

# The genus *Trematocarpus* (Sarcodiaceae, Rhodophyta) in southern Africa and the exclusion of *Sphaerococcus* (*Chondrus*) *scutellatus*

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## ABSTRACT

*Trematocarpus* Kützinger in southern Africa is found to comprise four taxa in three species: newly described is *T. fragilis* (Ag.) De Toni var. *divaricatus* Simons, var. nov. Two of the species, *T. flabellatus* (J. Ag.) De Toni and *T. affinis* (J. Ag.) De Toni are restored to independent specific rank after being regarded as synonyms of *T. scutellatus* (Her.) Searles. It is shown that *Sphaerococcus* (*Chondrus*) *scutellatus* Her., the basionym of *T. scutellatus* refers to a species of *Gigartina*, therefore a new combination *Gigartina scutellata* (Her.) Simons is made for this species which was formerly known as *G. fastigiata* J. Ag. and *G. scabiosa* (Kütz.) Papenf. *Trematocarpus elongatus* Kütz. is relegated to synonymy under *T. fragilis* var. *divaricatus*.

## RÉSUMÉ

### LE GENRE TREMATOCARPUS (SARCODIACEAE, RHODOPHYTA) EN AFRIQUE DE SUD ET EXCLUSION DE SPHAEROCOCCUS (CHONDRUS) SCUTELLATUS

*Trematocarpus* Kützinger comprend désormais en Afrique de Sud quatre taxa répartis en trois espèces: *T. fragilis* (Ag.) De Toni var. *divaricatus* Simons est nouvellement. Deux des espèces *T. flabellatus* (J. Ag.) De Toni et *T. affinis* (J. Ag.) De Toni, sont replacées chacune à un rang spécifique, après avoir été considérées comme synonymes de *T. scutellatus* (Her.) Searles. Il est démontré que *Sphaerococcus* (*Chondrus*) *scutellatus* Her., basionyme de *T. scutellatus*, se rapporte à une espèce de *Gigartina*; par conséquent, une nouvelle combinaison, *Gigartina scutellata* (Her.) Simons, est faite pour cette espèce qui était antérieurement connue sous les noms de *G. fastigiata* J. Ag. et *G. scabiosa* (Kütz.) Papenf. *Trematocarpus elongatus* Kütz. est placé en synonymie de *T. fragilis* var. *divaricatus*.

Schmitz (1889) lectotypified *Trematocarpus* Kütz. by *T. dichotomus* Kütz. from the Peruvian coast, at the same time citing *Dicurella* J. Ag. as its synonym, but making no specific transfers from *Dicurella*. These were made in 1900 by De Toni. Three species from South Africa were then recognized, namely *T. fragilis* (Ag.) De Toni, *T. flabellatus* (J. Ag.) De Toni and *T. affinis* (J. Ag.) De Toni. Kylin (1932, 1956), however, reinstated *Dicurella* J. Ag. as a separate genus with *D. fragilis* (Ag.) J. Ag. as lectotype, on the grounds that the anatomical details differed. In his earlier publication, Kylin (1932) suggested that *D. flabellatus* J. Ag. and *D. affinis* J. Ag. were conspecific, a view confirmed by Papenfuss (1940), who combined them under *D. scutellata* (Her.) Papenf.

More recently, Searles (1969) supported Schmitz's concept of *Trematocarpus*, reintroducing *T. fragilis* (Ag.) De Toni. *T. flabellatus* and *T. affinis*, however, he identified with *T. scutellatus* (Her.) Searles, therefore following Papenfuss's precedent.

My studies have, however, convinced me that *T. flabellatus* (J. Ag.) De Toni and *T. affinis* (J. Ag.) De Toni do indeed have separate status and that *T. scutellatus* (Her.) Searles is attributable to another genus. I have found, too, that there are forms assignable to *Trematocarpus* that do not fit any of the published descriptions except, perhaps, that of *T. elongatus* Kütz., which was described (Kützinger, 1868) as having come from the Pacific Ocean. I discovered the representative collections of *T.*

*elongatus* in the Leiden Rijksherbarium (NBV) and these are Pappe specimens collected at the Cape of Good Hope. *T. elongatus* Kütz. is quite clearly identifiable with *T. fragilis* (Ag.) De Toni and more particularly with what I regard as a new variety of this species, and that I here describe as *T. fragilis* var. *divaricatus* Simons, var. nov. *Trematocarpus*, as interpreted by Searles (*l.c.*), is basically cellular in structure and the fusion-cell of the cystocarps forms a complex network. I have found that the South African representatives assigned to *Trematocarpus* have these characters and, although the internal cells of terminal portions of both *T. flabellatus* and *T. fragilis* var. *divaricatus* are somewhat loosely associated, they are more compacted than are those of *T. dichotomus* specimens I have seen. It is possible that a separation of *Dicurella* and *Trematocarpus* is justifiable, but I hesitate to do so without better evidence. Figs 1–4 illustrate structures of the respective South African taxa. Cystocarps are hemispherical with an ostiole making a minute apical pore.

The identity of *Sphaerococcus* (*Chondrus*) *scutellatus* Hering seemed to have been resolved by Papenfuss (1940) when he found a specimen bearing this name in Herbarium Hamburgense (HBG) (Fig. 5). Not only did the specimen bear Hering's name, but also a description in Hering's own hand, little different from that published (Hering, 1841; Krauss, 1846); two specimens were apparently present, one fertile the other sterile (Papenfuss, *l.c.*) as was inscribed by Hering on the sheet. The evidence for supposing that the original Hering specimen of *S. (C.) scutellatus* had been traced seemed therefore to be complete and irrefutable. Having established that the relevant plant was, in his opinion, a *Dicurella*

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and that it was to be equated with the later names *D. flabellata* J. Ag. and *D. affinis* J. Ag., Papenfuss relegated these to synonymy of *Dicurella scutellata* (Her.) Papenf. My own researches led me to distinguish once again between the two J. Agardh taxa, so that it became necessary for me to decide to which of the two the combination *D. scutellata* should be applied. This could only be resolved by seeing and examining the type of *D. scutellata* sensu

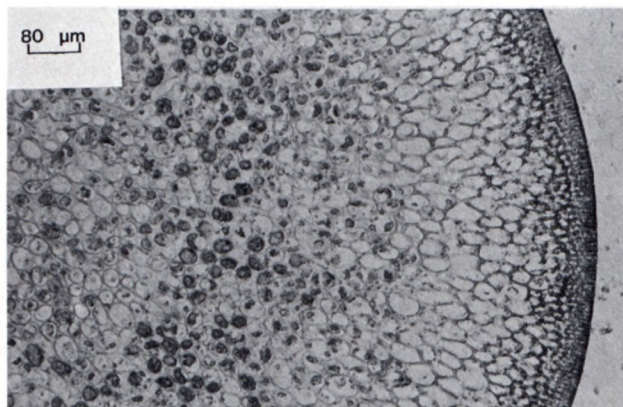


FIG. 1. — *Trematocarpus fragilis* var. *fragilis*. T. S. through a mature portion of an axis.

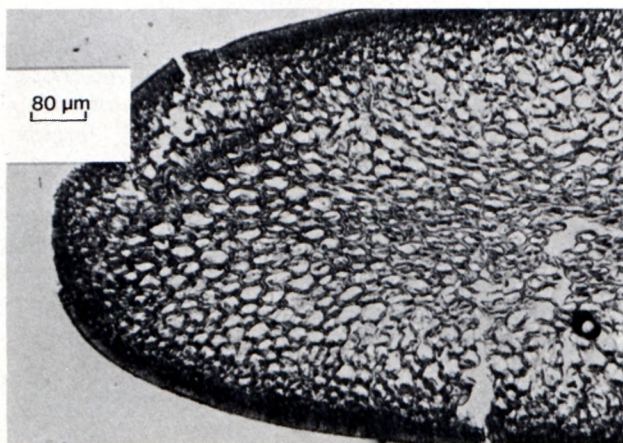


FIG. 2. — *Trematocarpus fragilis* var. *divaricatus* T. S. through a mature portion of an axis.

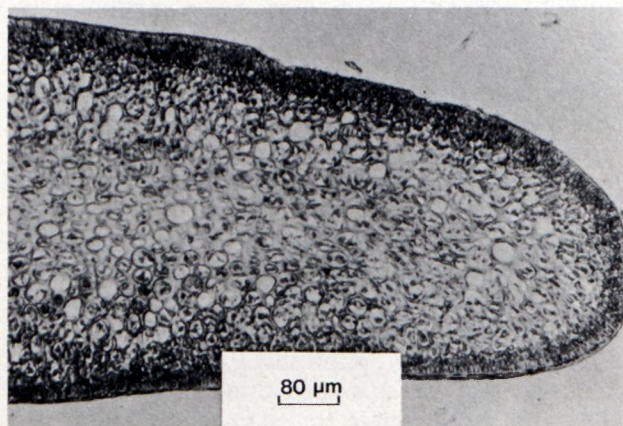


FIG. 3. — *Trematocarpus flabellatus*. T. S. through a mature portion of an axis (Simons 5245)

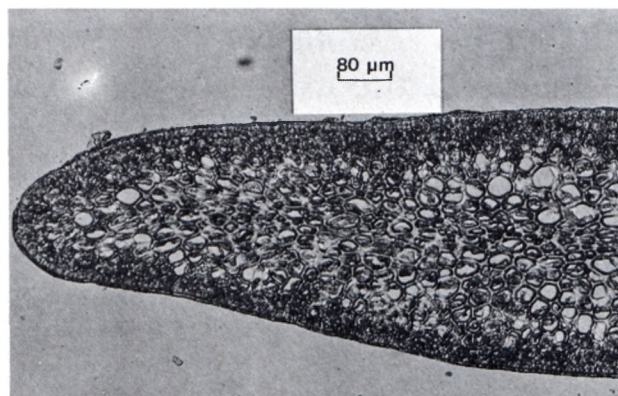


FIG. 4. — *Trematocarpus affinis*. T. S. through a mature portion of an axis.

Papenfuss. This I managed with the help of Dr. G. F. Papenfuss among others, but was disappointed to find only fragments of the relevant material. Nevertheless, I was able to ascertain that all the fragments were of a kind and probably came from the same plant, a tetrasporophyte, and that this plant is probably the same as that seen by Papenfuss, who described (*l.c.*) 'seriately divided tetrasporangia'. This was significant, because the inscription on the sheet included a reference to two specimens 'exempl. sterile et fructiferum'; and also to 'capsulis sphaericis'. The tetrasporangiferous specimen might easily be thought to be sterile, since there is no obvious evidence of fruiting, whereas a cystocarpiferous plant would not escape such notice, and it could well be carrying 'capsulis sphaericis' in the manner of so many Red Algae. I immediately suspected that the 'fruiting' specimen had been misplaced, but diligent searching on the part of the staff at HBG failed to produce it, and it must be accepted that the present sheet is incomplete. This would have no importance were it not for the fact that Barton (1896) identified the fruiting plant as *Gigartina fastigiata* J. Ag. In itself this is not enough to justify the view that the Hering mount contained two different taxa, but this opinion becomes undeniably weighted when Barton's (*l.c.*) statements are considered; she states unequivocally that the fruiting specimen = *G. fastigiata* J. Ag. is 'quite different' from the sterile one which has the 'whole interior filled with roundish, thick-walled cells'. Such an interior characterizes the specimen that Papenfuss saw ('the plant is entirely cellular') and the fragments of the plant now associated with the Hering specimen. Since the Hering description applies more appropriately to the missing fruiting specimen = *Gigartina fastigiata* J. Ag., especially with respect to the cystocarps with their scutellate ostioles, the epithet cannot justifiably be assigned to what Papenfuss and I recognize as belonging in *Dicurella* J. Ag. On the contrary, *G. fastigiata* J. Ag. and *G. scutellata* (Hering) Simons are to be regarded as synonyms; the Hering name is the earlier and therefore becomes the correct name for the taxon. This combination replaces *G. scabiosa* (Kütz.) Papenf., which substituted for *G. fastigiata* J. Ag., an illegitimate later homonym.

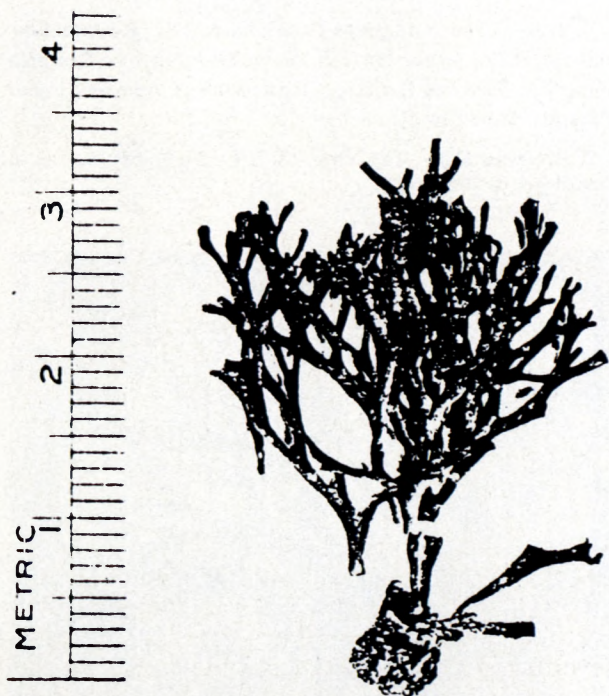


FIG. 5. — *Dicurella scutellata*. 'Type' of *Sphaerococcus* (*Chondrus*) *scutellatus* Hering in Herb. Hamburg: copy of a photograph of the sterile plant fragments associated with the Hering MS description of *S. (C.) scutellatus* as seen by Dr G. F. Papenfuss and referred to in his paper (Papenfuss, 1940).

### *Gigartina scutellata* (Her.) Simons, comb. nov.

*Sphaerococcus* (*Chondrus*) *scutellatus* Hering in Ann. Mag. Nat. Hist. 8: 91 (1841); Krauss (as *Chondrus scutellatus*) in Flora, Regensb. 29: 210 (1846); non Kütz., Sp. Alg.: 736 (1849); Tab. Phyc. 17: 16, t. 56 (1867) = *Polyopes constrictus* (Turn.) J. Ag. Neotype: Cape, 3217 (Vredenburg); Klein Paternoster Bay (—DD), Simons 452 (Seaweed Research Unit, Sea Fisheries Institute, Department of Agriculture and Fisheries, Cape Town).

*Gigartina fastigiata* J. Ag. in Vet.-Akad. Handl. 6: 86 (1850; dated 1849); Sp. Alg. 2: 276 (1851); Sp. Alg. 3: 193 (1876); non Postels et Rupr. (1840).

*Chondrus scabiosus* Kütz., Tab. Phyc. 17: 19, t. 63a—b (1867); *Gigartina scabiosa* (Kütz.) Papenf. in JI S. Afr. Bot. 9: 88 (1943).

This species is a common constituent of the intertidal flora of the whole Benguela System that washes the west coast of the Cape Province of South Africa. Its dichotomously branched axes present a similar appearance to those of *Trematocarpus*, but they are generally more fleshy in the fresh state, and either a deeper purple or a brownish-yellow.

***Trematocarpus fragilis* (Ag.) De Toni, Syll. Alg. 4: 417 (1900);** Searles in Phycologia 8: 26 (1969). Lectotype: Cap. bon. Spei (Cape Province, South Africa), *De La Lande* s.n. sub Agardh Herb. No. 28674 (LD).

Tufts of many erect wiry fronds up to 300 mm high, emerging from a disciform holdfast; fronds scarcely branched in the lower half, thereafter dichotomising subflabellately at progressively shorter intervals and attenuated to bluntly rounded or subacute tips.

Two varieties are here distinguished for the first time.

### (a) var. *fragilis*

*Sphaerococcus fragilis* Ag., Sp. Alg. 1: 253 (1824). *Dicurella fragilis* (Ag.) J. Ag., Sp. Alg. 2: 630 (1852); Sp. Alg. 3: 406 (1876); Searles in Univ. Calif. Publ. Bot. 43: 69 (1968). *Chondrus fragilis* (Ag.) Grev., Alg. Brit. 55 (1839); Kütz., Sp. Alg.: 738 (1849).

*Gigartina flabellata* Kütz., Sp. Alg.: 751 (1849); Tab. Phyc. 18: 2, t. 5 (1868).

*Dicurella elatior* Harv., Ner. Austr. t. 50 (1847). nom. nud.

Specimens incorrectly determined: *Ahnfeltia elongata* Kütz. in Herb. NBV sub Herb. Lugd. Bat. 939,6. . .100; ibid. as *Dicurella scutellata* (Her.) Papenf.; *Gelidium fastigiatum* Kütz.: Hohenacker 1860 sub Herb. Lugd. Bat. 938,334. . .141 (non Hohenacker 475a 1860 and 475a.c. sub Herb. Lugd. Bat. 938,334. . .143 = *Trematocarpus flabellatus* (J. Ag.) De Toni).

This variety (Fig. 6) has long axes, up to 300 mm, that are fairly rigid and branched in the distal half only. Branching is dichotomous-subflabellate with internodes becoming progressively shorter distally. The axils are more or less rounded and the ultimate segments look like the prongs of a hay-fork, that is, widely divergent at first, then becoming more or less parallel. The often entirely terete axes may in some specimens be somewhat compressed, but there is always a terete stipe and the ultimate segments are little, if at all, compressed.

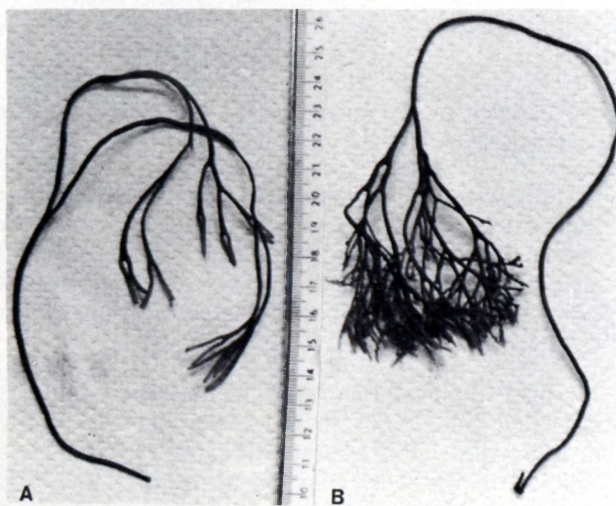


FIG. 6. — *Trematocarpus fragilis* var. *fragilis*. Whole plants: A, non-cystocarpiferous; B, cystocarpiferous.

The epidermal layer consists almost always of more or less cylindrical cells, with the long axes vertical to the surface, and up to four times longer than wide. Although entirely cellular (in transverse section), there is tissue differentiation into epidermis, outer cortex, inner cortex and medulla. The medulla can, when axes are terete, occupy up to half the sectional area, and consists of cells markedly variable in cross-sectional shape, but they are generally smaller than those surrounding them. The outer cortex contains two or three rows of roughly isodiametric cells, inside which is an inner cortex filled with coffin shaped cells whose long axes are at

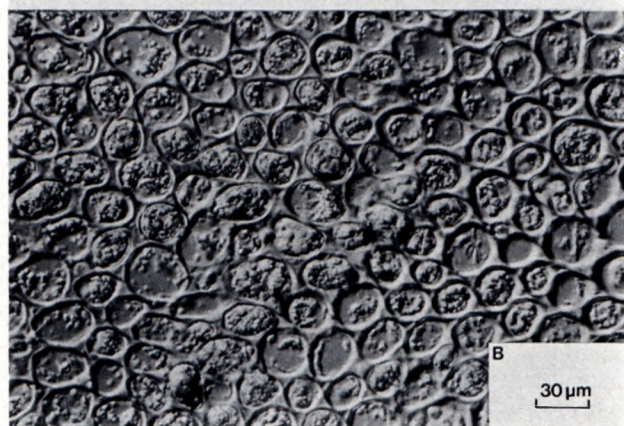
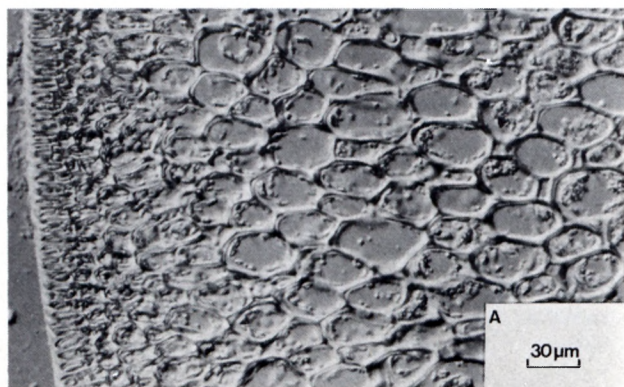


FIG. 7. — *Trematocarpus fragilis* var. *fragilis*. T. S. of mature portion of an axis: A, outer tissues; B, inner core.

right-angles to the surface. Fig. 7A & B show the various tissues.

Cystocarpiferous plants are often remarkable for their more slender distal segments so that the cystocarps, which in any case are rather prominent, appear disproportionately large. Tetrasporangia occur in pseudonemathecia that more or less cover terminal and subterminal segments.

This is mainly sublittoral but, not infrequently, it grows in tidal pools in the lower reaches of the littoral zone. It is characteristic of the Benguela System on the west coast of southern Africa and does not, as far as I know, reach east of Cape Agulhas. There is a record, via Suhr (1834), of *Halymenia furcellata* var. *cartilaginea* (= *Dicurella fragilis*, fide J. Agardh, 1852) from Algoa Bay (= Port Elizabeth), a locality well east of Cape Agulhas; unlike J. Agardh, I am of the opinion that the plant in question is *Trematocarpus flabellatus*, because, not only does Port Elizabeth lie beyond the known range of the plant but the illustration by Suhr (*l.c.*, t. 22, f. 16) shows what looks like a sorus typical of *T. flabellatus* (*q.v.*), a species known to occur as far east as Port Elizabeth. I have, therefore, excluded *Halymenia furcellata* var. *cartilaginea* Suhr from the synonymy of *T. fragilis* and placed it with *T. flabellatus*.

(b) var. ***divaricatus*** *Simons* var. nov., a typo thallo suo complanato, saepe ad apices submembranaceo et contorto, ramis divergentibus, differt. (Fig. 8).

TYPE.— Cape, 3318 (Cape Town): Oudekraal (= Hottentotshuisie) (—CD), *Jarman s.n. sub Simons 4994* (Seaweed Research Unit, Sea Fisheries Institute, Department of Agriculture and Fisheries, Cape Town).

*T. elongatus* Kütz., Tab. Phyc. 18: 2, t. 4d-g (1868); Searles in *Phycologia* 8: 26 (1969).



FIG. 8. — *Trematocarpus fragilis* var. *divaricatus* var. nov. Portion of a tuft sharing the same discoid holdfast.

The most remarkable differences between this variety and the typical variety are the flattened thallus and divergent forking at dichotomies, a characteristic that is not invariable. One or two branchings frequently occur in the proximal half. I have seen and collected many examples of this variety at Bakoven just a kilometre or two north of Hottentotshuisie. It seems always to be submerged at least 2 m below mean sea level. Anatomically there are slight differences between the two varieties such as the rather laxer tissues of var. *divaricatus* in the ultimate segments, but these are less obvious when comparing the respective female vegetative tissues; the pericarps making up the protective walls of cystocarps, however, seem to be distinguishable. Fig. 2 shows the main feature of the mature tissue-disposition of this variety.

The two taxa that Papenfuss (1940) sank under *Dicurella scutellata* (= *Trematocarpus scutellatus* sensu Searles), namely *D. flabellata* and *D. affinis*, are in fact distinguished from each other in the features detailed by J. Agardh (1852 and elsewhere). The differences are more subtle than they are obvious: branching in both is dichotomous in one plane and the plants are much the same height. *T. flabellatus*, though, is dorsiventral (Fig. 9) against the bilateral symmetry of *T. affinis* (Fig. 10): not only is this true of the vegetative axes, but it applies also to the distribution of the sori, both male and tetrasporangial. In *T. flabellatus* the segments are plano-convex in section and the sori confined to the plane surface, whereas in *T. affinis* sori discontinu-

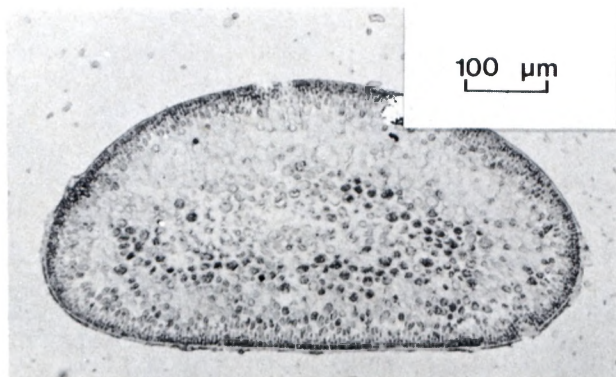


FIG. 9. — *Trematocarpus flabellatus*. T. S. through terminal segment showing plano-convex character of the thallus.

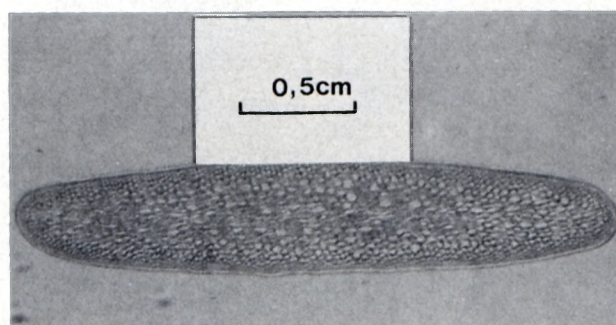


FIG. 10. — *Trematocarpus affinis*. T. S. through terminal segment showing bilateral character of the thallus.

ously coat the surface of fertile segments usually causing some distortion of the affected parts.

***Trematocarpus flabellatus* (J. Ag.) De Toni**, Syll. Alg. 4: 418 (1900). Lectotype: Cape, 3318 (Cape Town); Sea Point (—CD), *Harvey s.n. sub Agardh Herbarium* Nos. 28689 (Fig. 11) & 28690 as *Dicurella flabellata* J. Ag.

*Phyllotylus flabellatus* J. Ag. in Vet. -Akad. Öfvers. 4: 9 (1847). *Dicurella flabellata* Harv. t. 50 (1847). nom. nud., J. Ag., Sp. Alg. 2: 632 (1852); J. Ag., Sp. Alg. 3: 407 (1876).

*Halymenia furcellata* var. *cartilaginea* Suhr in Flora 17: 733 (1834).

*Trematocarpus polychotomus* Kütz., Sp. Alg.: 785 (1849); Tab. Phyc. 19: 27, t. 73 (1869).

*Gelidium fastigiatum* Kütz., Tab. Phyc. 18: 21, t. 61a–b (1868).

*Dicurella scutellata* Papenf. (1940), in part; *Trematocarpus scutellatus* Searles (1968), in part.

This species commonly occurs in tidal pools forming low-growing (up to 80 mm, rarely more) magenta-coloured compound fan-like tufts that are distinctive and very pretty. The fans are slightly retrorse. Although more typically a Benguela System (i.e. west coast) species, some collections have come from as far east as Port Elizabeth.

Ultimate segments of the axes are subspatulate (Fig. 12) with a convex surface often on the dorsal side, i.e. back of the upward-facing surfaces of the slightly arched lobes of the fan. The other surface is either plane (Fig. 9) or very little concave. The linear sori make a raised pad of tissue on the



FIG. 11. — *Trematocarpus flabellatus*. Agardh Herb. No. 28689 in Lund. Herb. (LD) — part of type material.

non-convex surface, disposed in such a manner as to leave a sterile surround at the margins. Only the most distal segments are involved. Male sori are yellowish and, therefore, distinctive.

Epidermal cells are usually cylindrical, being anticlinally elongated. The central tissue is composed of more or less large, and angled cells in which there may be a core of distinctly smaller cells buried in a thick matrix (Fig. 3).

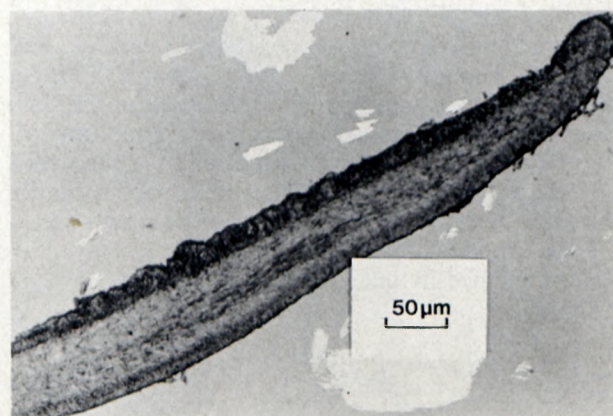


FIG. 12. — *Trematocarpus flabellatus*. Agardh. Herb. No. 28690 in Lund. Herb. (LD) — part of type material. L. S. through a terminal segment that is tetrasporiferous. Note subspatulate character, and sorus on one surface only.

I have found anomalous forms, some with sori containing only undivided sporangia (?monosporangia) that suggest immature tetrasporangia and others with parts having morphological and anatomical features similar to those of *T. affinis*. Monospores are not unusual features of many Red Algae and these are variously interpreted. In this instance, their production is sometimes associated with the vegetative anomalies mentioned above. I consider these forms to be hybrids involving *T. flabellatus* and *T. affinis* as parents.

***Trematocarpus affinis* (J. Ag.) De Toni Syll.** Alg. 4: 419 (1900). Type: Cap. bon. Spei (= Cape Province, South Africa). *Pappe* sub Agardh Herb No. 28695 (as *Phyllotylus affinis* J. Ag.) LD; authenticated representative material: *Phyllotylus affinis* J. Ag. 25. CBS Tabelbay in Herb. Binder (HBG) (vid. J. Ag., Sp. Alg. 2: 632, 1852).

*Dicurella affinis* J. Ag., Sp. Alg. 2: 632 (1852); Sp. Alg. 3: 407 (1876). *Phyllotylus affinis* J. Ag. ms. in Herb. LD & HBG, nom. nud.

*Dicurella scutellata* Papenf. (1940) in part and the specimen associated with the ms. name of *Chondrus scutellatus*/*Sphaerococcus* in Herb. HBG; Searles (1968), in part; *Trematocarpus scutellatus* Searles (1969), in part.

This species is quite a frequent constituent in samples of seaweeds dived out in Cape west coast waters as much as 15 m deep. It does, however, approach the intertidal zone, where, I think, a certain amount of natural crossing with *T. flabellatus* takes place. Its general appearance is very similar to that of *T. flabellatus*. Its naviculoid cross-sections (Fig. 10) and its tissue-construction and distribution, nevertheless, distinguish it from that species: epidermal cells are often cuboid (Fig. 13A), whereas the medulla occurs as scarcely more than a median plate of flattened cells (Fig. 13B); cortex consists of more or less isodiametric round-angled cells that may become slightly flattened parallel with the surface; sori more or less surround terminal and subterminal segments and their uneven distribution leads to some superficial distortion.

#### ACKNOWLEDGEMENTS

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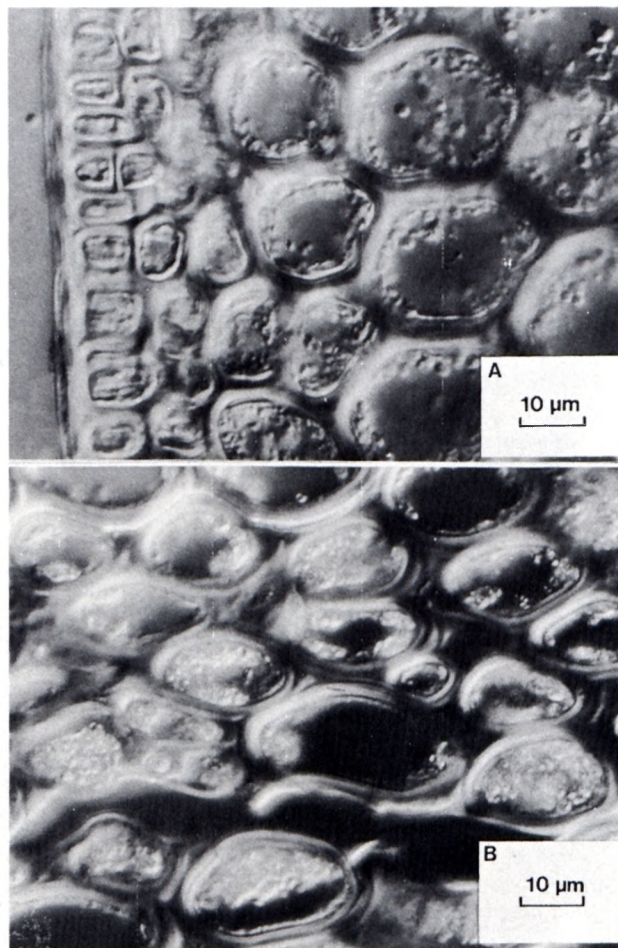


FIG. 13. — *Trematocarpus affinis*. T. S. of terminal segment: A, outer tissues; B, core tissue — cells are flattened in the plane of flattening of the thallus.

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