

## The marine benthic flora of the Cape Hangklip area and its phytogeographical affinities

J.J. Jackelman, H.S. Stegenga and J.J. Bolton

Botany Department, University of Cape Town, Private Bag, Rondebosch, Cape Town, 7700 Republic of South Africa

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A detailed collection of intertidal and subtidal marine macroalgal species from the Cape Hangklip area, a site centrally located in the south coast/west coast overlap, yielded a list of 199 taxa (27 Chlorophyta, 25 Phaeophyta, 147 Rhodophyta). The list of taxa included four new records for southern Africa (*Aphanocladia cf. skottsbergii*, *Audouinella endophytica*, *Centroceras distichum* and *Grateloupia doryphora*), five undescribed species (*Antithamnion* sp., *Colaconema* sp., *Erythrocladia* sp., *Erythroglossum* sp. and *Pterosiphonia* sp.) and one rhodophyte of uncertain affinity, probably representing a new genus in the Ceramiaceae. A new combination, *Colaconema caespitosum* (J. Ag.) comb. nov. is proposed.

A summary of the distribution of 170 species with adequate distribution records indicates that there is no dominance of species with warm-water or cold-water affinities. It is demonstrated that the south coast/west coast overlap area contains many west and south coast species which reach the limit of their ranges here.

Tussengety- en subgetymakroalgspesies van die Kaapse Hangklip-gebied, 'n terrein wat sentraal geleë is in die suidkus/weskus-oorvleueling, is versamel en het 'n lys van 199 taksa opgelewer (27 Chlorophyta, 25 Phaeophyta, 147 Rhodophyta). Die lys van taksa bevat vier nuwe optekeninge vir suider-Afrika (*Aphanocladia cf. skottsbergii*, *Audouinella endophytica*, *Centroceras distichum* en *Grateloupia doryphora*), vyf nuwe spesies wat nog nie beskryf is nie (*Antithamnion* sp., *Colaconema* sp., *Erythrocladia* sp., *Erythroglossum* sp. en *Pterosiphonia* sp.) en een rhodofiet waarvan die verwantskap nog onseker is, maar wat waarskynlik 'n nuwe genus in die Ceramiaceae verteenwoordig. 'n Nuwe kombinasie, *Colaconema caespitosum* (J. Ag.) comb. nov. word voorgestel.

'n Opsomming van die verspreiding van 170 spesies, met voldoende verspreidingsgewens, dui daarop dat daar geen oorheersing deur spesies met of warm- of kouewaterverbintnisse is nie. Daar word aange- toon dat daar baie wes- en suidkusspesies in die suidkus/weskus-oorvleuelingsgebied voorkom wat die grens van hulle verspreidingsgebied hier bereik.

**Key words:** benthic seaweeds, phytogeography, South Africa.

### Introduction

Along the southern African coastline, the contrast between the strong-flowing warm Agulhas current down the east coast and the weak cool Benguela current up the west coast has manifested itself in the different marine algal species found on the west and south coasts of South Africa. Where these currents meet, Stephenson (1944) defined, on the basis of determining intertidal faunal and floral species change around the coast, the south coast/west coast overlap region, a transitional area between the cool-temperate west coast and the warm-temperate south coast. Lüning (1990), following Briggs (1974), identified two provinces within the warm temperate southern African region, namely the south-western Africa province (encompassing the South African west coast) and the Agulhas province (south coast). The boundaries of the overlap between these two provinces are not yet clear, but biogeographers generally agree that they fall in the region between Kommetjie and Cape Agulhas (Figure 1), although Bolton and Anderson (1990) have suggested that the change from an overlap to a true west coast flora may be in the vicinity of Cape Columbine. The reasons for this well-defined overlap between the west and south coast floras are poorly understood. It is, however, apparent that a complex interplay of related physical and chemical factors, characteristic of both the west and south coasts, occurs in this region. These include patterns of oceanic circulation (Isaac 1938), periodicity and seasonality of ambient temp-

eratures (Isaac 1938; Bolton 1986; Hommersand 1986; Bolton & Stegenga 1990; Bolton & Anderson 1990) and levels of nutrients (Bolton 1986; Hommersand 1986).

It is only recently (e.g. Bolton 1986; Bolton & Stegenga 1987; Bolton & Stegenga 1990; Bolton & Anderson 1990; Stegenga & Bolton, in press) that South African phyco-geographers have evaluated detailed regional floristic composition with respect to the existing concepts of floristic regions and overlap zones of seaweed floras pioneered by Stephenson and his co-workers (summarized in Stephenson 1944, 1948). These detailed collections of macroalgae have, however, taken place primarily in the intertidal with only incidental beach cast macroalgae being considered. There is a paucity of detailed floristic information on the subtidal algal communities. Though Field *et al.* (1980) and Velimirov *et al.* (1977) have quantified the major algal species along the south-west Cape coast, they provide little detailed floristic information. In the only comprehensive published account of local subtidal algal communities, Anderson and Stegenga (1989) described the major communities at Bird Island near Port Elizabeth and listed 122 species, but the biogeographic affinities of the flora were not analysed. The aim of this paper is to provide a descriptive record of the intertidal and subtidal floristic composition of a site centrally located in the overlap region between the west and south Cape coasts. The biogeographic affinities of the macroalgal species recorded will be discussed.

**Study site and collection methods**

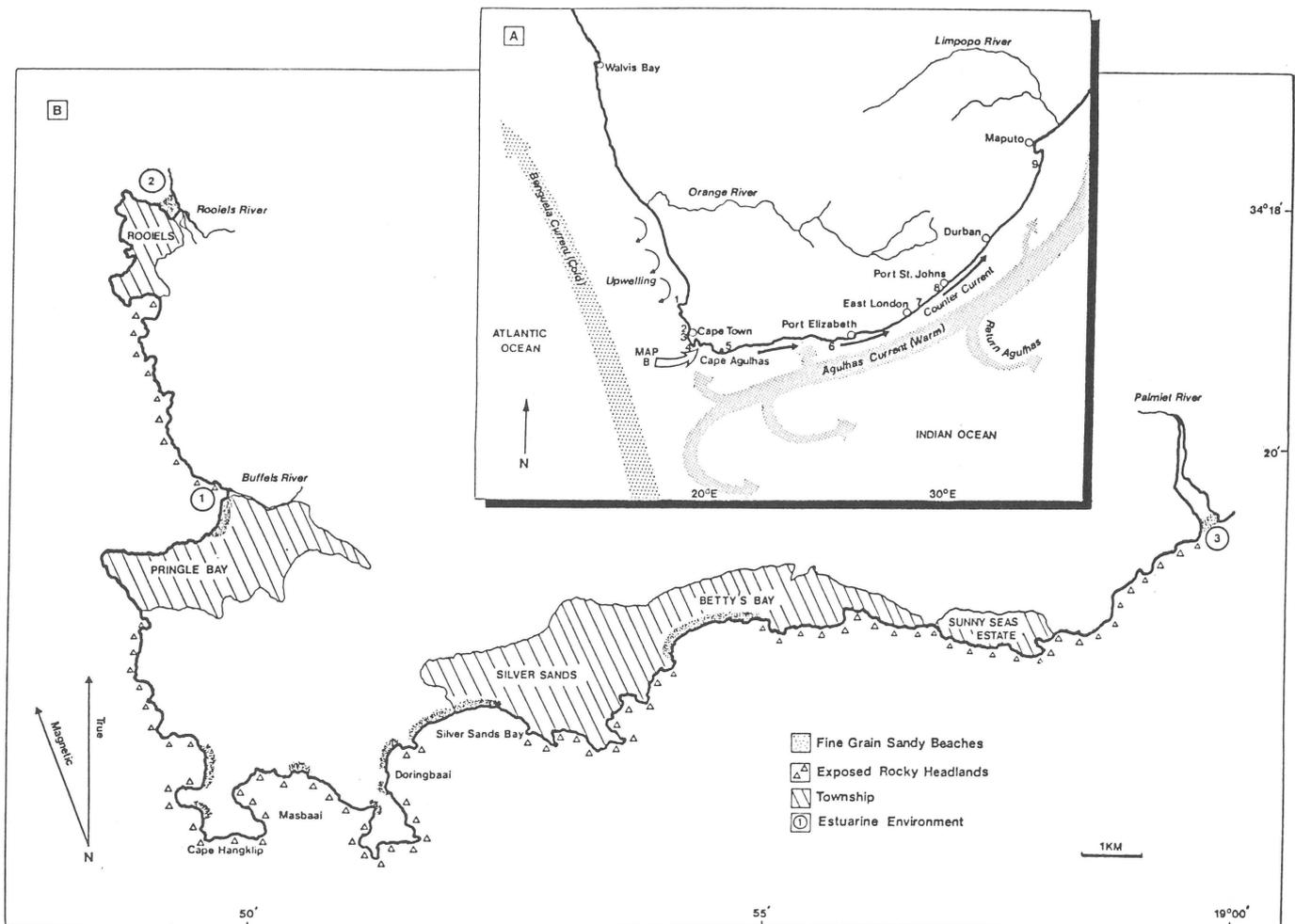
The Hangklip area, forming the south-eastern limit of False Bay in the south-western Cape, South Africa, is located approximately 30 km due east of Cape Point and is bounded by the Rooiels and Palmiet rivers (Figure 1). The coastline in general is rugged with rocky outcrops and the substratum belongs to the Peninsula formation of the Table Mountain group and consists of medium- to large-grained quartzitic sandstone. The intertidal coastal area exhibits variable topography which includes vertical rock faces of exposed rocky headlands; unstable boulder fields; sheltered medium-grained sandy beaches; broad, gently sloping beaches of medium-grain Table Mountain sandstone (TMS) and highly irregular and unevenly weathered pinnacles of large-grain TMS.

The substratum of the shallow subtidal is generally composed of a well-structured rocky substrate of TMS interspersed with patches of loose cobbles, boulders and sand. In sheltered areas, loose boulders in shallow water give way to rocky shelves which are seasonally covered by sand during the late spring and summer months. In exposed areas, weathered sandstone often forms jagged, submerged pinnacles running parallel to the shore with troughs typically filled with sand and cobbles.

The sublittoral fringe and subtidal are dominated by an

extensive laminarian overstorey (*Ecklonia maxima* — species authorities can be found in Appendix 1) and sub-canopy (*Laminaria pallida*). Winter storms and exposure to the prevailing summer wind (south-east) and swell direction (south to south-west) result in conditions of high wave energy prevailing along most of the coastline through much of the year, though Maasbaai and to a lesser extent Holbaai provide a degree of shelter. Both the Agulhas current and the cool Benguela upwelling system are influential in determining the chemical, physical and biological status of the area. Temperature conditions, considered to be an overriding factor regulating the geographical distribution of seaweeds (Lüning 1990), are, at about 8 m depth, intermediate between False Bay and the west coast of the Cape Peninsula (Anderson & Bolton 1989, and unpublished Sea Fisheries Research Institute data). Average minimum and maximum monthly mean temperatures for Betty's Bay for the period from 1986 to 1989 (11.4° and 15.6°C) are higher than for Oudekraal (9.7° and 14.6°C) on the west coast, but lower than for Buffelsbaai (11.5° and 17.4°C) in False Bay (Anderson & Bolton 1989, and unpublished Sea Fisheries Research Institute data). Low average monthly temperatures for Betty's Bay during the summer months are a result of wind-induced coastal upwelling.

Collections of intertidal and subtidal plants were made



**Figure 1** Map of the Cape Hangklip area (Map B) and inset (Map A) showing the South African coastline with the prevailing currents and sites mentioned in the text: Cape Columbine (1), Sea Point (2), Kommetjie (3), Cape Point (4), De Hoop (5), Cape St. Francis (6), Kei Mouth (7), Hluleka (8) and Ponte Do Ouro (9).

from June 1989 to July 1990. Samples preserved in 5% formalin in seawater were identified and mounted on herbarium sheets or permanent slides. Pressed or slide-mounted voucher specimens of species not previously recorded for the area were deposited in the Bolus Herbarium of the University of Cape Town (BOL). Species of crustose coralline Rhodophyta are not identified in this paper, as South African representatives of this group, including specimens from the Cape Hangklip area, are currently under review by Y.M. Chamberlain (Marine Laboratory, Dept. of Biological Sciences, Portsmouth Polytechnic, Ferry Rd, Hayling Island, PO11 0DG, U.K.).

### Description of intertidal and subtidal communities

A general account of the algal 'associations' and 'consociations' in the intertidal and sub-littoral fringe of the coast between Rooiels and Gansbaai has been documented by Isaac (1949). Despite the poorly defined term 'mixed algal vegetation', the generalizations are still relevant today. With the exception of the presence of *Ecklonia maxima*, the shore zonation generally concurs with the 'south coast zonation' of Branch and Branch (1981, p.28). However, the validity of this zonation pattern being indicative of a true south coast zonation is questionable since algal species such as *Gigartina stiriata*, *Gigartina radula* and *Bifurcaria brassicaeformis* are rare or absent east of Cape Agulhas. It is likely that this zonation pattern is more representative of the west coast/south coast overlap region than the south coast.

Truly intertidal algae (i.e. those algae occurring on open rock) are low in numbers and diversity (e.g. *Splachnidium rugosum*, *Gelidium pristoides*, *Gigartina* spp. and *Porphyra capensis*). It is apparent that as for rocky intertidal communities on the Cape Peninsula (cf. McQuaid & Branch 1984, McQuaid *et al.* 1985), wave exposure is the primary factor influencing the intertidal community structure in this area. In wave-exposed areas, the sublittoral fringe is dominated by *Bifurcaria brassicaeformis*, whereas there is no truly dominant species in the sheltered areas. Predominant sublittoral fringe flora generally include *Plocamium corallorhiza*, *Sargassum heterophyllum*, *Anthophycus longifolius*, *Hypnea spicifera*, *Pterosiphonia cloiophylla*, *Dictyota dichotoma* and *Laurencia flexuosa*. In sheltered areas, rockpools in the lower and middle eulittoral zone have high biomass and species diversity and are dominated by a wide variety of seaweeds, including *Ulva rigida*, *Chordariopsis capensis*, *Codium fragile* subsp. *capense*, *Aeodes orbitosa*, *Codium stephensiae*, *Gelidium capense*, *Jania crassa*, *Scinaia capensis* and *Pterosiphonia cloiophylla*. In rockpools in the upper eulittoral, *Enteromorpha intestinalis* predominates. The rockpool flora in the exposed areas, however, comprises different dominant species such as *Cladophora prolifera*, *Bifurcariopsis capensis*, *Centroceras clavulatum*, *Ceramium centroceratiforme*, *Champia lumbri-calis*, *Arthrocardia* spp. and *Rhodymenia natalensis*.

In a paper describing the shallow subtidal spatial variability of plant-animal communities at a number of localities, Field *et al.* (1980) recorded 14 large, common macroalgal species along a single 1300-m transect line at Betty's Bay but, to date, no detailed survey has been carried out in this area.

In the present study, five subtidal algal strata were recognized:

- (i) A floating canopy of *Ecklonia maxima*.
- (ii) A 0.25 – 2 m stipitate erect sub-canopy in which the fronds are supported well above the substratum (e.g. *Laminaria pallida*, *Sargassum heterophyllum*, *Anthophycus longifolius*).
- (iii) Fleshy, foliose and articulate stratum in which fronds lie immediately above the substratum (e.g. *Codium stephensiae*, *Aeodes orbitosa*, *Gigartina radula*, *Amphiroa ephedraea*).
- (iv) Short, entwined, tightly adherent turf stratum (e.g. *Poly-siphonia virgata*, *Griffithsia confervoides*).
- (v) Fleshy and coralline encrusting stratum (e.g. *Ralfsia verrucosa* and crustose corallines).

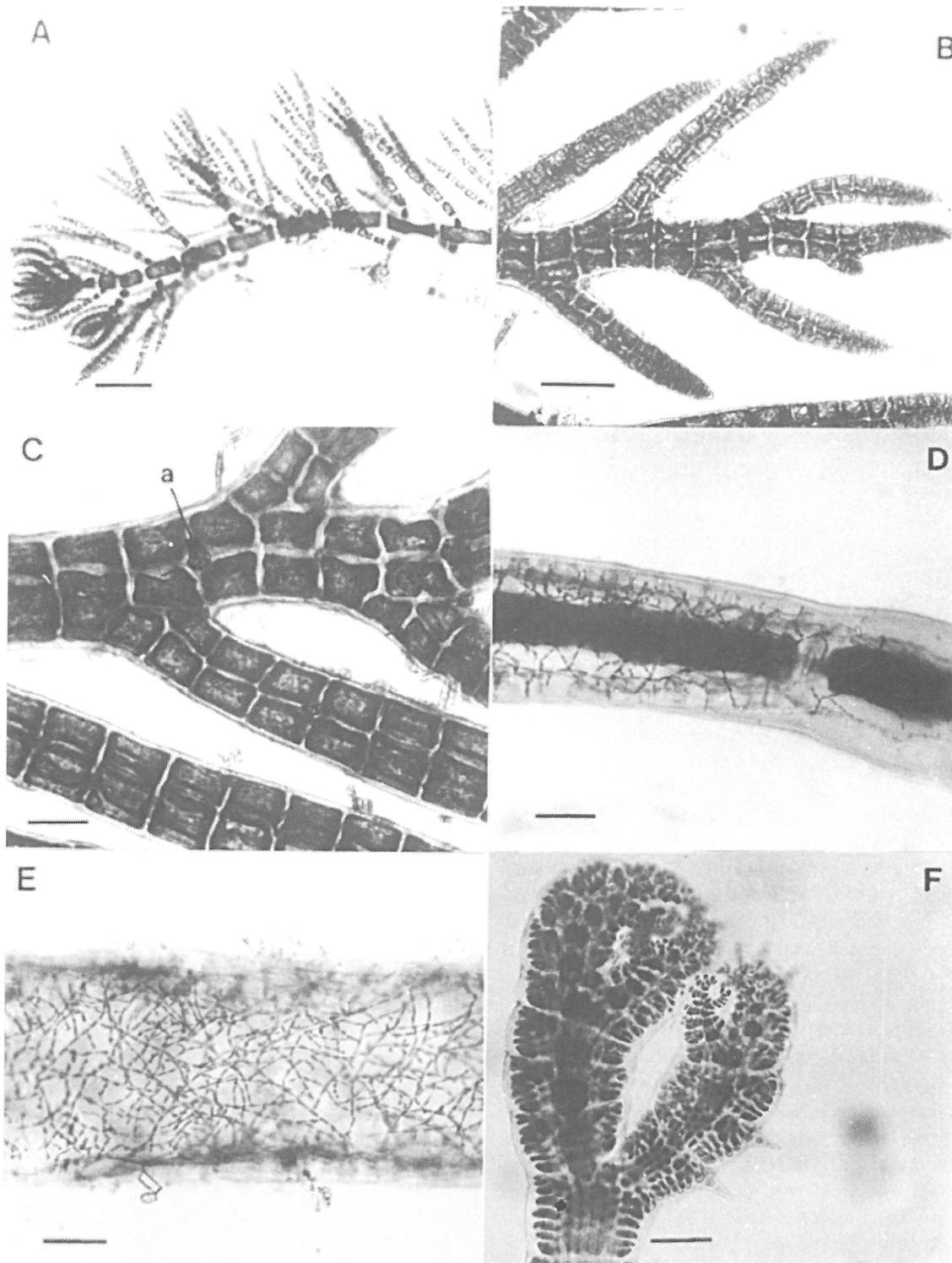
Water motion and depth appeared to directly influence species composition in the subtidal. In the shallow (< 5 m) sheltered water, large foliose macroalgae such as *Pachymenia carnososa*, *P. cornea*, *Nemastoma lanceolata*, *Gigartina radula* and *Aeodes orbitosa*, dominate the kelp understorey. In the deeper water (to 10 m), where sand scour and sand deposition is high, 'psammophytic' (cf. Daly & Mathieson 1977) algae such as *Gigartina insignis*, *G. pistillata*, *G. scutellata*, *G. bracteata*, *Chondria capensis*, *Jania natalensis* and turf species persist on the flat rocky shelves while species such as *Botryocarpa prolifera*, *Trematocarpus flabellatus*, *Bartoniella crenata*, *Laminaria pallida*, *Plocamium corallorhiza* and *P. cornutum* are abundant on the vertical rock faces or substrates not seasonally inundated with sand. In areas of high sand deposition and low water movement, biomass of the sea cucumber (*Henricia ornata* Perrier), Pelecypoda and the giant chiton (*Dinoplax gigas* Gmelin) increased significantly with increasing percentage cover of sand, whereas biomass of urchins (*Parechinus angulosus* Leske), tunicates (*Pyura stolonifera* Heller), *Turbo sarmaticus* L. and *Austrorhynchus cylindricus* Gmelin decreased.

In the shallow water of the wave-exposed sites, articulated corallines, *Halopteris funicularis*, *Gelidium pteridifolium*, *Codium stephensiae*, *Plocamium cornutum*, *Laurencia flexuosa*, *Bifurcariopsis capensis*, *Sargassum heterophyllum* and *Anthophycus longifolius* were common beneath the kelp canopy. In the deeper water, *Desmarestia firma*, *Laminaria pallida*, *Zonaria subarticulata*, *Plocamium suhrii*, *Gymnogongrus glomeratus*, *Amphiroa capensis* and *Cheilosporum cultratum* dominated the understorey.

Certain species such as *Plocamium rigidum*, *Caulerpa holmesiana*, *Halopteris funicularis* and *Pterosiphonia cloiophylla* were ubiquitous throughout the depth and exposure range. Major species composition and local dominants remained constant through the year of collection.

### Results

A total of 199 taxa (see Appendix 1) were collected, of which four [*Aphanocladia* cf. *skottsbergii* (Figures 2B, 2C), *Audouinella endophytica* (Figures 2D, 2E), *Centroceras distichum* (Figure 2F) and *Grateloupia doryphora*] are new records for southern Africa. Five taxa [*Antithamnion* sp. (Figure 2A), *Colaonema* sp., *Erythrocladia* sp. (Figure 3B), *Erythroglossum* sp. and *Pterosiphonia* sp. (Figure 3C)] are currently undescribed and two [*Pterosiphonia spinifera* and *Symphycocladia* cf. *marchantioides* (Figures 3D, 3E)] represent considerable extensions of the known range of distributions. One species [cf. *Ceramiales* *indet.* (Figure 3A)]

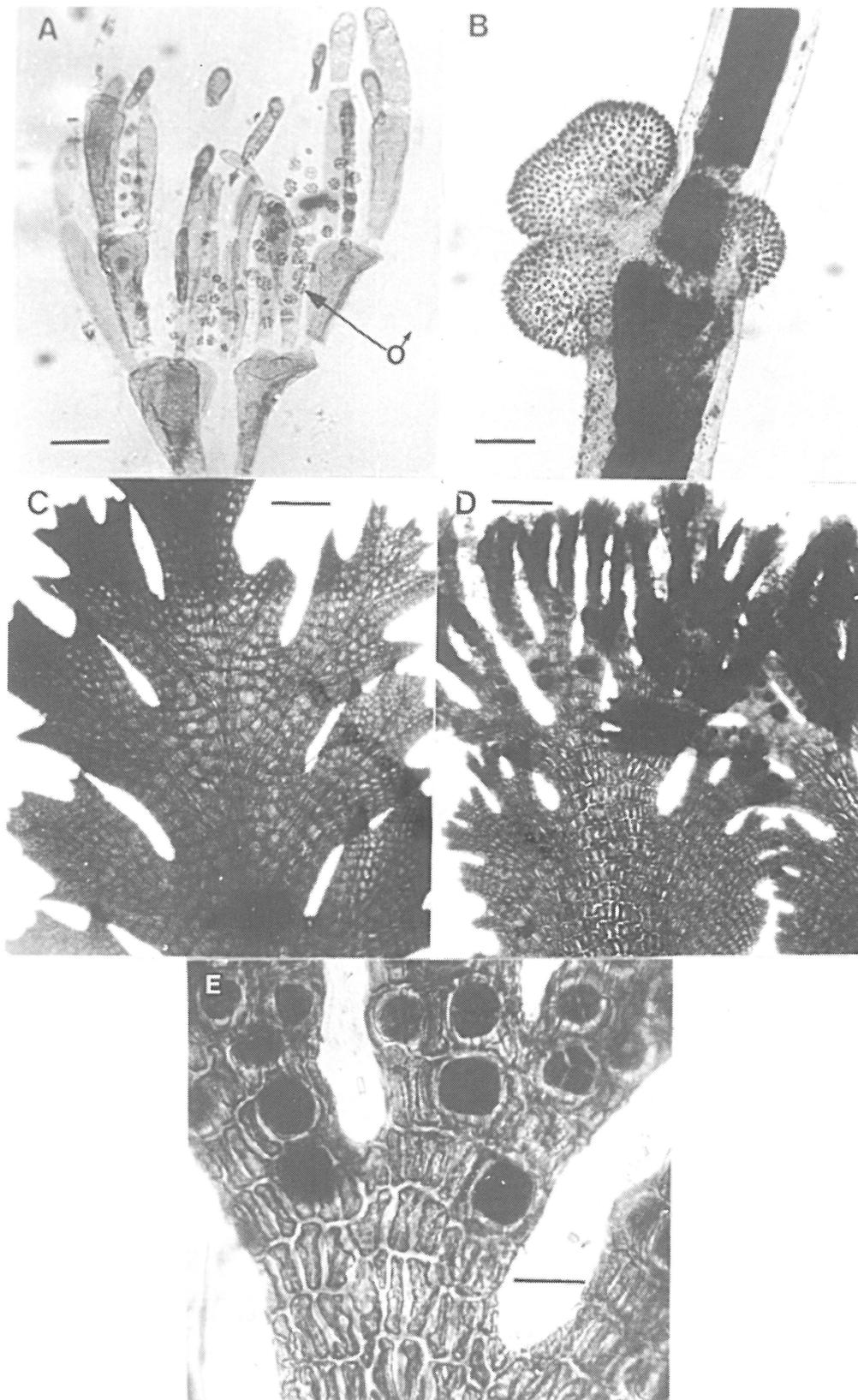


**Figure 2** (a) *Antithamnion* sp., main (prostrate) axis, multicellular haptera and opposite branchlets (scale = 100  $\mu\text{m}$ ); (b) *Aphanocladia* cf. *skottsbergii*, erect axis with alternating laterals (scale = 100  $\mu\text{m}$ ); (c) *Aphanocladia* cf. *skottsbergii*, non-lateral bearing segment with 'scar cell' (scale = 50  $\mu\text{m}$ ); (d) & (e) *Audouinella endophytica*, growing in the cell wall of an unidentified member of the Ceramiaceae (scale = 50  $\mu\text{m}$ ); (f) *Centroceras distichum*, thallus apex with embedded tetrasporangia (scale = 100  $\mu\text{m}$ ).

of as yet uncertain affinity, probably represents a new genus in the Ceramiaceae. The list comprises 10 genera of Chlorophyta (27 taxa), 23 genera of Phaeophyta (25 taxa) and 86 genera of Rhodophyta (147 taxa). A floristic ratio of Rhodophyta and Chlorophyta divided by Phaeophyta (Cheney 1977) commonly used to describe correlations between sea temperature and ratios of red, green and brown algal species

numbers in the North Atlantic, yields a value of 6.96 which is characteristic of a tropical flora. However, as Bolton (1986) has emphasized and is borne out here, this floristic ratio appears not to be applicable in southern Africa due to the depauperate brown algal flora in this region.

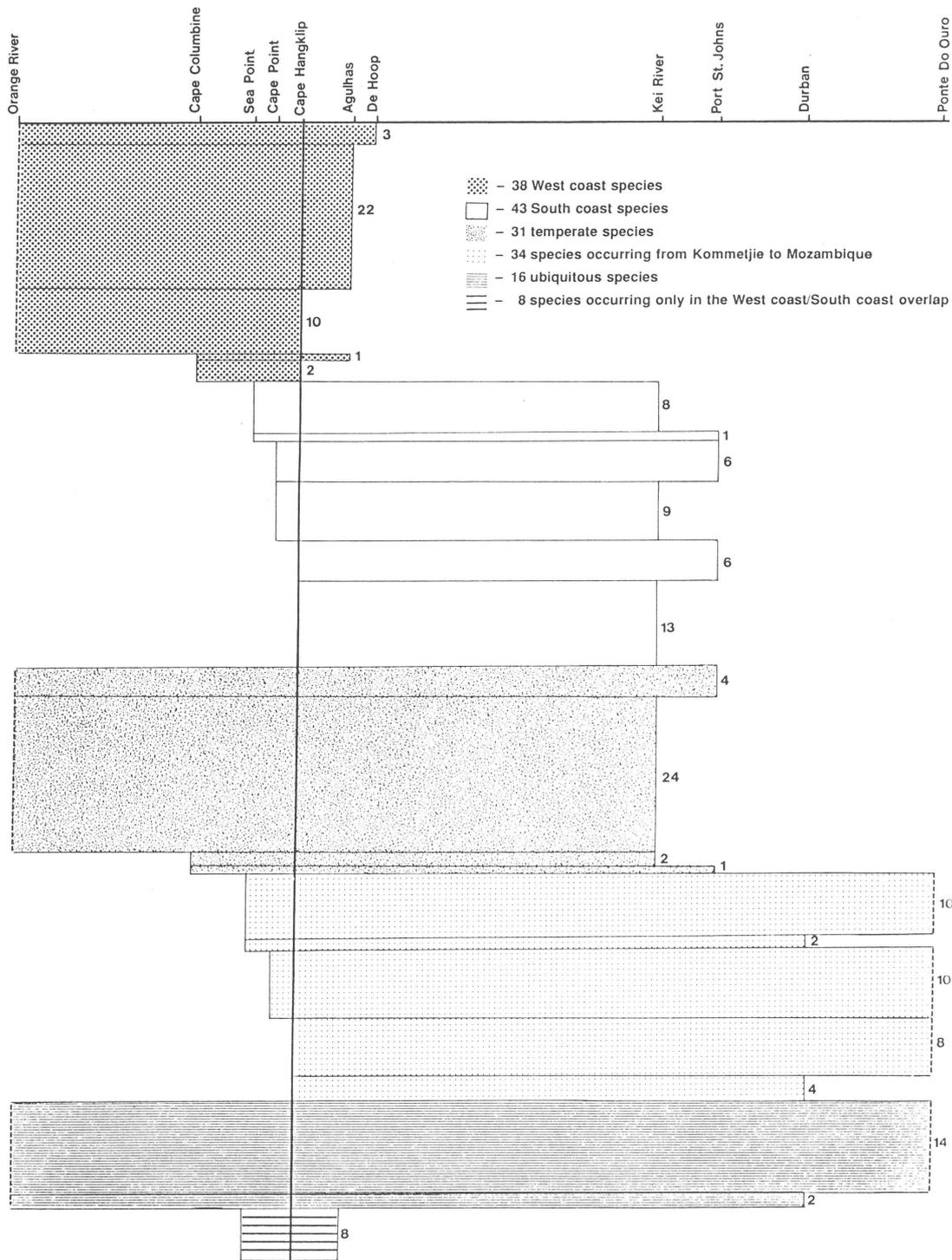
Figure 4 summarizes the distribution of 170 species for which adequate published and unpublished distribution



**Figure 3** (A) Ceramiaceae *indet.*, fascicle of branchlets at apex bearing male capitula (scale = 100  $\mu\text{m}$ ); (B) *Erythrocladia* sp., semi-globose cushions epiphytic on *Cladophora* sp. (scale = 100  $\mu\text{m}$ ); (C) *Pterosiphonia* sp., compressed, pinnate thallus (scale = 1 mm); (D) *Symphyocladia* cf. *marchantioides*, thallus (scale = 0.5 mm); (E) *Symphyocladia* cf. *marchantioides*, one tetrasporangium per segment (scale = 100  $\mu\text{m}$ ).

records exist. Those species whose distribution data or taxonomy are poorly known have been omitted from the analysis. It is apparent that there is no overwhelming dominance of either west coast (occurring west of Cape

Agulhas) or south coast (occurring east of Kommetjie and west of Port St. Johns) species, these numbering 38 (22%) and 43 (25%), respectively. Temperate species, defined as those species only occurring west of Port St. Johns, number



**Figure 4** Distributional analysis of 170 species with adequate distributional records, represented as proportional bar charts of number of species. Biogeographical groups with similar distributions and affinities are clustered. Solid vertical line depicts study site.

31 (18%), while species occurring east to the Mozambique border but not recorded west of Kommetjie number 34 (20%). Ubiquitous species which occur along the whole South African coastline total 16 (9%) species, and 8 (5%) species have, to date, not been recorded outside the west coast/south coast overlap region.

In this survey, based on current distribution records, 31 warm-water species reach their western limit and 12 cold-water species their eastern limit at Cape Hangklip (Table 1).

**Discussion**

It is evident from recent literature (Bolton & Anderson

1990; Bolton & Stegenga 1990) that at the eastern boundary of the overlap region there is a rapid change in community composition over a relatively short length of coastline in the area immediately west of Cape Agulhas. This apparent discontinuity is characterized by a rapid gain of species with warm-water distributions and a simultaneous, but less rapid, loss of species with cold-water distributions. The western boundary of the overlap area is, however, not as well-defined, as a number of common south coast and overlap species have been recorded west of Kommetjie (Bolton & Anderson 1990), the suggested junction between the overlap

and the west coast (see Brown & Jarman, 1978 for discussion).

The seaweed flora of the Cape Hangklip area has neither a predominance of west or south coast species. This suggests that the overlap region can be described as an area demarcated by two boundaries where major floral compositional changes take place, but within which an intermixing of primarily south and west coast species that reach the extent of their distributional ranges, occurs. In the vicinity of Cape Agulhas, many species with warm-water affinities do reach their western distribution limits, but as is evident from the list of species from Cape Hangklip, a large number (77 species) extend beyond this boundary. These species are then likely to reach the limits of their distribution at different localities along the length of the overlap zone. For example, 43 (25%) of 170 species with sufficient distribution data, reach their eastern or western boundary in the Cape Hangklip area (Figure 4 and Table 1), although more detailed subtidal collections in other regions of the overlap may extend the range of many of these species. The location of the western boundary of the overlap zone is currently uncertain, but it may be speculated that the Cape Peninsula acts as a significant topographical or physical barrier to the westward spread of warm-water species. In an analysis of individual distributions of species of Ceramiaceae, Stegenga and Bolton (in press.) found that the most dramatic change in floristic composition occurs in the area between the Cape Peninsula and Cape Agulhas.

**Table 1** List of species reaching the eastern and western limit of their distribution in the Cape Hangklip area

Warm-water species	Cold-water species
<i>Amphiroa cf. beauvoisii</i>	<i>Botryocarpa prolifera</i>
<i>Amphiroa capensis</i>	<i>Ceramium capense</i>
<i>Amphiroa ephedraea</i>	<i>Colaconema plumosum</i>
<i>Arthrocardia duthiae</i>	<i>Gigartina bracteata</i>
<i>Bartoniella crenata</i>	<i>Gigartina scutellata</i>
<i>Bryopsis cf. setacea</i>	<i>Lomathamnion humile</i>
<i>Callithamnion cordatum</i>	<i>Macrocytis angustifolia</i>
<i>Ceramium centroceratiforme</i>	<i>Microcladia gloria-spei</i>
<i>Chaetomorpha antennina</i>	<i>Nemastoma lanceolatum</i>
<i>Cladophora prolifera</i>	<i>Phyllymenia belangeri</i>
<i>Compsothamnionella sciadophila</i>	<i>Schizymenia obovata</i>
<i>Delisea flaccida</i>	<i>Streblocladia corymbifera</i>
<i>Gelidium pteridifolium</i>	
<i>Gelidium cf. reptans</i>	
<i>Gigartina insignis</i>	
<i>Gigartina paxillata</i>	
<i>Gracilaria capensis</i>	
<i>Halicystis sp.</i>	
<i>Herposiphonia prorepens</i>	
<i>Jania adhaerens</i>	
<i>Jania capillacea</i>	
<i>Jania verrucosa</i>	
<i>Laurencia cf. obtusa</i>	
<i>Nienburgia serrata</i>	
<i>Pachychaeta cryptoclada</i>	
<i>Peyssonnelia capensis</i>	
<i>Placophora binderi</i>	
<i>Pollexfenia minuta</i>	
<i>Pterosiphonia spinifera</i>	
<i>Sargassum elegans</i>	
<i>Symphyclocladia cf. marchantioides</i>	

For species with west coast affinities, the lack of dominance by west coast species in the Hangklip area indicates that a gradual or drastic loss of cold-water species occurs west of Cape Hangklip. The significantly higher temperatures of False Bay (sites 8, 9 and 10, Bolton 1986) may be instrumental in limiting the eastward spread of many west coast species. A re-evaluation of seaweed distributional information may reveal that the western boundary of the overlap is in the vicinity of Cape Point. More detailed collections in other sectors of the overlap region and subsequent mapping of the intermixing of species is needed to elucidate more clearly the factors limiting distribution of many south and west coast species.

Detailed reports of local seaweed diversity include: the region west of Cape Agulhas to the Namibia/Angola border (268 taxa, Bolton 1986); De Hoop Nature Reserve (126 taxa, Bolton & Stegenga 1990); East Cape coast (Cape St. Francis to Kei mouth) (276 taxa, Seagrief 1988); Bird Island (122 taxa, Anderson & Stegenga 1989); and Hluleka, Transkei (178 taxa, Bolton & Stegenga 1987). The seaweed species diversity of Cape Hangklip compares favourably with data from other parts of the temperate southern African region. The floristic richness of this region may be attributed to a wide variety of microhabitats for growth, the nature of the overlap of two distinct floras, and infrequent summer upwelling with consequent relatively stable temperature conditions.

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**Appendix 1** List of algae from the Hangklip area. The species nomenclature follows Seagrif (1984), and those species not catalogued by Seagrif are marked with an asterisk. Brief descriptions and taxonomic notes on noteworthy records are included.

### Chlorophyta

- \* *Acrochaete viridis* (Reinke) R. Nielsen
- Bryopsis cf. setacea* Her.
- Bryopsis* sp.
- Caulerpa bartoniae* Murray
- Caulerpa filiformis* (Suhr) Her.
- Caulerpa holmesiana* Murray
- Chaetomorpha aerea* (Dillw.) Kuetz.
- Chaetomorpha antennina* (Bory) Kuetz.
- Chaetomorpha robusta* (Aresch.) Papenf.
- \* *Chloropelta caespitosa* Tanner
- Cladophora capensis* (C. Ag.) De Toni
- Cladophora flagelliformis* (Suhr) Kuetz.
- Cladophora mirabilis* (C. Ag.) Rabenh. in Hohenack.
- Cladophora prolifera* (Roth) Kuetz.
- Cladophora radiosa* (Suhr) Kuetz.
- Cladophora* sp.
- Codium duthieae* Silva
- Codium fragile* (Suring.) Hariot subsp. *capense* Silva
- Codium papenfussii* Silva
- Codium platylobium* Aresch.
- Codium stephensiae* Dickinson
- Enteromorpha intestinalis* (L.) Link in Nees
- Enteromorpha cf. prolifera* (O.F. Muell.) J. Ag.
- \* *Halicystis* sp.
- Ulva capensis* Aresch.
- Ulva rigida* C. Ag.
- Ulva* sp.

### Phaeophyta

- Anthophycus longifolius* (Turner) Kuetz.
- Axillariella constricta* (J. Ag.) Silva
- Bifurcaria brassicaeformis* (Kuetz.) Barton
- Bifurcariopsis capensis* (Aresch.) Papenf.
- Carpomitra* sp.
- Chordariopsis capensis* (Kuetz.) Kylin
- Colpomenia sinuosa* (Roth) Derbés et Solier in Castagne
- Desmarestia firma* Skottsberg in Nordenskjöld
- Dictyota dichotoma* (Huds.) Lamour.
- Ecklonia maxima* (Osbeck) Papenf.
- Ectocarpus siliculosus* (Dillw.) Lyngb.
- Feldmannia irregularis* (Kuetz.) Hamel
- Halopteris funicularis* (Montagne) Sauvageau
- Iyengarina stellata* (Boerg.) Boerg.
- Laminaria pallida* Greville ex J. Agardh
- Leathesia difformis* (L.) Aresch.
- Macrocystis angustifolia* Bory
- Phloiocaulon squamulosum* (Suhr) Geyler
- Ralfsia verrucosa* (Aresch.) J. Ag.
- Sargassum elegans* Suhr
- Sargassum heterophyllum* (Turner) C. Ag.
- Sphacelaria* sp.
- Splachnidium rugosum* (L.) Grev.
- Zonaria harveyana* (Pappe ex Kuetz.) Aresch.
- Zonaria subarticulata* (Lamour.) Papenf.

## Rhodophyta

- \* *Acrochaetium catenulatum* Howe  
*Acrosorium acrospermum* (J. Ag.) Kylin  
*Acrosorium maculatum* (Kuetz.) Papenf.  
*Acrosorium uncinatum* (Turner) Kylin  
*Aeodes orbitosa* (Suhr) Schmitz  
*Amphiroa cf. beauvoisii* Lamour.  
*Amphiroa capensis* Aresch. in J. Ag.  
*Amphiroa ephedraea* (Lamarck) Decaisne
- \* *Anotrichium tenue* (C. Ag.) Naegeli
- \* *Antihamnion cf. diminutum* Wollaston  
*Antihamnion* sp.: Only a small sterile fragment was found of an *Antihamnion* species which is different from South African species described so far. Plants attach by multicellular haptera originating from basal cells of opposite branchlets. The main (prostrate) axis is 40 – 50  $\mu\text{m}$  in diameter and cells about three times longer than broad. Branchlets are opposite, decussate in successive segments, up to 300  $\mu\text{m}$  long, ca. 20  $\mu\text{m}$  in diameter basally, tapering towards the apex and with a deciduous acute apical cell. Opposite branchlets are sometimes simple, but usually with a pectinate series of 3 – 5 ramuli. Gland cells are rare, occurring on a four-celled branchlet in the position of an ordinary ramulus. Indeterminate laterals replacing a determinate branchlet are adventitious and originate from the basal cell of a determinate branchlet. To date three species of *Antihamnion* are known from the Southern African coast outside of Natal; *A. diminutum* Wollaston, *A. pseudoarmatum* Stegenga and the Namibian species *A. leptocladum* (Montagne) Wynne. Both *A. pseudoarmatum* and *A. leptocladum* have pectinate opposite branchlets, but differ from our material in the distichous arrangement of the branchlets. The same applies to *A. secundum* Itono, the only one of several Natalian species that shows a superficial similarity with our species (*cf.* Norris 1987).
- \* *Aphanocladia cf. skottsbergii* (Levring) Ardré: Plants with prostrate filaments, erect axes at frequent intervals and about 7 mm tall. Four pericentrals and no secondary cortication. Erect axes, once pinnately branched, have alternating laterals every other segment, the non-lateral bearing segments with a prominent 'scar cell' (= reduced lateral initial). No reproductive structures were found. Comparing our specimen with the literature, it shares with *A. skottsbergii* the once pinnately branched erect axes and the regular distribution of laterals (*cf.* Ardré 1970). *A. skottsbergii* is known from the eastern South Pacific. The genus *Aphanocladia* appears to be a new record for South Africa.
- Apoglossum ruscifolium* (Turner) J. Ag.  
*Aristothamnion collabens* (Rudolphi) Papenf.  
*Arthrocardia duthiae* Johansen  
*Arthrocardia flabellata* (Kuetz.) Manza  
*Arthrocardia cf. palmata* (Ellis et Solander) Aresch. in J. Ag.  
*Arthrocardia* sp.
- \* *Audouinella endophytica* (Batters) Dixon: New to South Africa and found growing in the cell wall of an unidentified member of the Ceramiaceae (see below). *A. endophytica* is known from the European Atlantic as well as the eastern North Pacific (Garbary 1987).
- \* *Ballia callitricha* (C. Ag.) Kuetz.  
*Bartoniella crenata* (J. Ag. ex Mazza) Kylin
- \* *Bornetia repens* Stegenga
- \* *Bostrychia intricata* (Bory) Montagne  
*Botryocarpa prolifera* Grev.
- \* *Callihamnion cordatum* Boerg.  
*Callophycus densus* (Sonder) Kraft  
*Carpoblepharis flaccida* (C. Ag.) Kuetz.  
*Caulacanthus ustulatus* (Turner) Kuetz.  
*Centroceras clavulatum* (C. Ag. in Kunth) Montagne
- \* *Centroceras distichum* Okamura: This species, known from southern Japan (Itono 1977), was found growing epiphytically on *Amphiroa* sp. and on crustose corallines. It differs from *C. clavulatum* (the only other species of *Centroceras* known from South Africa) in: (i) the prostrate rather than erect habit; (ii) the alternate rather than dichotomous branching, laterals being formed at intervals of 4 – 6 segments; (iii) the slightly fewer periaxial cells, viz. 8 – 14 rather than the 16 – 20 in South African *C. clavulatum*; (iv) the tetrasporangia being embedded, as opposed to exerted in *C. clavulatum* (*cf.* Stegenga 1986).
- Ceramiaceae indet.: A species of as yet uncertain affinities, probably representing a new genus. Thus far only male and tetrasporangial specimens have been found. In external appearance it resembles small species of *Griffithsia* or *Bornetia*, with several erect filaments arising from a prostrate filamentous part. Erect filaments up to 10 mm high, ca. 300  $\mu\text{m}$  in diameter and virtually unbranched, though a fascicle of branchlets bearing the reproductive structures is provided at the apex. Tetrasporangia and globose spermatangial heads (on separate plants) in adaxial double rows on the cells of the terminal fascicle and up to 8 or 10 sporangia or male capitula per cell. To our knowledge no other member of the Ceramiaceae shows a similar arrangement of reproductive structures and its taxonomic affinities can only be established after the study of female reproductive material.
- Ceramium capense* Kuetz.  
*Ceramium centroceratiforme* Simons  
*Ceramium glanduliferum* Kylin  
*Ceramium papenfussianum* Simons  
*Ceramium planum* Kuetz.  
*Ceramium tenerrimum* (Martens) Okamura  
*Champia compressa* Harv.  
*Champia lumbricalis* (Roth) Desvaux  
*Cheilosporum cultratum* (Harv.) Aresch. in J. Ag.  
*Cheilosporum sagittatum* (Lamour.) Aresch.  
*Chondria capensis* (Harv.) Falkenb.  
*Chylocladia capensis* Harv.
- \* *Colaconema caespitosum* (J. Ag.) comb. nov. (basonym: *Callihamnion caespitosum* J. Ag. 1851:18): Formerly known from South Africa as *C. botryocarpum* (Harv.) J. Ag. (Stegenga 1985). Bidoux and Magne (1989) have demonstrated that this species complex within the Acrochaetiaceae should be split up into two entities, one widely distributed in temperate areas to be known as *Rhodothamniella caespitosa* (J. Ag.) Feldmann, the other from tropical and subtropical Atlantic localities and known as *Rhodothamniella codicola* (Boerg.) Bidoux ex Magne. Our west Cape material, including the Hangklip specimens, undoubtedly belongs to the former species. Specimens previously collected from Transkei (Bolton & Stegenga 1987) were found to belong to the latter species. Since we believe that these species belong in the genus *Colaconema* rather than in *Rhodothamniella*, a new combination becomes necessary: *Colaconema caespitosum* (J. Ag.) comb. nov.
- \* *Colaconema daviesii* (Dillw.) Stegenga
- \* *Colaconema nemalionis* (De Notaris) Stegenga
- \* *Colaconema plumosum* (Drew) Woelkerling  
*Colaconema* sp.: A semi-endophytic species on/in *Anthophycus longifolius*. Plants with a large basal cell immersed in the epidermis of the host, a rhizoidal multicellular endophytic part and two or three short erect filaments that bear the reproductive structures (i.e. monosporangia). The basal cell measures up to 20  $\times$  15  $\mu\text{m}$ , emergent filaments rarely measure longer than 150  $\mu\text{m}$  and 5 – 6  $\mu\text{m}$  in diameter often tapering towards the apex, and the monosporangia terminal or lateral measure 13 – 15  $\times$  8 – 10  $\mu\text{m}$ . The endophytic system gives rise to secondary emergent axes that can be distinguished by the absence of a much enlarged basal cell. The presence of a large basal cell (apparently the persistent original spore) suggests that this species belongs to the gametophytic part of the genus *Colaconema*.
- \* *Compsothamnionella sciadophila* Stegenga  
*Corallina officinalis* L.  
*Corallina* sp.  
*Dasya scoparia* Harv. ex J. Ag.  
*Dasya* sp.
- \* *Delesseria papenfussii* Wynne  
*Delisea flaccida* (Suhr) Papenf.  
*Epymeria capensis* (J. Ag.) Papenf.  
*Erythrocladia* sp.: Plants epiphytic on *Cladophora* sp., at first flat discoid becoming pulvinate and forming semiglobose cushions up to 0.5 mm in diameter. In a cross-section of the thallus, the cells are arranged in a monostromatic layer on the periphery of the cushion, the centre of the thallus being mucilaginous and devoid of cells. Cells are radially elongate, 5 – 10  $\mu\text{m}$  in

- diameter and up to 50  $\mu\text{m}$  long and with a stellate chloroplast. Reproduction is via monospores cut off towards the exterior of the plant by unequal division of vegetative cells. This species is reminiscent of pulvinate species of the genus *Erythrotrichia* (e.g. *E. pulvinata* Gardner and *E. tristanensis* Baardseth), but we have not observed erect filaments in our material. It differs from *Erythrocladia polystromatica* Dangeard in being strictly monostromatic.
- Erythroglossum* sp.: An as yet undescribed species, also known from the East Cape (Seagrief 1988).
- Falkenbergia rufolanosa* (Harv.) Schmitz in Engler et Prantl  
*Gelidium abbotiorum* R.E. Norris  
*Gelidium capense* (Gmelin) Silva  
*Gelidium pristoides* (Turner) Kuetz.
- \* *Gelidium pteridifolium* Norris, Hommersand et Fredericq  
*Gelidium cf. reptans* (Suhr) Kylin  
*Gigartina bracteata* (Gmelin) Setch. et Gard.  
*Gigartina insignis* (Endlicher et Diesing) Schmitz in Barton  
*Gigartina paxillata* Papenf.  
*Gigartina pistillata* (S.G. Gmelin) Stackhouse  
*Gigartina radula* (Esper) J. Ag.  
*Gigartina scutellata* (Her.) Simons  
*Gigartina stiriata* (Turner) J. Ag.  
*Gracilaria capensis* Schmitz ex Mazza  
*Gracilaria verrucosa* (Huds.) Papenf.
- \* *Grateloupia doryphora* (Montagne) Howe: A large foliaceous species with proliferations from the margins, apparently not recognized from South Africa before. Irvine (1983) states that '... foliose plants belonging to the genus *Grateloupia* ... are probably all conspecific with *G. doryphora*.' The morphological variation of the South African material is in actual fact very large and might well include the more familiar *G. longifolia* Kylin.
- Grateloupia filicina* (Lamour.) C. Ag.  
*Grateloupia longifolia* Kylin  
*Griffithsia confervoides* Suhr
- \* *Griffithsia subbiconica* Stegenga  
*Gymnogongrus glomeratus* J. Ag.  
*Gymnogongrus polycladus* (Kuetz.) J. Ag.  
*Helminthocladia papenfussii* Kylin  
*Helminthora furcellata* (Reinbold apud Tyson) Martin  
*Heringia mirabilis* (C. Ag.) J. Ag.  
*Herposiphonia prorpens* (Harv.) Schmitz in Engler  
*Heterosiphonia crispa* (Suhr) Falkenb.  
*Heterosiphonia dubia* (Suhr) Falkenb.  
*Hildenbrandia pachythallos* Dickinson  
*Hildenbrandia rosea* Kuetz.  
*Hypnea ecklonii* Suhr  
*Hypnea spicifera* (Suhr) Harv. in J. Ag.  
*Iridaea capensis* J. Ag.  
*Jania adhaerens* Lamour.
- \* *Jania capillacea* Harv.  
*Jania crassa* Lamour.  
*Jania verrucosa* Lamour.  
*Jania* sp.  
*Kallymenia agardhii* R.E. Norris  
*Kallymenia schizophylla* J. Ag.  
*Laurencia flexuosa* Kuetz.  
*Laurencia glomerata* Kuetz.  
*Laurencia cf. obtusa* (Huds.) Lamour.
- \* *Lomathamnion capense* Stegenga  
\* *Lomathamnion humile* (Kuetz.) Stegenga
- \* *Microcladia gloria-spei* Stegenga  
*Nemastoma lanceolata* J. Ag.  
*Nienburgia serrata* (Suhr) Papenf.  
*Nothogenia erinacea* (Turner) Parkinson  
*Ophiodocladus simpliciusculus* (Crouan) Falkenb.  
*Pachychaeta cryptoclada* Falkenb.  
*Pachymenia carnosa* (J. Ag.) J. Ag.  
*Pachymenia cornea* (Kuetz.) Chiang  
*Peyssonnelia capensis* Montagne  
*Phyllymenia belangeri* (Bory) Setchell et Gardner  
*Placophora binderi* (J. Ag.) J. Ag.
- \* *Platythamnion cf. capense* Stegenga  
*Pleonosporium harveyanum* (J. Ag.) De Toni  
*Plocamium beckeri* Simons  
*Plocamium corallorhiza* (Turner) Harv. in Hooker et Harv.  
*Plocamium cornutum* (Turner) Harv.  
*Plocamium maxillosum* (Poiret) Lamour.  
*Plocamium rigidum* Bory in Bélanger  
*Plocamium suhrii* Kuetz.  
*Pollexfenia laciniata* Harv.  
*Pollexfenia cf. minuta* (Kylin) Papenf.  
*Polyopes constrictus* (Turner) J. Ag.  
*Polysiphonia incompta* Harv.  
*Polysiphonia urbana* Harv.  
*Polysiphonia virgata* (C. Ag.) Sprengel  
*Porphyra capensis* Kuetz.  
*Pterosiphonia cloiophylla* (C. Ag.) Falkenb. in Schmitz
- \* *Pterosiphonia spinifera* (Kuetz.) Norris et Aken: Earlier recognized in Natal (Norris & Aken 1985), the present record presents a considerable extension of the known range of distribution.
- Pterosiphonia* sp.: Thallus compressed and pinnate. Segments with five pericentral cells, developing complete cortication. Material not fertile. Differs from other compressed South African species [*P. cloiophylla* and *P. stangeri* (J. Ag.) Falkenb.] by the laterals being confluent with the main axis for the proximal 6 – 8 segments (2 – 4 segments in the other species). Cortication is more developed than in *P. stangeri*, but only one layer thick, not several as in *P. cloiophylla*.
- Rhodophyllis reptans* (Suhr) Papenf.  
*Rhodymenia natalensis* Kylin
- \* *Rhodymenia linearis* J. Ag.  
*Schizymenia obovata* (J. Ag.) J. Ag.
- \* *Scinaia capensis* (Setchell) Huismann  
*Streblocladia corymbifera* (C. Ag.) Kylin  
*Stromatocarpus parasiticus* Falkenb. in Engler et Prantl  
*Suhria vittata* (L.) J. Ag.
- \* *Symphyclocladia cf. marchantioides* (Harv.) Falkenb.: Sterile material of *S. marchantioides* was earlier reported from Natal (Norris & Aken 1985). Our material is of similar habit, but it differs from earlier descriptions by the possession of only 5 pericentral cells per segment (6 – 8 in *S. marchantioides* – Ardré 1974). A light cortication is present, developing laterally between adjacent segments, especially on the dorsal side of the thallus. Our specimen was a fertile tetrasporophyte, showing the typically decaulesced thallus margin and one tetrasporangium per segment.
- Tayloriella tenebrosa* (Harv.) Kylin  
*Thamnophyllis discigera* (J. Ag.) Norris  
*Trematocarpus flabellatus* (J. Ag.) De Toni  
*Trematocarpus fragilis* (C. Ag.) De Toni  
*Vidalia serrata* (Suhr) J. Ag.  
*Wrangelia purpurifera* (Harv.) J. Ag.