizable in the field. Three species of *Callithamnion*, including *C. stuposum*, were recognized on the West Cape coast (Stegenga, 1986).

The present investigation shows that at least seven species can be recognized along the East Cape coast:

- *C. cordatum*, new to South Africa;
- *C. furcellariae*, new to South Africa;
- *C. granulatum*, a species earlier reported from Transkei (Bolton & Stegenga, 1987);
- *C. hookeri*; this represents an extension of the range of distribution; it was earlier reported from the Cape Peninsula (Stegenga, 1986);
- *C. stuposum* (see above);
- *C. tripinnatum*, new to South Africa;
- *C. spec.*, described but not named in Stegenga (1986).

The allied genus *Aristothamnion*, distinguished from *Callithamnion* by the possession of polysporangia instead of tetrasporangia, is represented by *A. collabens* (Rudolphi) Papenfuss; it is basically a west coast species and in the present study was found only as far east as Kini Bay, but was reported from Port Alfred (Wollaston, 1984).

The eastern Cape species of *Callithamnion* can be keyed out as follows:

- 1a. Plants up to 100 mm tall, spongy, in live condition often greenish iridescent; ramuli often with terminal and subterminal spines ***C. stuposum***
- b. Plants usually smaller, not strongly iridescent; ramuli usually without spines 2
- 2a. Plants brownish-red to greyish, of slender, almost rope-like habit; main axes densely clothed with branchlets, these many times subdichotomously branched, and strongly tapering to acute, proximally up to 70–100 µm in diameter
C. granulatum

- b. Plants usually red, of more open branching type; branchlets subdichotomously to alternately branched, sometimes simple, proximally 50 μm in diameter at the most, sometimes strongly tapering and with an acute apex, but more often blunt 3
- 3a. Laterals of first to third order all regularly distichously arranged and alternately branched **C. tripinnatum**
- b. Laterals polystichously arranged, sometimes distichous in apical sections of the plants 4
- 4a. Plants from the high intertidal, growing in shaded places; tetrasporangia in adaxial rows on usually unbranched ramuli; ramuli tapering to acute
C. hookeri
- b. Plants from the lower intertidal or subtidal, or tidal pools; tetrasporangia adaxial on alternately to subdichotomously branched laterals; ramuli tapering, but with blunt apex 5
- 5a. Main axis not very prominent, up to 100 μm in diameter; thallus apices not notably crowded **C. furcellariae**
- b. Main axis prominent, up to 200 μm or more in diameter; thallus apices with corymbs of crowded branchlets. 6
- 6a. Cells in proximal parts of main axes shorter than broad **C. cordatum**
- b. Cells in proximal parts of main axes longer than broad **C. sp.**

Note. *Callithamnion* species are often not easily identified; an indication of the problems is given by Wollaston (1984), who, besides *C. stuposum*, listed seven species of *Callithamnion* from eastern and southern African coasts without providing names for them. Characters like main axis diameter, degree of cortication, cell length/width ratio vary with age, diameter of full-grown ramuli is perhaps useful. General branching characteristics ('habit') are useful for such species as *C. tripinnatum* and *C. granulatum*, but not well defined in other species. Size of tetrasporangia, the most frequently found reproductive structures, does not vary greatly between species.

With these restrictions in mind, the key given above should be used with caution.

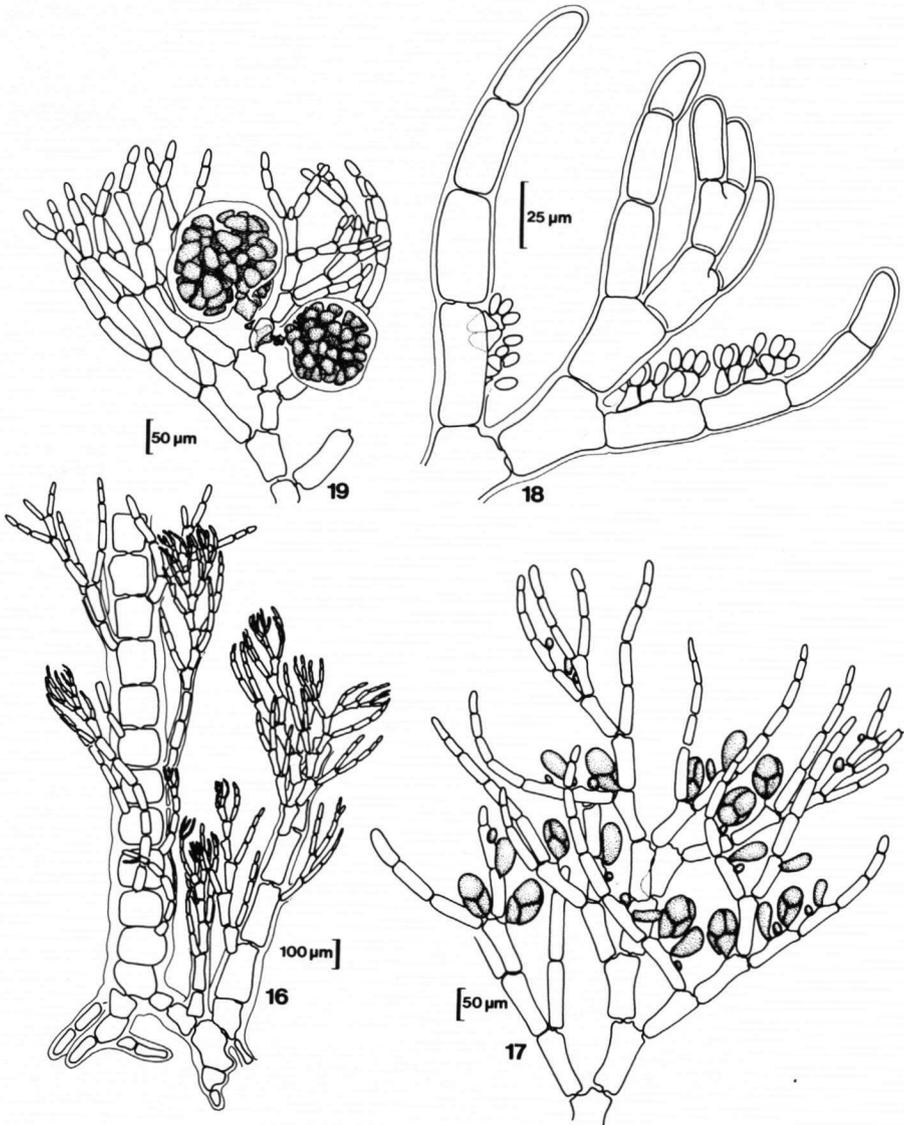
Callithamnion cordatum Boergesen (Figs. 16–19)

Plants with a prominent main axis, up to 10 mm tall, uncorticated. Main axis in proximal parts up to 200 μm in diameter, the cells about half as long as broad, thick-walled; axis narrowing toward the apex, with cells up to twice as long as broad. Primary laterals often indeterminate, clothed with determinate branches. Determinate laterals alternately to subdichotomously branched, c. 50 μm in diameter at the base, 20–25 μm at the apices. Branchlets at thallus apices crowded into dense corymbs.

Tetrasporangia adaxial on the determinate branches, often two (or three) sporangia of different ages on one cell. Sporangia ovate, c. 75 \times 55 μm (fig. 17).

Spermatangia in identical positions as tetrasporangia, up to four low spermatangial clusters per branchlet cell.

Procary and postfertilization development typical of genus; carposporophytes with twin rounded or rounded-angular gonimolobes.



Figs. 16–19. *Callithamnion cordatum*. – 16: Proximal part of main axis (EC 293). – 17: Tetrasporangia (EC 293). – 18: Spermatangia (EC 255). – 19: Carposporophyte (EC 269).

MATERIAL EXAMINED: Keurboomstrand, 11-vi-1987 (EC 293), on *Zonaria* sp. (tetrasporangial); Nature's Valley, 12-vi-1987 (EC 269) (male, female, tetrasporangial); Kini Bay, 13-vi-1987 (EC 255), on *Cheilosporum cultratum* (male); Port Elizabeth, 31-iii-1987 (EC 152, 156), on *Stypopodium zonale* (Lamouroux) Papenfuss and *Sargassum* sp. (female, tetrasporangial); Bird Island, 20-viii-1987 (EC 402, 412) on *Amphiroa* sp. and *Laurencia* sp. at 1–3 m depth (male); Port Alfred,

Piano Rocks, 18-iii-1987 (EC 163), on *Dictyopteris macrocarpa* (Areschoug) Schmidt; Idem, 23-ix-1987 (EC 430), on *Phloiocaulon squamulosum* (female); Port Alfred, Sharks Bay, 17-iii-1987 (EC 107), on articulated corallines.

Callithamnion cordatum, not recorded for South Africa before, is relatively common along the East Cape Coast. Substrates from the groups of the brown algae and articulated corallines appear to be preferred. This species was originally described from the Caribbean (Boergesen, 1909), and is now known from the E. Pacific (Abbott & Hollenberg, 1976), S. Japan (Itono, 1977) and Australia (Cribb, 1983). The occurrence in South Africa therefore seems to indicate a worldwide distribution in tropical to warm-temperate areas. However, not all the descriptions make mention of the typical short-celled proximal part of the main axis (cf. Boergesen, 1909, fig. 5A), and some of the records may be in need of reexamination. On the other hand, the South African material differs from the original description in the significantly thicker apical cells (8 μm according to Boergesen).

***Callithamnion furcellariae* J. Agardh (Figs. 20, 21)**

Plants of rather open structure, lax; main axis not prominent, with little or no cortication. Main axis up to 100 μm in diameter, cells in proximal regions 1.5–2 times longer than broad, distally up to five times; cells often somewhat constricted. Laterals alternately to subdichotomously branched, ramuli sometimes with flagelliform tips that may develop into rhizoidal structures. Ultimate ramuli 15–25 μm in diameter.

Tetrasporangia adaxial on branchlets, one per cell, or two sporangia of different ages. Tetrasporangia ovate, up to 90 \times 60 μm .

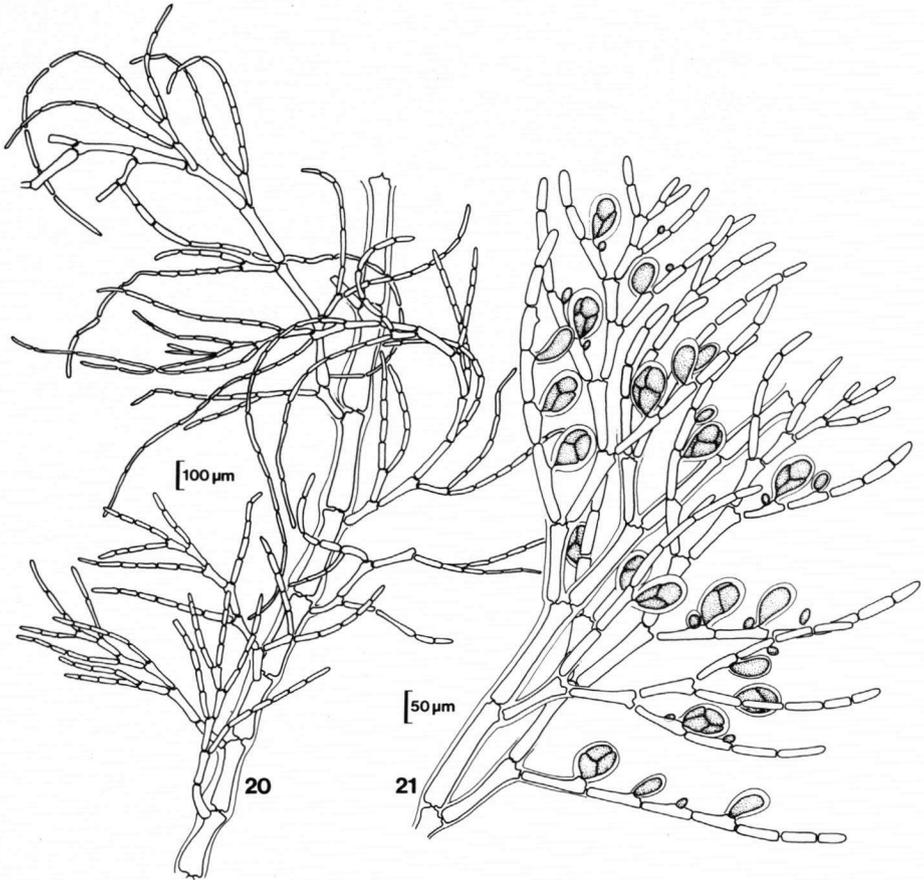
No other reproductive structures observed.

MATERIAL EXAMINED: Kenton on Sea, 2-xii-1987 (EC 468), on *Gracilaria beckeri* (J. Agardh) Papenfuss (tetrasporangial); Ciskei, Hamburg, 17-v-1987 (EC 221, 229), on articulated corallines and on *Gunnerea* (reef worm).

Not described from South Africa before, this species was known from the European N. Atlantic and the Mediterranean (e.g. Feldmann-Mazoyer, 1940). If *C. furcellariae* is a synonym of *C. byssoides* Arnott ex Harvey in Hooker (cf. Dixon & Price, 1981), then the distribution is much wider, also covering the North and South American Atlantic and the Caribbean (Taylor, 1960; Oliviera Filho, 1969).

***Callithamnion granulatum* (Ducluzeau) C. Agardh (Fig. 22)**

Plants up to 50 mm tall, with a prominent main axis and few well defined laterals. Main axis and laterals heavily corticated. Each segment with a determinate branchlet; determinate laterals stout, many times subdichotomously branched, 70–100 μm in diameter at the base, tapering to acute. Tetrasporangia in apical sections of the branchlets, ovate, c. 70 \times 55 μm . Spermatangial clusters hemispherical. Carposporophytes with rounded gonimolobes.



Figs. 20 & 21. *Callithamnion furcellariae*. – 20: Proximal part of thallus, with flagelliform ramuli (EC 229). – 21: Tetrasporangia (EC 229).

MATERIAL EXAMINED: Nature's Valley, 12-vi-1987 (EC 272), on *Phloiocaulon squamulosum* (Suhr) Geyler (tetrasporangial); Kini Bay, 13-vi-1987 (EC 256), on *Gelidium robustum* (Gardner) Hollenberg et Abbott (tetrasporangial); Three Sisters, 28-iv-1987 (EC 207), on *Arthrocardia* sp. (tetrasporangial); Idem, 11-viii-1987 (Sa 1640, EC 333), on *Sargassum* sp. and *Laurencia flexuosa* Kützing (male, female, tetrasporangial); Ciskei, Hamburg, 16-v-1987 (EC 233, 235), on *Hypnea spicifera* (Suhr) Harvey in J. Agardh; East London, East Beach, 20-xi-1987, on *Gelidium amansii* (Lamour.) Lamour. (female, tetrasporangial); East London, Bat's Cave, 9-ix-1987 (Sa 1727), on *Gelidium* sp. and *Cheilosporum cultratum* (Harvey) Areschoug in J. Agardh (male, tetrasporangial).

Callithamnion granulatum is a relatively common, though never abundant epiphyte along the East Cape coast. In many characters it resembles *Aristothamnion collabens*; the presence of tetrasporangia seems to be the only really discriminating feature, and for this reason its identity may have been mistaken in the past.

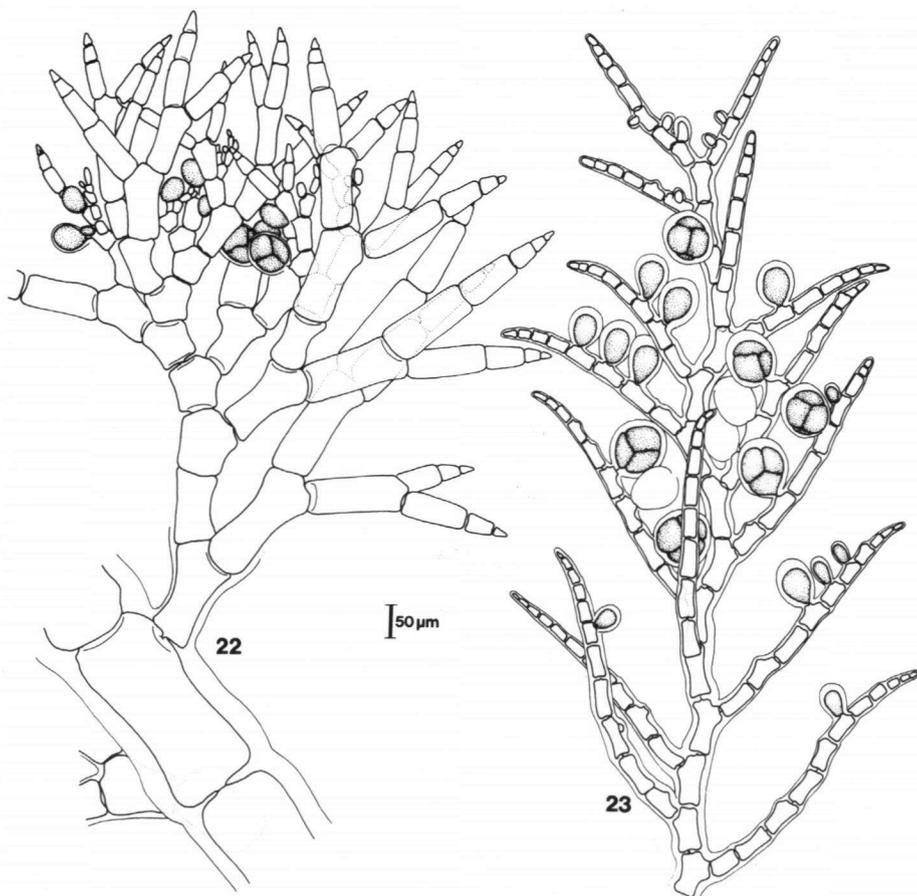
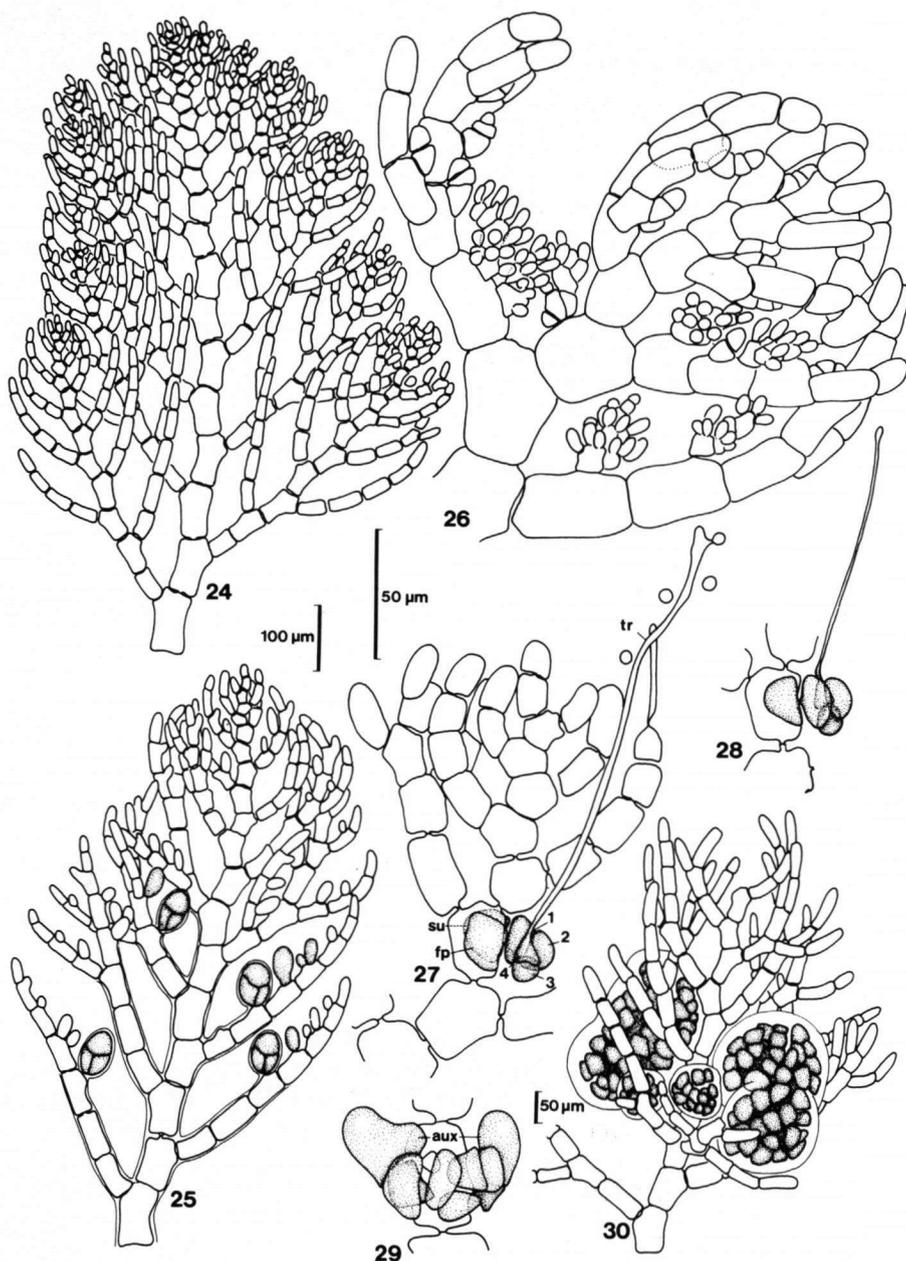


Fig. 22. *Callithamnion granulatum*, determinate branch with tetrasporangia (EC 333). — Fig. 23. *Callithamnion hookeri*, tetrasporangia (EC 316).

Callithamnion granulatum was so far known from the E. Atlantic, from N. Great Britain south to W. Africa (Lawson & John, 1982) and from Transkei (Bolton & Stegenga, 1987).

***Callithamnion hookeri* (Dillwyn) S.F. Gray (Fig. 23)**

For a full description of South African material, see Stegenga (1986). At the time the West Cape material was described, no mature tetrasporangia were known; they are commonly present in the East Cape material, occurring in second rows on the adaxial side of branchlets; tetrasporangia are nearly globular, measuring up to $80 \times 75 \mu\text{m}$.



Figs. 24–30. *Callithamnion tripinnatum*. – 24: Thallus apex. – 25: Tetrasporangia. – 26: Spermatangia. – 27–30: Procarp and development of carposporophyte. – Legend: aux = auxiliary cell, f. p = fertile pericentral cell, su = supporting cell, tr = trichogyne, 1, 2, 3, 4, = cells of carpogonial filament. – All material: EC 427.

MATERIAL EXAMINED: Three Sisters, 5-iii-1987 (Sa 1003, EC 23) (male, tetrasporangial); Idem, 27-vii-1987 (EC 316) (female, tetrasporangial); East London, Bat's Cave, 9-ix-1987 (Sa 1763, EC 362) (female, tetrasporangial).

On all occasions *C. hookeri* was found in the high intertidal, growing among *Bostrychia mixta* Hooker f. et Harvey, on (vertical) shaded rock walls. The present observations present an extension of the range of distribution into the Indian Ocean. *Callithamnion hookeri* was already known from E. Atlantic localities between N. Europe and S. Africa (Lawson & John, 1982; Wynne, 1986; Stegenga, 1986).

Callithamnion stuposum Suhr

For a description see e.g. Stegenga (1986). During the present study *C. stuposum* was found in every locality from Kenton on Sea eastward, and often abundantly, but not to the west of it. Hence, although the area of distribution is known to stretch from N. Natal (Wollaston, 1984) to just east of Cape Agulhas (Stegenga, 1986), *C. stuposum* is apparently primarily an east coast species.

Callithamnion tripinnatum C. Agardh (Figs. 24–30)

Plants small, up to 5 mm tall, consisting of a main axis with two or three orders of alternating laterals, all complanate. Main axis up to 100 µm in diameter, the cells in the proximal parts about as long as broad, in the distal parts twice as long as broad; apical cells of the ramuli c. 15 µm in diameter. Tetrasporangia in second series on the adaxial side of the ramuli in apical sections of the thallus, ovate, c. 70 × 50 µm (fig. 25). Spermatangia in identical positions as tetrasporangia; individual spermatangial stands with a 4- or 5-celled axis (fig. 26). Development of carpogonial filament and postfertilization typical of genus (figs. 27–30). Mature carposporophytes with rounded or rounded angular gonimolobes (fig. 30).

MATERIAL EXAMINED: Keurboomstrand, 11-vi-1987 (EC 286) (female); Port Alfred, Piano Rocks, 23-ix-1987 (Sa 1774, EC 427), on *Halimeda cuneata* Hering in Krauss (male, female, tetrasporangial); East London, East Beach, 19-xi-1987 (EC 442), on *Halimeda cuneata* (male, tetrasporangial).

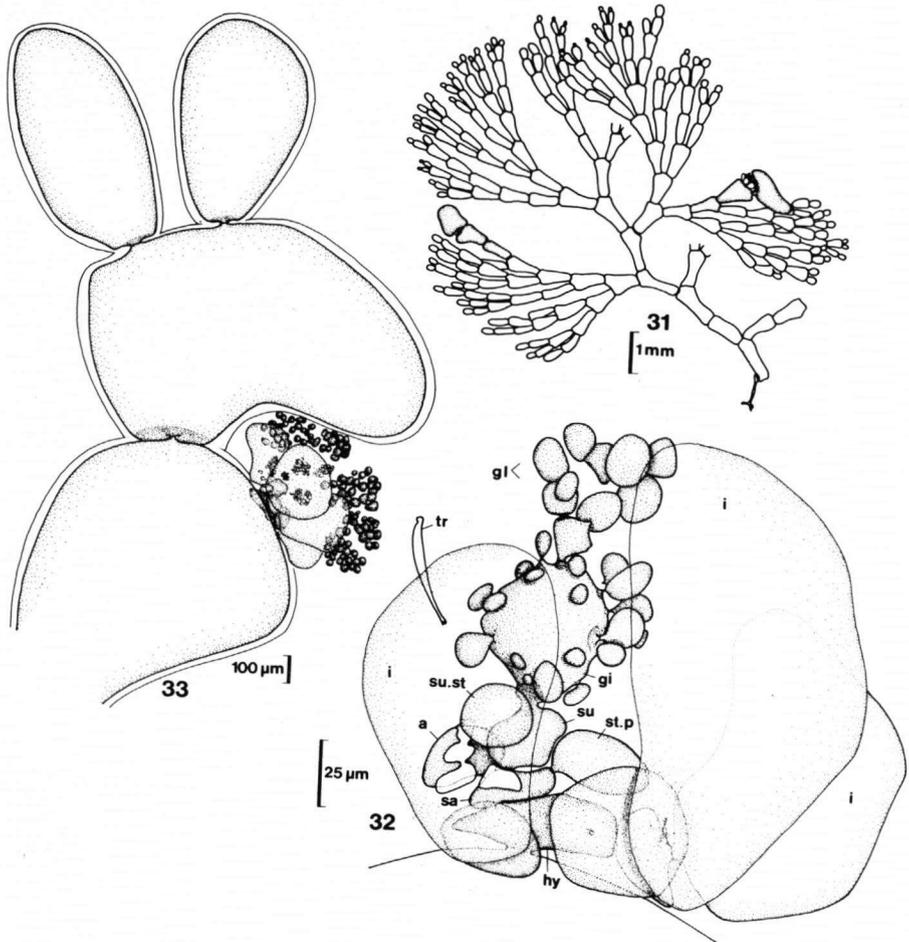
Callithamnion tripinnatum is sometimes considered as a possible synonym of *C. hookeri* (Dixon & Price, 1981), but in the East Cape they seem to represent quite distinct entities, differing primarily in the mode of branching. *Callithamnion tripinnatum* was found only in the sublittoral fringe, *C. hookeri* in the upper intertidal.

Callithamnion tripinnatum has been reported from the European Atlantic and the Mediterranean (e.g. Feldmann-Mazoyer, 1940).

Callithamnion sp.

For a full description of this as yet unidentified species, see Stegenga (1986).

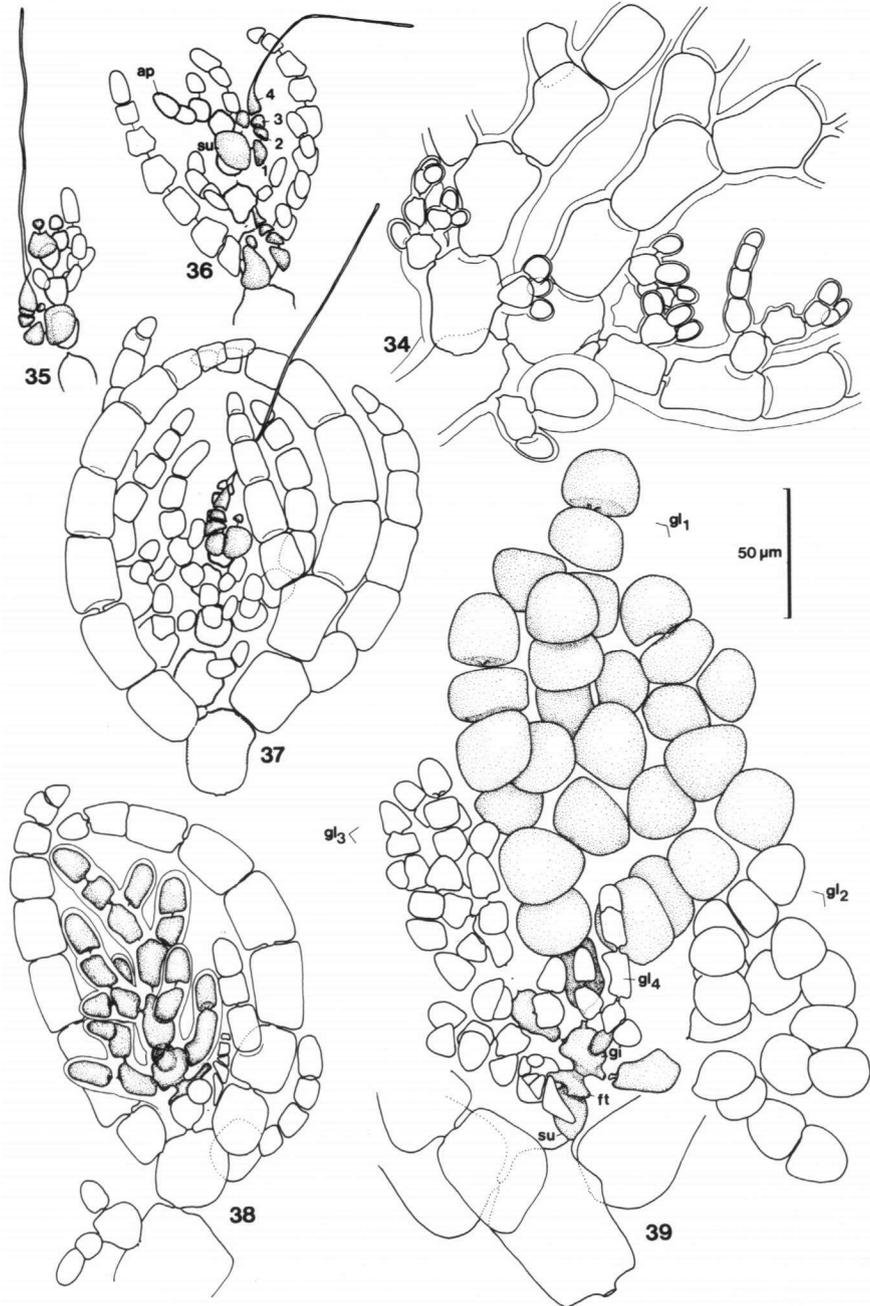
MATERIAL EXAMINED: Three Sisters, 5-iii-1987 (EC 12) (tetrasporangial); Ciskei, Hamburg, 16/17-v-1987 (female, tetrasporangial); East London, Bat's Cave, 9-ix-1987 (male, tetrasporangial).



Figs. 31–33. *Griffithsia subbiconica*, female reproductive structure. – 31: Habit of female plant with two developing carposporophytes (Sa 1812). – 32: Young carposporophyte; note numerous gonimolobe initials (EC 132). – 33: Mature carposporophyte (EC 1). – Legend: a = apical cell of fertile filament, gi = gonimoblast initial, gl = gonimolobe, hy = hypogenous cell, i = involucre filaments (apical cell of two-celled filament indicated), sa = subapical cell of fertile filament, st. p = sterile pericentral cell, su = supporting cell, su. st = sterile cell on supporting cell, tr = trichogyne.

Griffithsia subbiconica Stegenga (Figs. 31–33)

This species was described from the West Cape (Stegenga, 1986), and at the time only tetrasporangial and male plants were recorded. It is a relatively common and in certain places abundant species in the East Cape. It is now possible to give details on the morphology of the female reproductive structures:



Figs. 34–39. *Laurenciophila minima*, sexual reproduction. – 34: Spermatangia (EC 290). – 35–37: Thallus apices with carpogonial filaments (EC 290). – 38: Young carposporophyte; note filamentous gonimolobes (EC 265). – 39: Mature carposporophyte (EC 265). – Legend: ap = apical cell of vegetative axis, ft = foot cell, gi = gonimoblast initial, gl = gonimolobes (numbered in sequence of development), su = supporting cell, 1, 2, 3, 4 = cells of carpogonial filament.

Female plants are in habit and size not different from male and tetrasporangial plants (fig. 31). Female fertile filaments are usually borne on a swollen subapical cell (fig. 32). The fertile filaments are three-celled, consisting of an apical, a subapical and a hypogenous cell; the subapical cell bears a sterile and a fertile pericentral cell (= supporting cell); the supporting cell bears a sterile cell and a four-celled carposporogonial filament. Immediate post-fertilization developments were not found. The (young) carposporophyte (fig. 32) consists of a large gonimoblast initial, borne on the supporting cell; it gives rise to many gonimolobes (figs. 32, 33); no extensive cell fusions appear to take place in the carposporophyte. The carposporophyte is surrounded by 5 or 6 involucrel filaments borne by the hypogenous cell. Involucrel filaments are two-celled, consisting of a relatively small basal cell and an inflated apical cell, the upper cell up to $300 \times 300 \mu\text{m}$. As the carposporophyte develops, the vegetative cell above the cell bearing the fertile filament inflates and forms a sort of cap above the carposporophyte; this cell is often the terminal cell, but it may give rise to further vegetative cells (fig. 33); together with the involucrel filaments this cell forms an effective protection for the developing gonimolobes. Mature gonimolobes are up to $200 \mu\text{m}$ in diameter, individual carpospores c. $40 \mu\text{m}$.

MATERIAL EXAMINED: Kenton on Sea, 2-xii-1987 (Sa 1949); Port Alfred, Piano Rocks, 18-iii-1987 (Sa 1194); Idem, 23-ix-1987 (Sa 1812); Port Alfred, Sharks Bay, 17-iii-1987 (EC 129, 132) (female); Idem, 10-vi-1987 (Sa 1536) (female, tetrasporangial); Three Sisters, 5-iii-1987 (EC 1, 2) (female, tetrasporangial); Idem, 28-iv-1987 (Sa 1235, EC 179, 187) (tetrasporangial); Idem, 11-viii-1987 (Sa 1600) (tetrasporangial); East London, East Beach, 19-xi-1987 (Sa 1845) (tetrasporangial); East London, Bat's Cave, 9-ix-1987 (Sa 1674, 1747).

The morphology of the carposporophyte with its numerous gonimolobes, and the peculiar shape of the vegetative cell forming a cap above the carposporophyte seem to be distinctive of this species. The development of the carposporophyte and the origin of the involucrel filaments reconfirm its place in the *Griffithsia corallinoides*-group (Baldock, 1976 – also called *G. monilis*-group, Baldock, l.c.: 516).

The presently known range of distribution of this species, i.e. the South African coast between Cape Agulhas and East London (and probably some way further east), indicate that *G. subbiconica* is a typical south coast element; material in the M. A. Pocock collection comes from localities ranging from Swartklip (False Bay) to East London. This species is most abundantly found in light-reduced localities, although it was not found in the deeper sublittoral samples at my disposal. Inside Bat's Cave it was found in dense stands as high as 1 m above low tide mark, in other localities under overhanging rocks. In most cases the material was fertile, tetrasporophytes being more abundant than gametophytes.

Laurenciophila minima Stegenga (Figs. 34–39)

This species was described from the western Cape Province, as a semi-endophyte of *Laurencia flexuosa* (Stegenga, 1986). At the time only tetrasporangial plants were known. Along the East Cape coast this species has been found on several occasions, always growing on *Laurencia* spp., but not only *L. flexuosa*. There is now also in-

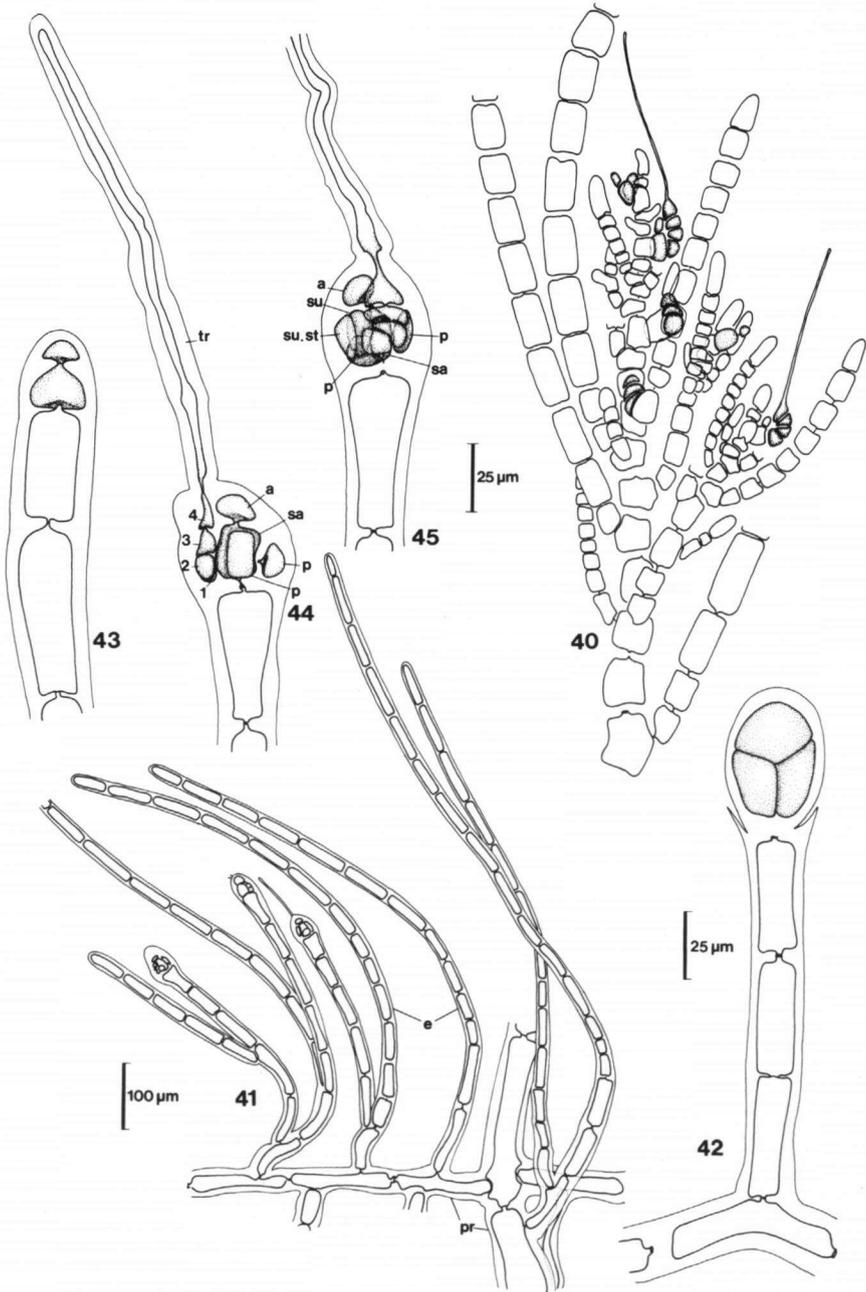


Fig. 40. *Callithamniella capensis*, thallus apex with carposogonial filaments (EC 446). — Figs. 41–45. Spermiothamnieae indet. — 41: Habit of female plant. — 42: Tetrasporangium. — 43–45: Development of procarp. — Legend: a = apical cell of fertile filament, e = erect filament, p = pericentral cell, pr = prostrate filament, sa = subapical cell of fertile filament, su = supporting cell, su.st = sterile cell on supporting cell, 1, 2, 3, 4 = cells of carposogonial filament. — All material: EC 101.

formation on male and female structures available, and hence more conclusive evidence with regard to taxonomic affinities.

Plants were often found to bear reproductive structures of both sexes on one and the same thallus; in cases these plants also bore tetrasporangia, an interesting phenomenon that has no explanation so far.

Male structures occur in the form of small 'stichidia', often not more complex than one spermatangium mother cell with three or four terminal spermatangia, sometimes consisting of a few-celled axis with more numerous spermatangia (fig. 34). Stichidia are borne on a number of proximal cells of the branchlets.

Female structures are formed a little below thallus apices; specialized two-celled branchlets, consisting of a normal-sized basal cell and a very small apical cell, develop at intervals of circa two segments on the apical sections of the indeterminate axes (figs. 35–37). The basal cell of this branchlet acts as a supporting cell, giving rise to a four-celled carpogonial branch (fig. 36). The post-fertilization stages are typical of members of the Heterothamnieae and for instance completely comparable with *Antithamnionella* (cf. Wollaston, 1968; Stegenga, 1986). The gonimoblast initial, borne on top of a flattened foot cell (fig. 39), gives rise to four or five gonimolobes of different ages. Gonimolobes are at first of an open filamentous construction, and even in mature structures carpospores can be found lying in chains (fig. 39). Virtually all cells of the gonimolobes turn into carpospores, which are rounded angular, up to 30 μm in diameter. No special involucre structures are formed, but the carposporophyte is surrounded by branchlets from the fertile main axis cell and the segments below.

MATERIAL EXAMINED: Keurboomstrand, 11-vi-1987 (EC 290), on *Laurencia flexuosa*; Nature's Valley, 12-vi-1987 (Sa 1430, EC 265), on *Laurencia flexuosa* and *L. natalensis* Kylin; Bird Island, 19-viii-1987 (EC 405), on *Laurencia obtusa* (Hudson) Lamouroux, from 2–3 m depth; Port Elizabeth, 31-iii-1987, on *Laurencia flexuosa* and *L. natalensis*; Port Alfred, Sharks Bay, 17-iii-1987 (EC 106, 117, 118), on *Laurencia flexuosa* and *L. natalensis*; material was on most occasions fertile, both sexual and tetrasporic.

The female pre- and post-fertilization structures of *L. minima* firmly put this species in the tribe Heterothamnieae, as suspected earlier (Stegenga, 1986). The geographical range is now known to stretch from Infanta to Port Alfred, and it seems safe to call *L. minima* a typical south coast element. The range of substrates is extended to other species of *Laurencia*, i.e. *L. natalensis* and *L. obtusa*.

Spermothamnieae indet. (Figs. 41–45)

Plants caespitose, consisting of branched prostrate filaments, virtually every cell provided with an unbranched erect filament. Cells of the prostrate filaments 25–50 μm in diameter, 2–3 times longer than broad, many cells provided with unicellular haptera. Erect filaments up to 1 mm long, unbranched, fairly uniformly 20–25 μm in diameter, the cells cylindrical, 2.5–5 times longer than broad.

Tetrasporangia single, terminal on short erect filaments, c. 45 \times 32 μm , tetrahedrally divided.

Male structures unknown.

Female fertile filaments two-celled, terminal on erect axes, the subapical cell with three pericentral cells; one pericentral cell, the supporting cell, with a sterile cell and a four-celled carpogonial filament. No post-fertilization structures observed.

MATERIAL EXAMINED: Port Alfred, Sharks Bay, 17-iii-1987 (EC 101), on *Pyura stolonifera*, washed ashore (female, tetrasporangial).

Generic placement of this species must remain uncertain, as post-fertilization structures are absent. Depending on whether one or two auxiliary cells are formed, and whether or not involucrel filaments develop after fertilization, this species could be placed in *Ptilothamnion* (one auxiliary cell, involucrel filaments present) or *Gordoniella* (two auxiliary cells, involucrel filaments absent). Other genera of the Spermiothamnieae usually have a more distinct hypogenous cell and sometimes subhypogenous cell, but it is not certain that this character has any value at generic level.

Ptilothamnion subsimplex Gordon, recorded from Transkei (Bolton & Stegenga, 1987), differs from the present species by its relatively shorter cells, while involucrel filaments start developing prior to fertilization. In the present material no trace of involucrel filaments was found. Also, in *P. subsimplex* tetrasporangia are sessile and lateral, not terminal.

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