

ADDITIONS TO THE MARINE ALGAL FLORA OF CURAÇAO, NETHERLANDS ANTILLES¹

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SUMMARY

Nine species of benthic marine algae are reported from the Caribbean island of Curaçao for the first time: Chlorophyta: *Derbesia marina* and *Trichosolen longipedicellata*; Phaeophyta: *Ectocarpus rhodochortonoides*, *Feldmannia elachistaeformis*, *Hecatonema floridanum*, *Herponema tortugense* and *Sphacelaria novae-hollandiae*; Rhodophyta: *Polysiphonia scopulorum* and *Polysiphonia sphaerocarpa*.

The Curaçao algal flora, with at present about 350 species recorded with reasonable certainty, equals some of the richest known areas in the Caribbean.

INTRODUCTION

The marine algal flora of Curaçao has been covered in several publications: Sluiter (1908), Taylor (1942), Diaz-Piferrer (1964), Van den Hoek (1969, 1978), Van den Hoek et al. (1972, 1975, 1978). Recently Stegenga & Vroman (1987) gave an account of several new records of Ceramiaceae, and a survey of the species of that family ever found on Curaçao. Stegenga & Kemperman (unpublished observations) found ten species of previous unrecorded Acrochaetiaceae in the Curaçao flora. Both observations on Ceramiaceae and Acrochaetiaceae were based upon a collection made by M. Vroman, 1957/1958. The same collection yielded a number of algal species of other groups apparently new to Curaçao; some of the more interesting finds from the Curaçao northeast coast are reported in the present paper.

MATERIALS AND METHODS

Algae were collected on Curaçao by M. Vroman, during the period 3-xii-1957 to 11-vii-1958. The samples collected on the exposed NE. coast have been completely screened by now: exact localities and collecting dates are listed in Stegenga & Vroman (1987). The material, as far as herbarium specimens are concerned, is in the

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Rijksherbarium at Leiden (L), permanent slides are in the collections of the Association of European Phycologists (SEA), Amsterdam.

OBSERVATIONS

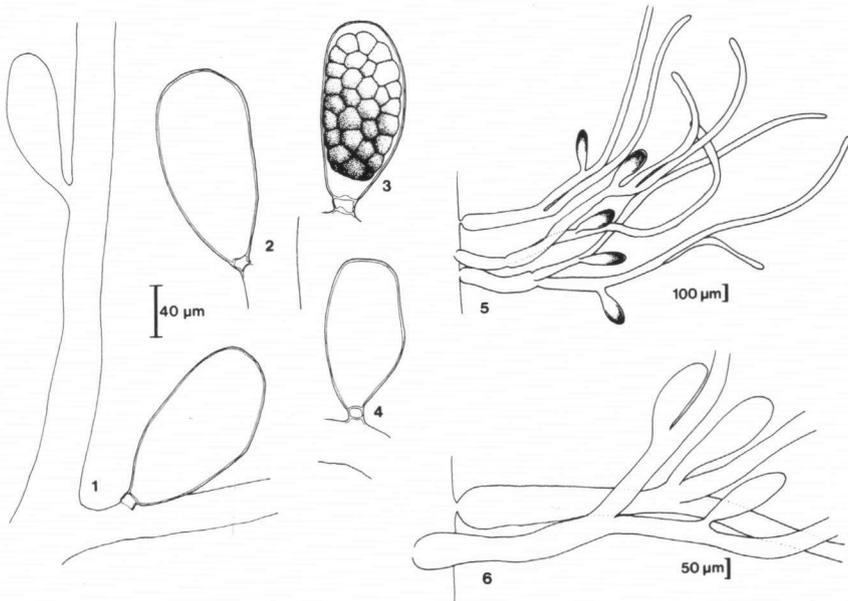
CHLOROPHYTA

Derbesia marina (Lyngb.) Kjellm. (Figs. 1–4)

MATERIAL EXAMINED: Boca Labadera, 8-vii-1958, on *Dictyosphaeria vanbossae* Boergesen (sporangial).

Our material shows the following basic characteristics: filament diameter 30–40 μm , sporangia obovate or somewhat truncate, 100–140 \times 55–70 μm .

Taylor (1960) mentioned four species of *Derbesia* from the western tropical and subtropical Atlantic: *D. ? fastigiata* Taylor (no reproductive structures known), *D. vaucheriaeformis* (Harvey) J. Ag., *D. marina* (Lyngb.) Kjellm., and *D. lamourouxii* (J. Ag.) Solier. *Derbesia osterhoutii* (Blinks et Blinks) Ziegler Page was added after the sporophyte of *Halicystis osterhoutii* had been found in culture (Ziegler Page, 1970).



Figs. 1–4. *Derbesia marina*, zoosporangia. — Figs. 5 & 6. *Trichosolen longipedicellata*, branchlets with gametangia.

The dimensions of our material do not correspond very well to one of the above-mentioned species: filament diameter falls within the range given for *D. vaucheriaeformis* (25–50 µm, Taylor, 1960) and *D. osterhoutii* (24–57 µm, Ziegler Page, 1970 – however 50–135 µm according to Schnetter, 1978), but sporangia are smaller: 190–300 × 100–130 µm in *D. vaucheriaeformis* (Taylor, 1960 – however, the type of the species appears to be sterile, see Sears & Wilce, 1970), 116–212 × 103–181 µm in *D. osterhoutii* (Ziegler Page, 1970). Likewise, the sporangia in *D. marina* and *D. lamourouxii* are bigger than in our material (cf. Taylor, 1960). Southern Australian plants of *D. marina* appear to correspond very well to our material: Womersley (1984) gives filament diameters of (25–)30–40 µm, sporangia 80–110(–140) × 50–65 µm. Also the type of *D. marina* appears to have dimensions that would not exclude our material from this species: filaments 15–48 µm in diameter, sporangia 164 × 60 µm (Sears & Wilce, 1970).

Derbesia ryukyuensis, described by Yamada & Tanaka (1938), perfectly matches our material: filaments 35–45 µm in diameter, sporangia 115–154 × 60–77 µm, but according to the authors the sporangia in *D. ryukyuensis* are not separated from the filaments by the characteristic double septum.

It is on basis of these observations that we have assigned our material to *D. marina*, but it should be borne in mind that *D. marina* is usually considered to be a species of cold temperate environments (Womersley, 1984).

An unidentified species of *Derbesia* has been recorded from Curaçao before (Van den Hoek, 1969).

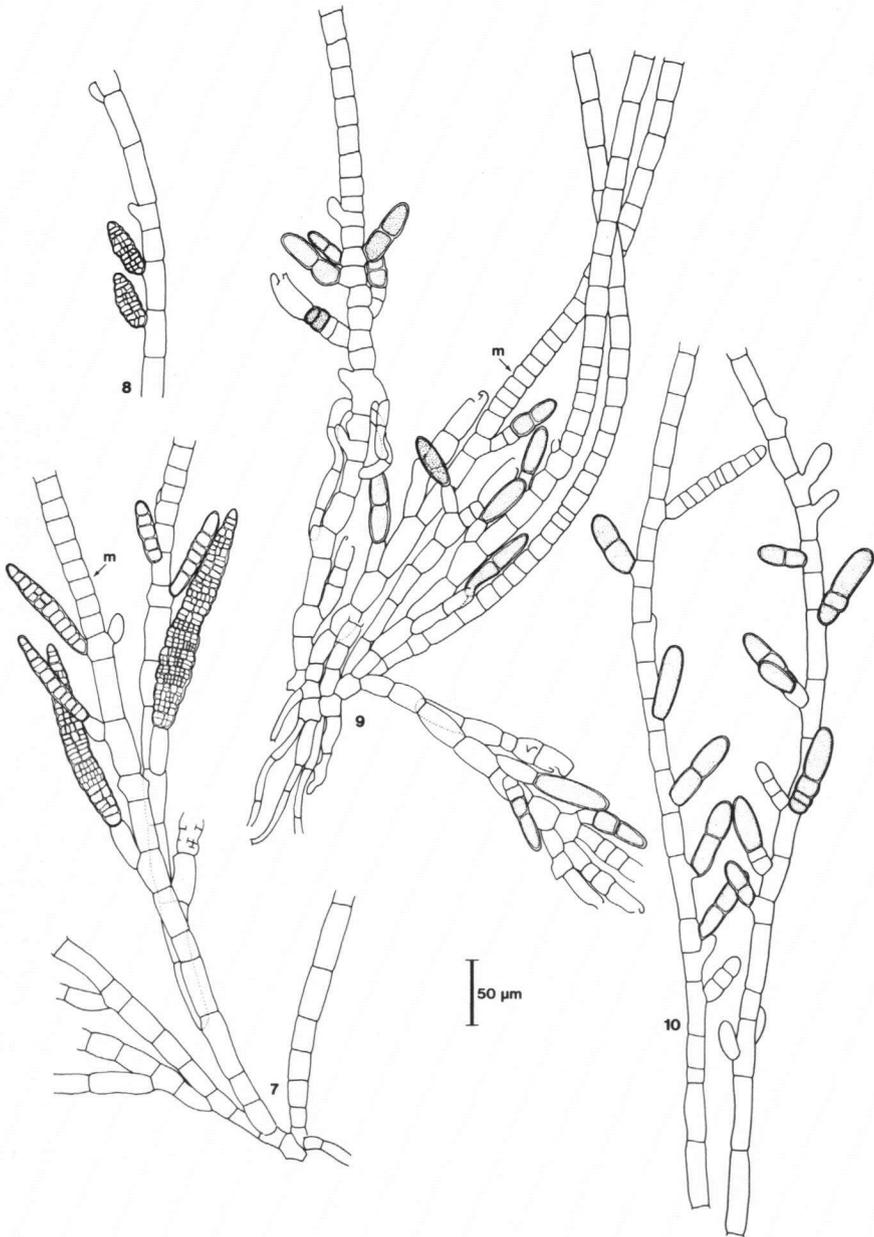
***Trichosolen longipedicellata* (Blomquist et Diaz-Piferrer) D.M. John** (Figs. 5, 6)

MATERIAL EXAMINED: Boca Ascension, 27-ii-1958, epilithic (gametangial).

Our material has the following basic characteristics: plants c. 50 mm tall, a few times dichotomously branched, main axis c. 250 µm in diameter, densely clothed with branchlets up to 2 mm long, 75 µm in diameter proximally, tapering to 20 µm, with one or two (three) dichotomies, and bearing one or two gametangia. Gametangia narrowly obovate, with a non-mucronate apex, measuring up to 350 × 75 µm. Plasmatic contents of the gametangia strongly concentrated in their apices. No septum observed at the basis of the gametangia.

To our knowledge, four species of *Trichosolen* (synonym: *Pseudobryopsis* – see Taylor, 1962b) have been described from the Caribbean area:

1. *Trichosolen duchassaingii* (J. Ag.) Taylor (synonym: *T. antillarum* Montagne), the most commonly reported species in the area.
2. *Trichosolen longipedicellata* (Blomquist et Diaz-Piferrer) D.M. John (John, 1977) (synonym: *Pseudobryopsis longipedicellata* Blomquist et Diaz-Piferrer), from Puerto Rico (Blomquist & Diaz-Piferrer, 1961).
3. *Trichosolen venezolana* Taylor, from Venezuela (Taylor, 1962a).
4. *Trichosolen blomquistii* (Diaz-Piferrer) D.M. John (synonym: *Pseudobryopsis blomquistii* Diaz-Piferrer), from Puerto Rico (Diaz-Piferrer, 1965).



Figs. 7–10. *Feldmannia elachistaeformis*. – 7: Base of plant with plurilocular zoidangia. – 8: Plurilocular zoidangia in distal part of the plant. – 9: Base of plant with 'sporangioform bodies'. – 10: 'Sporangioform bodies' in distal part of the plant; m = meristematic zone.

Clearly our material could not belong to *T. venezolana* or *T. blomquistii*, which both have much more squat gametangia. As for size and shape of the gametangia, our material is very close to *T. longipedicellata*, save that in the original description the authors give a much reduced length of the gametangia proper, and a very long stalk cell indeed. As our material lacks a septum at any place near the base of the gametangium, we have been reluctant to recognize a 'stalk cell'.

Taylor (1962b) and Wynne (1986) placed *Pseudobryopsis longipedicellata* in synonymy of *Trichosolen duchassaingii*, but Taylor (1962a) described gametangia of the latter species as much broader than in *Trichosolen longipedicellata* and our material. Also, gametangia in *T. duchassaingii* appear to be mucronate (Taylor, 1962a, figs. 17–25; see also Schnetter, 1978), a condition not found in our material or in *T. longipedicellata* (see Diaz-Piferrer, 1965, table I – Diaz-Piferrer did not include *T. duchassaingii* in his survey of the genus *Pseudobryopsis*).

Diaz-Piferrer (1965) announced a proposal to conserve *Pseudobryopsis* against *Trichosolen*, on grounds of the not so clear definitions of both *T. antillarum* and *Bryopsis duchassaingii*, but as far as we are aware, this has not been consummated, and the name *Trichosolen* still has priority.

Van den Hoek et al. (1975) have earlier reported an unidentified species of *Trichosolen* from Curaçao.

PHAEOPHYTA

Ectocarpus rhodochortonoides Boergesen

MATERIAL EXAMINED: Boca Playa Canoa, 10-vii-1958, epiphytic on *Dictyopteris justii* Lamour. (with plurilocular zoidangia).

Not reported from the island before, probably through an oversight: *E. rhodochortonoides* is not uncommon in the Caribbean or elsewhere in the tropics.

Feldmannia elachistaeformis (Heydrich) Pham Hoang (Figs. 7–10)

MATERIAL EXAMINED: Boca Diego, 28-vi-1958, on *Sargassum* sp. (plurilocular zoidangia); between Boca Grandi and Boca Mangel, 4-vii-1958, on *Sargassum* sp. (plurilocular zoidangia and sporangioform bodies); Boca Labadera, 8-vii-1958, on *Padina gymnospora* (Kütz.) Vickers, and *Gelidiala acerosa* (Forssk.) Feldmann et Hamel (plurilocular zoidangia); Boca Playa Canoa, 10-vii-1958, on *Sargassum platycarpum* Montagne (plurilocular zoidangia); Boca San Pedro, 11-vii-1958, on *Sargassum* sp.

In addition to plurilocular zoidangia, sporangioform bodies were found that could not be typified with certainty; we have not found subdivision of the contents of these cells, but a reproductive function seems possible as we have seen emptied cells of this type (fig. 9). Apparently similar structures were considered to be unilocular sporangia in *Ectocarpus mitchellae* (Boergesen, 1941), and called 'cellules hypertrophées' in *E. fasciculatus* (Ardré, 1970). Cardinal (1964) has discussed the various interpretations of similar structures in '*Ectocarpus dimorphus* Silva' (actually this 'species' appears to consist of modified forms of other known species of *Ecto-*

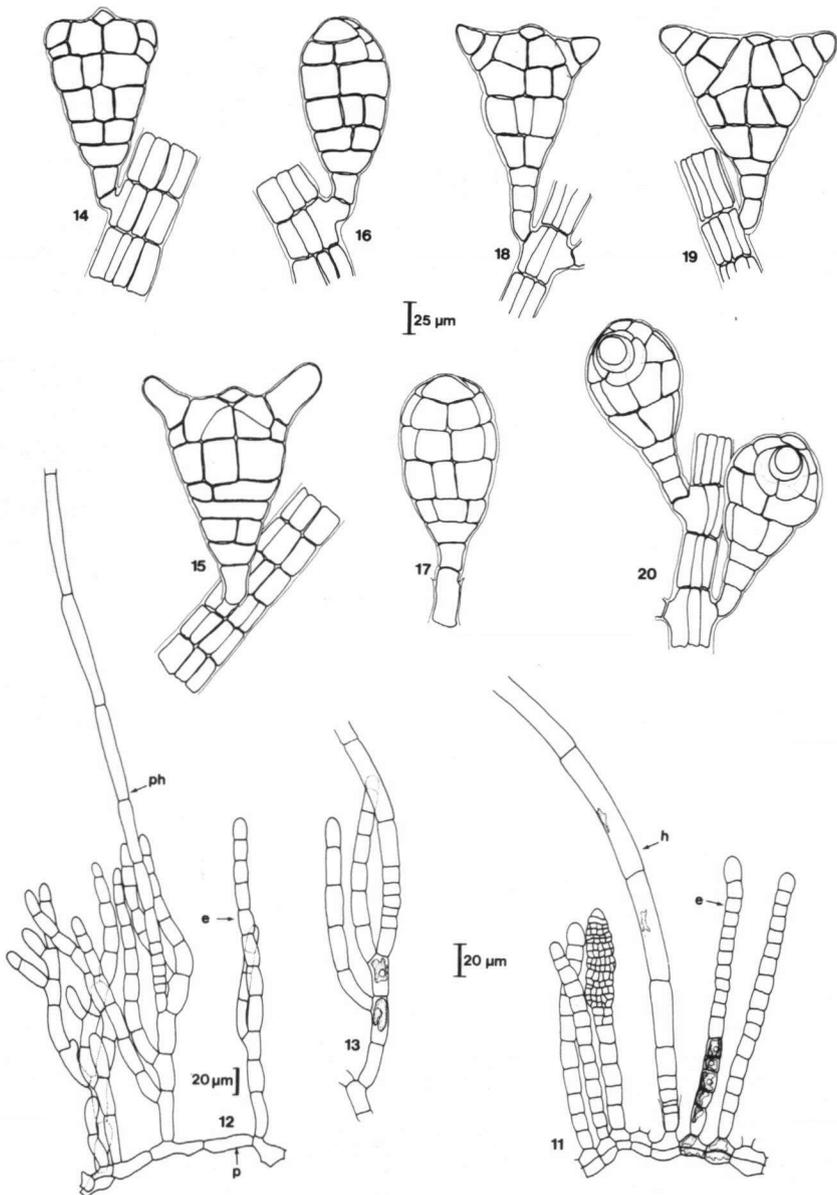


Fig. 11. *Hecatonema floridanum*, base of plant with erect filaments (e), hair (h), and plurilocular zoidangium. — Figs. 12 & 13. *Herponema tortugense*, details of plant with prostrate filament (p), erect filaments (e), and pseudohairs (ph). — Figs. 14–17. *Sphacelaria novae-hollandiae*, propagula in various lateral views. — Figs. 18–20. *Sphacelaria tribuloides*, propagula in various lateral views.

carpus – Cardinal, 1964), and favours bacterial or viral infections as their most likely cause.

It is uncertain whether *Feldmannia elachistaeformis* is the correct name for this species. It is identical to *F. elachistaeformis* as used by e.g. Lawson & John (1982) and Schnetter (1976 – as *Ectocarpus*), but Kapraun (1984) stated that there is no meristematic zone in *Ectocarpus elachistaeformis*, in that respect differing from *Giffordia rallsiae* (Vickers) Taylor. Already Boergesen (1941) has recognized the difficulties surrounding the delimitation of species of this type, and has synonymized several of them under *Ectocarpus irregularis* Kütz.

Hecatonema floridanum (Taylor) Taylor (Fig. 11)

MATERIAL EXAMINED: Boca Playa Canoa, 10-vii-1958, epiphytic on *Dictyopteris justii* (with plurilocular zoidangia).

Described by Taylor (1928 – as *Phycocoelis floridana*), this species has rarely been recorded since. Lawson & John (1982) mention a *Hecatonema* sp. from West Africa, 'similar to ... *H. floridana*'.

Our material is in perfect agreement with Taylor's (1928) description. It is at present unknown whether this species may represent a phase in the life history of another (larger) brown alga. *Hecatonema*-like phases have been detected in the life histories of *Myriotruchia* (Loiseaux, 1969) and possibly *Punctaria* (Clayton, 1974); as a consequence Pedersen (1981) advocates a placement of *Hecatonema* in the Punctariaceae rather than in the Ectocarpaceae.

Herponema tortugense (Taylor) Taylor (Figs. 12, 13)

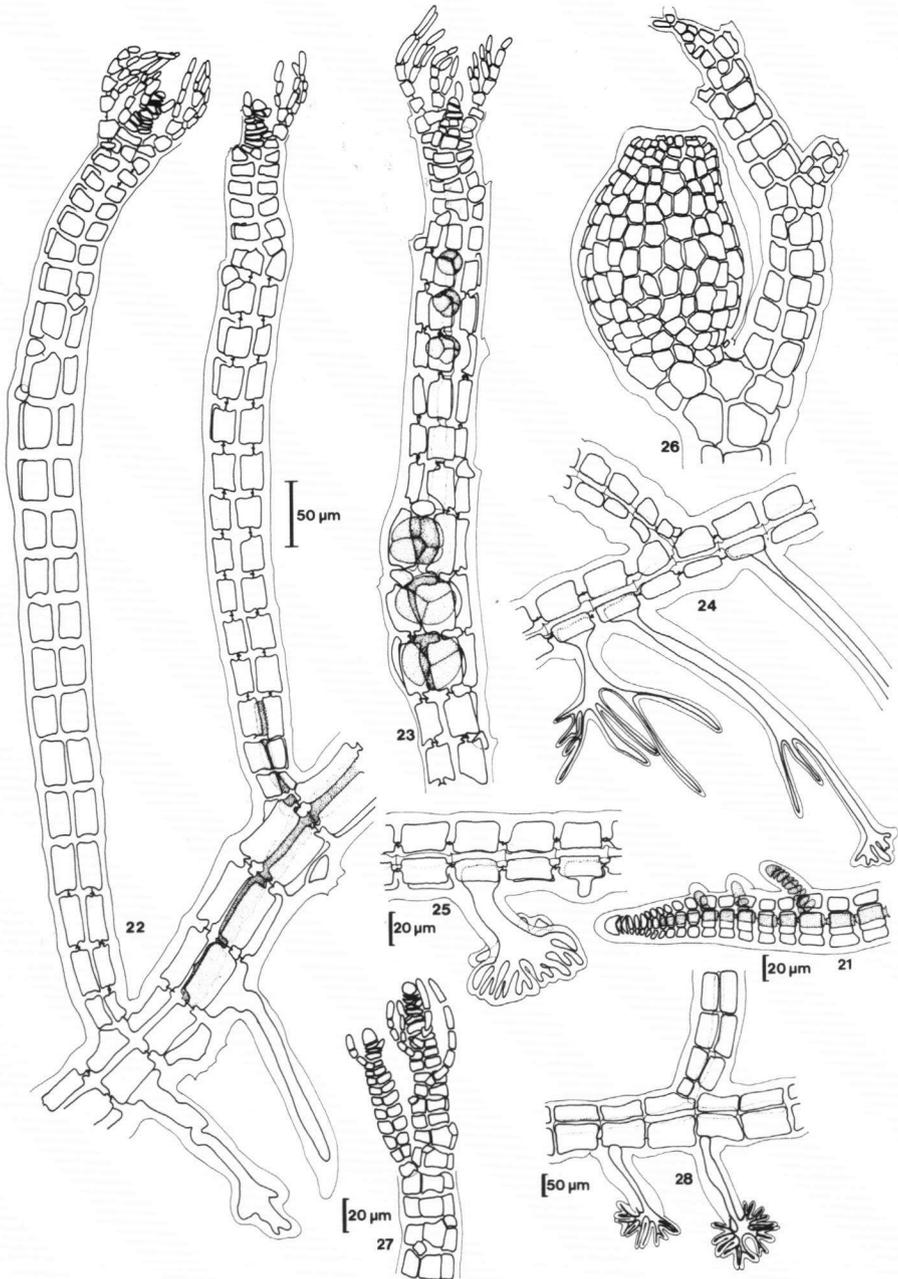
MATERIAL EXAMINED: Boca Playa Canoa, 10-vii-1958, epiphytic on *Dictyopteris justii* (material sterile).

Our plants match the description of *H. tortugense* (Taylor, 1928 – as *Ectocarpus tortugensis*) with respect to cell dimensions and branching characteristics of the erect axes. The material also bears pseudohairs, mentioned by Hamel (1939) as one of the peculiarities of the genus: these pseudohairs do have a sort of basal meristem (fig. 13) but lack the sheath typical of phaeophytan hairs.

Sphacelaria novae-hollandiae Sonder (Figs. 14–17)

MATERIAL EXAMINED: Boca Diego, 1-vii-1958, epilithic on terrace in splash zone; Boca Masalinja, 1-vii-1958, on *Sargassum* sp.; Boca Labadera, 8-vii-1958, on *Dictyosphaeria vanbossae*.

So far, two species of *Sphacelaria* were recorded from Curaçao: *S. rigidula* Kütz. (Diaz-Piferrer, 1964; Van den Hoek et al., 1972, 1975, 1978 – all as *S. furcigera* – see Prud'homme van Reine, 1982), and *S. tribuloides* Meneghini (mentioned in the same publications). *Sphacelaria novae-hollandiae* has about the same habit and filament diameter as *S. tribuloides*, but differs in the shape and cell configuration of the propagula, especially near the 'horns', in *S. novae-hollandiae* these horns develop-



Figs. 21–26. *Polysiphonia scopulorum*. — 21: Apex of prostrate filament (note endogenous origin of erect filaments). — 22: Prostrate and erect filaments. — 23: Tetrasporangia. — 24 & 25: Haptera of various shapes. — 26: Cystocarp. (21–23 material from *Dictyosphaeria*, 24–26 material from *Lobophora*). — Figs. 27 & 28. *Polysiphonia sphaerocarpa*. — 27: Apex of erect filament. — 28: Haptera.

ing from the upper half of the divided apical cells of the propagular arms, whereas in *S. tribuloides* they develop from undivided apical cells (compare figs. 14–17 and 18–20).

On Curaçao, *S. tribuloides* appears to be the more common species: it is often found as a constituent of algal turfs. *Sphacelaria novae-hollandiae* was mainly found as an epiphyte on other algae.

RHODOPHYTA

Polysiphonia scopulorum Harvey (Figs. 21–26, 29–31)

MATERIAL EXAMINED: Boca Diego, 1-vii-1958, on *Lobophora variegata* (Lamour.) Womersley (tetrasporangial, cystocarpic); Boca Labadera, 8-vii-1958, on *Dictyosphaeria vanbossae* (tetrasporangial).

Polysiphonia scopulorum has formerly been assigned to the genus *Lophosiphonia* (Womersley, 1950; Ardré, 1970), and its habit and frequently endogenous origin of erect axes are much reminiscent of that genus. Hollenberg (1968), however, has argued that this species does belong to *Polysiphonia* (see also Womersley, 1979).

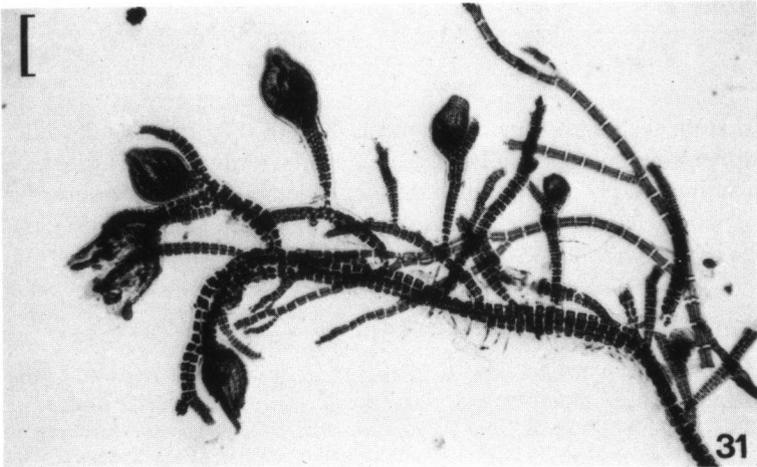
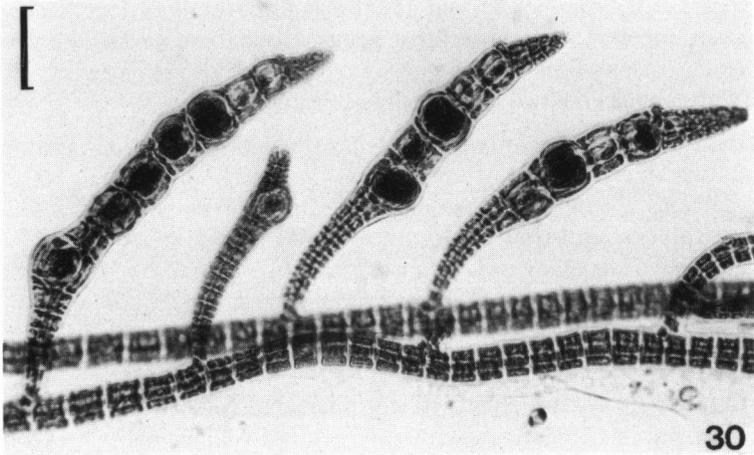
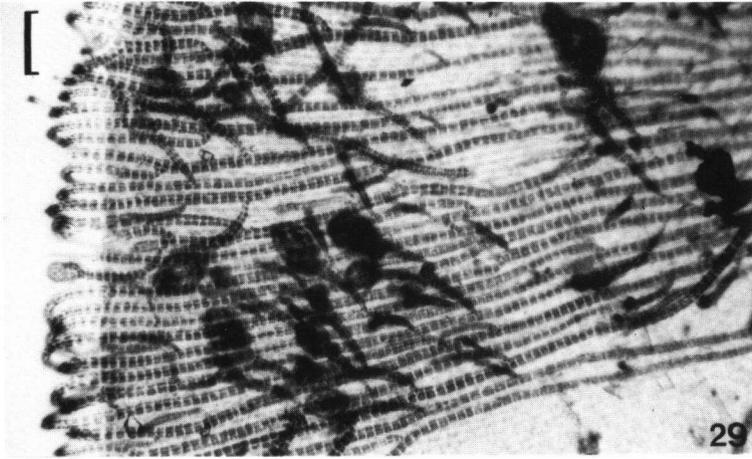
In the Curaçao material two forms could be distinguished:

1. A form epiphytic on *Lobophora variegata* (figs. 24–26, 29–31) forming very typical mats of crowded prostrate filaments with very short (up to 800 µm tall) erect filaments arising at irregular intervals. This form clearly corresponds to the variety *villum* (J. Ag.) Hollenberg.
2. A form epiphytic on *Dictyosphaeria vanbossae* (figs. 21–23), with erect filaments up to 2 mm tall. In this form the erect filaments are much more abundant, and they arise about every second or third segment of the prostrate axis. This material corresponds to the typical variety.

Both forms have strictly unbranched erect filaments. Curaçao plants are small and filaments narrow in comparison with southern Australian material: Womersley (1979) gives a diameter of prostrate filaments of 80–130 µm (in our material 75 µm at maximum) and erect filaments 80–120(–140) µm (50–62.5 µm in our material). Other records are more in line with the Caribbean material: Cribb (1983): prostrate axes 40–80(–90) µm, erect axes 25–80(–90) µm in eastern Australian plants; Abbott & Hollenberg (1976): erect filaments 40–60(–80) µm in Californian plants; similar dimensions are found in Portuguese material (Ardré, 1970 – measures derived from her figures, pl. 29). Although the two varieties appear to be quite distinct, in our case this may be due to the lack of sufficient material. Cribb (1983) remarks that there is no sharp dividing line between the two.

Polysiphonia sphaerocarpa Boergesen (Figs. 27, 28)

MATERIAL EXAMINED: Boca Ascension, 27-ii-1958, in algal turf with *Hypnea spinella* (C. Ag.) Kütz. (tetrasporangial, cystocarpic); Boca Ascension, 23-iv-1958, in clumps of *Cladophoropsis membranacea* (C. Ag.) Boergesen; Boca Diego, 1-vii-1958, epiphytic on *Sargassum* sp. (bisporangial); Boca Playa Canoa, 10-vii-1958, on *Penicillus capitatus* Lamarck (bisporangial).



As Kapraun & Norris (1982 – see also Kapraun, 1980) have remarked, this minute species has not truly prostrate axes, but erect axes are decumbent and become attached by means of rhizoids cut off from the pericentral cells. By these characters the species is distinguished from i. a. *P. atlantica* Kapraun, *P. howei* Hollenberg and *P. subtilissima* Montagne, species already recorded from Curaçao (Diaz-Piferrer, 1964; Van den Hoek, 1969; Van den Hoek et al., 1972 – *P. atlantica* as *P. macrocarpa* Harvey – see Kapraun & Norris, 1982).

Polysiphonia sphaerocarpa appears to be a rather common species in algal turfs and epiphytically. Part of the material was bisporangial, as reported for specimens from Bonaire (Vroman & Stegenga, 1988).

GENERAL DISCUSSION

After several investigations it appears as though floristic aspects of the Curaçao marine algal flora have been studied almost to saturation point. An estimate of the number of species ever collected on this island prior to the present publication gives a total of c. 340 species (c. 100 Chlorophyta, 40 Phaeophyta and 200 Rhodophyta), a number based on the publications mentioned in the introduction of this paper (species only identified as to genus were excluded). The present paper, based on a survey of the northeast coast, yields nine species not recorded before. Such in contrast to the extensive list of additions to the flora of the neighbouring islands of Aruba and Bonaire (Vroman & Stegenga, 1988), islands which apparently have not been studied with the same intensity, and probably also harbour a smaller variety of marine habitats.

Perhaps the number of species now recorded from Curaçao gives a more general indication of the richness of several regional algal floras in the Caribbean. Almodovar & Ballantine (1983), in summarizing numerous investigations, list 384 species from Puerto Rico, at present probably the highest total recorded for any given region within the Caribbean. Stegenga & Vroman (1987) have argued that regions with significantly lower numbers of species have probably been undercollected, and it is clear that this seriously hampers comparison of different regions for phytogeographical purposes.

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Figs. 29–31. *Polysiphonia scopulorum*, from *Lobophora variegata*. – 29: Typical habit along edge of *Lobophora*. – 30: Prostrate filaments with tetrasporiferous erect axes. – 31: Prostrate filaments with cystocarp-bearing erect axes. – Scale bar in figs. 29 & 31 = 200 µm, in fig. 30 = 100 µm.

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