MARINE BENTHIC ALGAE OF NAMIBIA

Jordi Rull Lluch

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Institut de Ciències del Mar, CMIMA-CSIC Barcelona, Spain

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Foreword

Spanish research in Namibia dates back to 1979. Since then, the Scientific Research Council (CSIC) has played a leading role in marine scientific production. The origin of this research activity must be sought within the historic framework of this country, which was not recognised as such until 1990. Before this date, Namibia's waters were open to all, and since they contain one of the world's most important fishing grounds, the 1960's saw the start of intense fishing activity by vessels flying various flags. This international fleet was already a reality by the mid-1960's, but it was not until 1972 that a commission, named the International Commission for the Southeast Atlantic Fisheries (ICSEAF), was created to manage the stocks of the South-East Atlantic. This commission, which at the time was responsible for the management of the fishery, held its first working group meeting in 1972. Three years later the first management measures were implemented, and later the responsibility for the monitoring and investigation of the different commercial species was distributed among a number of countries. Within this sphere of action, Spain was entrusted with sampling and monitoring the hake populations in Namibian waters. The Fisheries Ministry, as the financing body, and the Instituto de Ciencias del Mar of Barcelona, as the research centre, made it possible to perform intense research activity during the 1980's.

This research activity was much more ambitious than anticipated, and those monitoring surveys generated a high volume of published science. Among these publications, many doctoral theses were produced, the last one being presented in 1999. It is this last thesis which is presented here as a monograph whose quality and painstaking work are clear to see and fully explain the time that has been required to complete it. This excellent work, which will be extremely useful for the new generations of Namibian researchers, has the special characteristic of having been developed in two clearly differentiated historical periods, and demonstrates once again that scientific values are permanent and not constrained by circumstances. I also want to thank the Namibian Ministry of Fisheries and Marine Resources and the Spanish Agency of International Co-operation (AECI) which made possible the present scientific cooperation between the National Marine Information and Research Centre and the Spanish Scientific Research Council (CSIC). The gratefulness is extended to the environmental system of Namibian waters which has such great scientific interest that those of us who have had the opportunity to work in this region are well aware of the privilege this represents.

Finally, I would like to take advantage of the publication of this monograph to thank Dr. Jan Jurgens for the great interest in science and the generous support for scientists he has always shown. His unconditional support both before and after Namibia's independence has made it possible to carry out scientific works such as the study presented here.

ANA GORDOA
Guest Editor
Centre d'Estudis Avançats de Blanes - CSIC

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JORDI RULL LLUCH

Laboratori de Botànica, Facultat de Farmàcia, Universitat de Barcelona, Av. Joan XXIII s/n. 08028 Barcelona. Spain.
E-mail: rull@farmacia.far.ub.es

SUMMARY: The first comprehensive study of the marine algal flora of Namibia including descriptions and illustrations of most species is presented. The main objective of this work is to report a flora that, until now, has scarcely been studied. The work compiles all the available information on the marine benthic flora of Namibia and provides new data about it composition and biogeography, as well as detailed descriptions and remarks of most of its species. The samples on which this study is based were collected between 1986 and 1989 in the eulittoral and the upper sublittoral zones of the north half of the Namibian coast. According to the present data, the marine benthic flora of Namibia comprises 196 taxa (147 Rhodophyceae, 20 Phaeophyceae, 15 Ulvophyceae, 6 Cladophorophyceae and 8 Bryopsidophyceae), 21 of which has not been recorded from this coasts. This temperate flora is mainly characterized by a low number of species, a low proportion of Phaeophyceae and a high degree of endemism. Concerning the species number, the flora is quite poor due to both the scarce availability of colonizable substratum and the low diversity of habitats. On the other hand, the low proportion of Phaeophyceae is the reason for which the R/P and (R+C)/P ratios take disproportionately high values and so they are not useful in this geographical area. As regards the degree of endemism, the marine benthic flora of Namibia includes quite a high number of taxa endemic to southern Africa (55 taxa; 28.1% of the flora); 25 of these 55 taxa (12.8% of the flora) are endemic to the biogeographic Benguela Marine Province and only *Acrosorium cincinnatum* is endemic to the Namibian coasts.

Key words: Namibia, marine algae, morphology and anatomy, distribution, biogeography, taxonomy, check-list.

RESUMEN: ALGAS BENTÓNICAS MARINAS DE NAMIBIA. – Este trabajo recoge toda la información existente hasta el momento sobre la flora bentónica marina de Namibia y proporciona nuevos datos sobre su composición y biogeografía, además de descripciones detalladas y valoraciones críticas de muchas de sus especies. El trabajo se ha realizado a partir de muestras florísticas recolectadas entre los años 1986 y 1989 en las zonas eulitoral y sublitoral superior de la costa de la mitad norte del país, entre Walvis Bay y la desembocadura del río Kunene. Según los datos actuales, la flora bentónica marina de Namibia está representada por 196 táxones (147 Rhodophyceae, 20 Phaeophyceae, 15 Ulvophyceae, 6 Cladophorophyceae y 8 Bryopsidophyceae), 21 de los cuales no habían sido citados hasta el momento de las costas de este país. Se trata de una flora de carácter templado que se caracteriza principalmente por el bajo número de especies, la escasa proporción de feofíceas y el elevado grado de endemismo. En cuanto al número de especies, la flora de Namibia es relativamente pobre, debido a la escasa disponibilidad de substrato colonizable y a la baja diversidad de hábitats. Por otra parte, la baja proporción de feofíceas hace que los índices R/P y (R+C)/P adopten valores desproporcionadamente elevados, lo que hace que no sean aplicables en esta área geográfica. Por lo que se refiere al grado de endemismo, la proporción de táxones endémicos del sur de Africa es bastante elevada (55 táxones; 28.1% de la flora); de estos 55 táxones endémicos, 25 (el 12.8% de la flora) lo son de la Provincia Marina de Benguela y únicamente *Acrosorium cincinnatum* es endémico de las costas de Namibia.

Palabras clave: Namibia, algas marinas, morfología y anatomía, distribución, biogeografía, taxonomía, check-list.

INTRODUCTION

Namibia is a country with approximately 1500 km of coast that stretches in a north-south direction between the mouth of the rivers Kunene (17º16'S) and Orange (28º30'S). Along this coast the cold Benguela current and the descending warm waters from Angola converge. In addition, the effect of the Benguela current, together with the prevailing winds, originate a coastal upwelling system of deep

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water, cold and nutrient rich, which maintains a general high production during most of the year. The combination of both these factors confers to the Namibian coast certain ecological features which are particularly interesting. They are mainly responsible for the temperate climate of this zone, which is included in a tropical area, with its corresponding biogeographical effects. Although the Namibian coast exhibits such attractive ecological and biogeographical conditions, this zone has been scarcely studied, at least regarding its marine benthic flora. This is mainly due to the inhospitable and inaccessible characteristics of this coast, given that along much of the coast the desert dunes stretch to the sea.

Since the Institut de Ciències del Mar of Barcelona had a research project to study the fisheries of the Austral Africa, we thought it would be interesting to start a study in parallel of the marine benthic flora of Namibia. At first, the main purpose of this work was to record information about the marine flora of Namibia and consequently to contribute to filling the gap in the general knowledge of the flora of the Atlantic African coasts, which was well-known for the countries above Namibia (Lawson and John, 1987) but less so for the South African coasts, whence the scattered information was compiled into a catalogue by Seagrief (1984).

Shortly after our last collecting campaign, Lawson *et al.* (1990) gathered the sparse information about the marine benthic flora of Namibia (mainly unpublished and originating from a campaign carried out in 1957) in a paper which includes a catalogue of the flora, as well as a description of the zonation in two coastal areas and data about the biogeography. This led us to modify the main purpose of our work in order to highlight the description of the species, which was not covered in the work of Lawson *et al.* (1990) and, until recently, neither in most studies about South African flora, with which that of Namibia shares a great number of species.

This work is not meant to be an exhaustive study of the marine benthic flora of Namibia, but aims to lay the foundations for carrying out such a work in the future. In contrast, it is meant to offer a compilation of all the information available up to this moment about this subject and to contribute to the knowledge of the marine benthic flora of Namibia. In this way, we supply new data about its composition and biogeography, as well as detailed descriptions and critical remarks about many of the species that form it.

It may seem an anachronism to produce a work of these characteristics at a time when new technologies direct botany to the study of the phylogenetic relations between the species, which leads one to reconsider their taxonomic classification, or to the implementation of systematic revision of certain groups. However, we think this work is justified by the fact that most of the species of Namibian marine flora are not accurately documented. This often obliged us to resort to the original descriptions or to the classical works.

Historical background

In spite of its ecological and biogeographical interest, the coasts of Namibia have been scarcely studied from the point of view of the marine benthic algae, at least until the 1990s. Until then, the works that studied exclusively the marine algae of Namibia were few and generally very old, such as the ones by Foslie (1893), Pilger (1908) and Dinter (1919-1928). Among the more recent ones, it is worth mentioning the one by Wynne (1986) and the one by Rotmann (1987). Wynne (1986) produces a commented and illustrated catalogue of the species collected near Swakopmund during a short stay at that site. Rotmann (1987), in contrast, comments on the exploitation of *Gracilaria verrucosa* at Lüderitz Bay and studies its farming possibilities in this geographical area. It is also important to point out that during this period (in 1957) there was a field excursion organized by Professor W.E. Isaac, of the Department of Botany of the University of Cape Town, to collect seaweeds from the Namibian coasts. However, it is also noteworthy that the results from this campaign were not published until 1990, in a work about the marine algal flora of Namibia (Lawson *et al.*, 1990). During this period, several papers refer to these data citing them as Simons (1973, unpublished list) and Lawson and Isaac (1982, unpublished manuscript). Although works that specifically study the marine flora of Namibia are scant, it is also true that information about marine algae of this country can be found in mainly faunal works or in studies that focus on South African marine algae, or from other geographic areas, as well as in ecological or biogeographical works. Among the studies about fauna it is worth mentioning those by Penrith and Kensley (1970a and b) that study the zones of Lüderitz and Rocky Point respectively, and the one by Kensley and Penrith (1980) that studies the zone comprised between

False Cape Frio and the Kunene river mouth. In these works the authors describe the vertical distribution of algae and animals based on transects from the eulittoral zone. Among the works that do not specifically study Namibia, some that deal with South African marine algae produce species descriptions that were partly taken from the observation of material collected in Namibia. Such is the case of Silva (1959), Simons (1964, 1966 and 1970) and Simons and Hewitt (1976). In the same way, species descriptions partly based on material from Namibia can be found in the works that comprise a broader study area, such as the tropical Atlantic (Silva, 1960) or the southern hemisphere (Searles, 1968). On the other hand, there are works with varied subjects in which information about the distribution of certain species of the Namibian coasts can be found (Delf and Michell, 1921; Simons, 1969; Anderson and Stegenga, 1985; Anderson *et al.*, 1989) or that simply observe their presence in this country (Lawson and Price, 1969; Price *et al.*, 1978, 1986 and 1988; John *et al.*, 1979). Finally, information about Namibian marine flora can also be found in studies about vegetation (Schmidt, 1957) or biogeography (Bolton, 1986; Hommersand, 1986; Lawson, 1988).

During the 1990s the number of studies about Namibian marine algae increased significantly. It is worth mentioning the one by Lawson *et al.* (1990) which compiles all the information available hitherto and offers the first catalogue of the flora of this zone. The authors also describe the zonation type at Elisabeth Bay, Lüderitz (two localities in the south of the country) and Swakopmund, and they indicate the relations of the Namibian flora with other surrounding ones. Although it is an important contribution to the knowledge of Namibian marine flora, this work does not take into account species descriptions, most of which are scantly documented. Another work that contributes to the knowledge of the marine flora of this country is the one by Rull Lluch and Gómez Garreta (1993), in which the authors describe three species not recorded previously from the Namibian coasts. More numerous are the works that deal with algae from the point of view of the ecology, biogeography or economic interest of the species. Among the firsts, the more noteworthy ones are the one by Engledow and Bolton (1994) and the ones by Molloy and Bolton (1996a and b). In the first one, the authors analyse the influence of the environmental conditions on flora diversity in several localities along the coast, while the two others study the effect of the environmental parameters on the morphology of *Laminaria schinzii* (Molloy and Bolton, 1996a) or on the growth of *Gracilaria gracilis* (Molloy and Bolton, 1996b). On the other hand, Engledow *et al.* (1992) carry out a biogeographic study of the Namibian flora and they conclude that it is an extension of the flora of the South African west coast with little tropical influence in its northernmost region. Many of these data are more extensively treated in a recent work on the biogeography and biodiversity of the Namibian intertidal seaweed flora by Engledow (1998). Among the works that refer to the economic interest of the species, the one by Molloy (1990) provides information about the ecology and distribution in Namibia of species that produce alginic acid, agar or carrageenans, and other species suitable for human and animal consumption. On this point, the works by Molloy and Bolton (1992 and 1995) and Molloy (1998), which concentrate on the collection and farming of *Gracilaria gracilis* at Lüderitz Bay, are also noteworthy.

As in the previous decades, it is also possible to find information about the benthic marine algae of Namibia in works that study the ones from South Africa. In the ones by Chamberlain and Keats (1994), Keats and Chamberlain (1995), Chamberlain (1996) and Keats and Maneveldt (1997), that are part of a general project on the study of the South African nongeniculate corallinaceae, the authors base the description of certain species on material also collected from the Namibian coasts. Another interesting study is the one by Stegenga *et al.* (1997), the first monograph about South African seaweeds. It is a work in which the authors produce a suitably illustrated description of the species occurring on the South African west coast. They also supply keys for their identification and information about their ecology and distribution. Most of the species of the Namibian flora appear in this work. One of them (*Polysiphonia namibiensis*) is described as a new species from material collected in this country; others are cited in this geographical area for the first time, although in most cases the authors do not specify the origin of the samples and do not refer to any other work. Apart from these works, which represent an important advance in the knowledge of the Atlantic flora of southern Africa, scarcely documented until then, there are other works that give information about the distribution of some of the cited species of Namibia, such as the ones by Anderson and Bolton (1990) and Levitt *et al.* (1995).

Finally, it is also worth mentioning the works by Price *et al.* (1992), John *et al.* (1994) and Lawson *et al.* (1995) about marine algae of the Atlantic coast of tropical Africa, in which, among others, we can find the citations of certain species of red algae from Namibia.

The environment

Note: This section has mainly been elaborated from the studies by Martin (1973) and Lancaster (1989), as well as from the reviews about the Benguela ecosystem made by Shannon (1985) and Chapman and Shannon (1985). The reader is referred to these works for further information on this subject.

Coastal geology and topography

Namibia's desert stretches along the Atlantic coast of southern Africa, from 14ºS to 32ºS, and reaches its maximum width (roughly 200 Km) in the central zone, where its main sand sea is placed (Ward *et al.*, 1983; Lancaster, 1989). The so called Namib Sand Sea is located in the section of coast between Walvis Bay and Lüderitz (Fig. 1), and the dunes often reach the sea, where they are eroded by the action of the waves (Rogers, 1979). Other important, although less extensive, dune fields are the Kunene Sand Sea (Bremner, 1984) and the one of Skeleton Coast (Lancaster, 1982). Between the mouth of the Orange River and the Koichab River valley there is an extended rocky plane that is more or less covered with sand, with some disperse hills and small dune fields (Lancaster, 1989). The zone between Walvis Bay and Skeleton Coast is also constituted by an extensive rocky plane, called the Namib Platform, which represents an outcrop of Precambrian material characteristic of the marginal zone of the continent (Martin, 1973). Over this rocky plane, which is formed by mica schists and granite intrusions of the Damara geosynclinal sequence from the late Proterozoic (Lancaster, 1989), there are alignments of hills and dunes, the latter being specially abundant at the south of Swakopmund. At Skeleton Coast, the Namib Platform is more or less eroded, with dune fields and basaltic lava promontories (Kaoko Laves), which in certain places, like Rocky Point, reach the coast (Penrit and Kensley, 1970b; Martin, 1973; Lancaster, 1989; Fig. 3). The beds of the rivers Kunene (at the north) and Orange (at the south) go through the desert and represent Namibia's administrative lim-

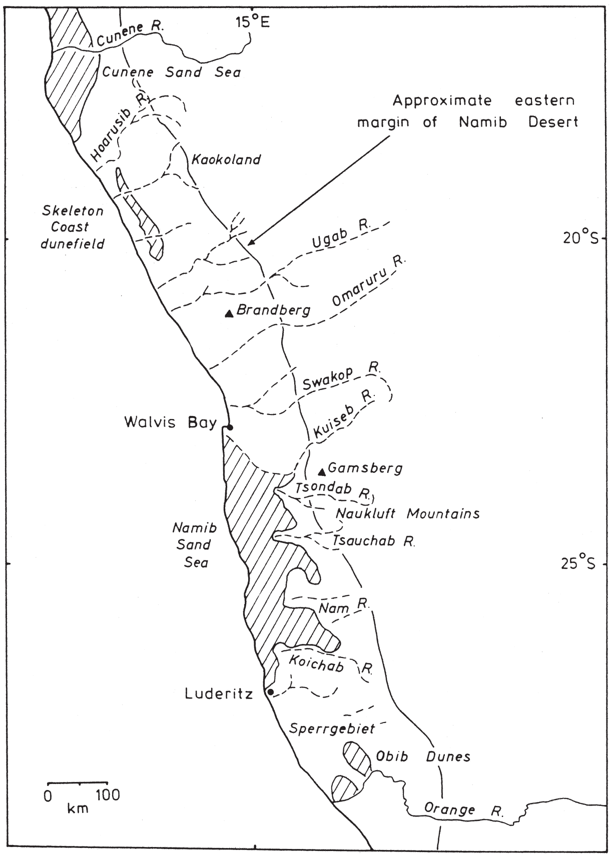

FIG. 1. – The Namib Desert: sand accumulations and major drainage systems. (After Lancaster, 1989).

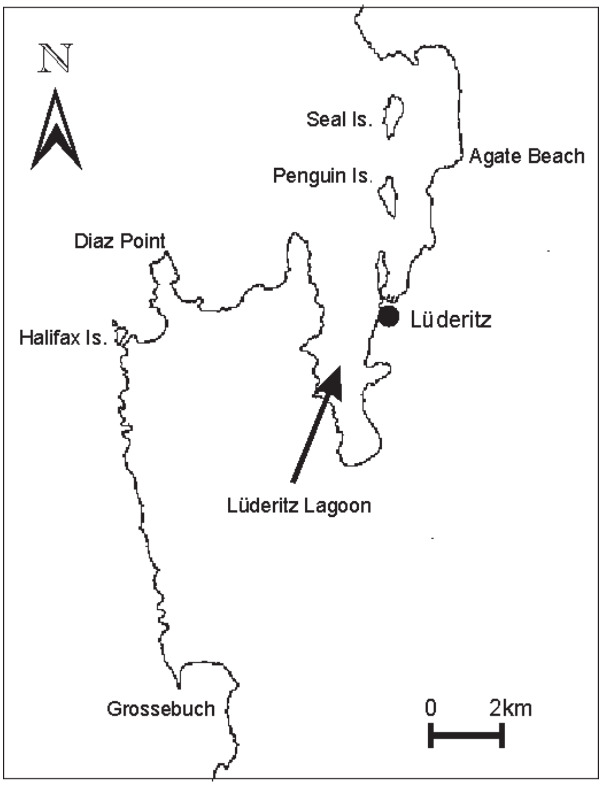

FIG. 2. – Coastal outline of the Lüderitz area showing the localities mentioned in the text.

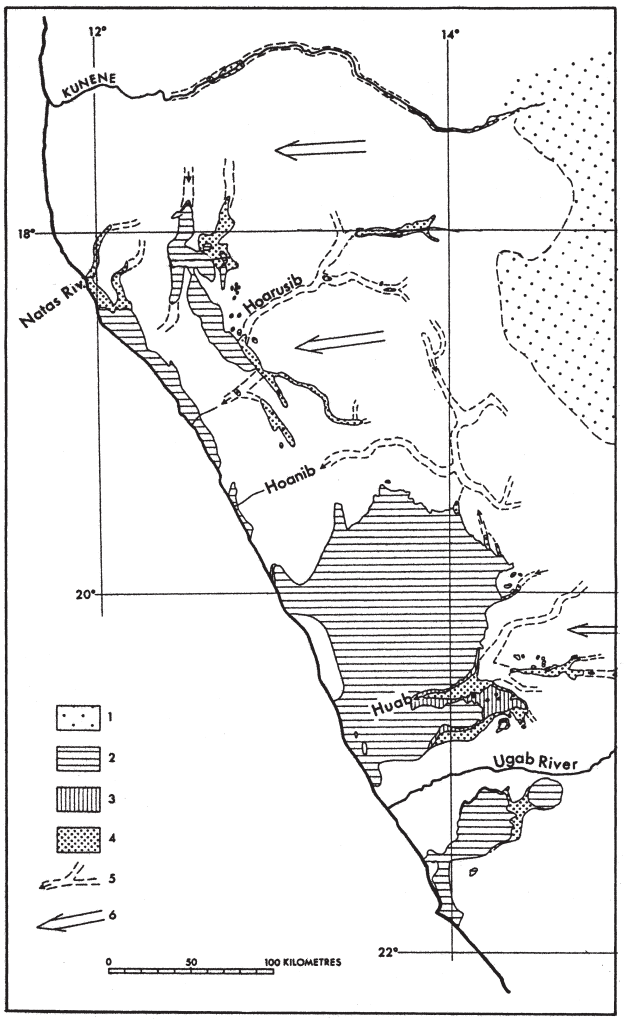

FIG. 3. – Map showing the glacial valleys of the north western part of Namibia. (1) Kalahari Beds; (2) Lower Cretaceous Kaoko Lavas; (3) Etjo Beds; (4) outcrops of glacial and periglacial Dwyka Beds; (5) parts of valley along which the Paleozoic, glacially shaped relief is still recognizable; (6) generalized direction of ice flow. (Modified after Martin, 1973).

its. Between these two rivers, which are the main ones on the western coast of southern Africa, several less important fluvial courses, generally dry, reach the coast (the Ugab, the Uniab and the Hoanib, among others). Extensive sand beaches with several occasional rocky outcrops mainly constitute the coastline (Shannon, 1985). The most important of these rocky outcrops is located in the Lüderitz area (Fig. 2). In this zone and at Walvis Bay are the main bays and sheltered sites of the Namibian coast, which in general is mainly regular (Shannon, 1985).

Between 18ºS and 28ºS, most of the Namibian coast, the average width of the continental shelf is about 140 km. It stretches up to roughly 350 m depth (Birch *et al.*, 1976), Lüderitz being its most narrow part (75 km). Opposite Walvis Bay the continental shelf is formed by two parts separated by a slope: one near the coast, that reaches around 140 m depth, and next to it the other one that penetrates up to 400 m depth. Opposite the mouth of the Kunene River the continental shelf is very narrow (45 km) and relatively less deep (it stretches up to 200 m depth). In contrast, opposite the Orange River, the continental shelf achieves its maximum width (180 km).

Climatic factors

The climate of Namibia's desert is arid or hyperarid, but relatively cold, especially in the coastal areas (Lancaster, 1989). According to this author, this is mainly due to the effect of the cold Benguela current, which flows in a northward direction along the west coast of southern Africa. One important feature of the region's climate is the strong prevailing gradient from the cold hyper-arid coastal zone (the mean annual precipitation in form of rain is roughly 15 mm) to the warmer interior zone, with a higher mean annual precipitation (87 mm).

A distinctive factor of Namibia's climate is the coastal fog, which is caused when the moisture-rich wind from the ocean freshens as a result of passing over the Benguela current. Its effect can be observed as far as 100 km inland. The fog mainly occurs during the winter months on the coast, and yields a mean annual precipitation of 34 mm (Lancaster, 1989). As a result of the fog, the humidity is fairly high (87% mean annual at Walvis Bay) although when the east wind blows it can drop to 10%. Likewise, the cold waters of the Benguela current keep the temperatures in Namibia's desert relatively moderate (the mean annual maximum daily temperature is 17°C on the coast and ranges between 28°C and 33°C inland).

The wind system is determined by the south Atlantic anticyclone, and also by the effect of the topography and the thermal differences. As a result, the prevailing winds have a southern component and are favourable to the coastal upwelling of deep waters (Shannon, 1985; Lancaster, 1989). In summer, when the anticyclone is more persistent and the thermal contrast between sea and earth is more evident, the winds deflect to the land (SSW-SW) and yield marine breezes. In autumn and winter, as a result of the establishment of a high-pressure system over the continent, east winds (berg winds) originate, and occasionally (during 10-15 days a year) reach the coast (Shannon, 1985; Lancaster, 1989). These winds are capable of transporting large quantities of sand and dust to the sea (Shannon and Anderson, 1982).

Oceanographic aspects: the Benguela System

The oceanographic features of the Atlantic coast of southern Africa are determined by both the existence of the cold Benguela Current, which represents the ascending branch of the anticyclone gyre of the south Atlantic, and the action of southerly winds, which prevail at the zone during most of the year and are responsible for the upwelling of deep and nutrient-rich waters at several sites of the coast (Shannon, 1985). The combined action of both these factors constitutes a complex circulation system named the Benguela System. It stretches from Cape Agulhas, where it receives the warm water influence from the Agulhas Current, to the converging zone with the warm Angola Current (the northern limit of the Benguela System would be roughly placed at 17ºS, although its influence is detected up to 15ºS). The Benguela System is limited towards the ocean by a more or less winding thermal front, which to the South of Lüderitz coincides approximately with the limit of the continental shelf, while it is not so well defined to the north of this locality (Shannon, 1985). According to this author, the Benguela System accomplished its total development between the end of the Pliocene and the beginning of the Pleistocene, although its origins go back to the end of the Miocene, 12 million years ago. Although upwelling phenomena probably existed before this time, the upwelling water may have had very different characteristics (temperature, salinity, nutrient concentration) in such a way that it may have sustained different fauna and flora from the ones at the end of the Miocene and later epochs (Shannon, 1985).

The Benguela System comprises several water masses with different origins. They include the south Atlantic central water, which is formed at the subtropical convergence and then sinks and travels

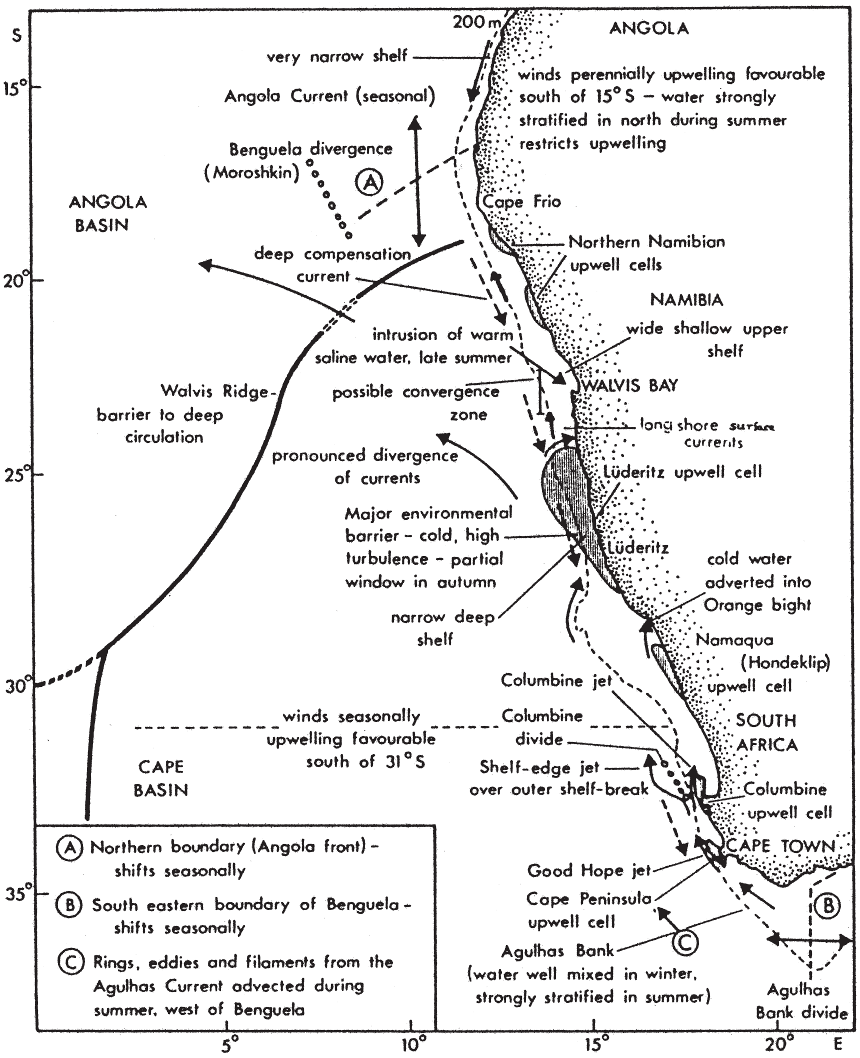

FIG. 4. – A conceptual model of the Benguela system. (After Shannon, 1985).

northwards following the Atlantic coast of southern Africa, between a deep layer of Antarctic waters and a warm surface layer (Shannon, 1985; Stegenga *et al.*, 1997). This south Atlantic central water (with a temperature of 6-16ºC and a salinity of 34.5-35.5‰; Shannon, 1985) flows in contact with the continental shelf of the Atlantic coasts of South Africa and Namibia, reaching the surface at the upwelling zones. According to Shannon (1985), the upwelling influences a maximum depth of 200 m on the central coast of Namibia; this depth generally limits the lower end of the continental shelf. The upwelling persistence and intensity vary seasonally and also yearly, mainly depending on the position of the south Atlantic anticyclone (one of the factors responsible for the prevailing winds) and the width of the continental shelf (Shannon, 1985; Stegenga *et al.*, 1997). On the South African coast the winds responsible for the upwelling show a very clear seasonal variation, and reach their maximum levels in spring and summer (Shannon, 1966), so the upwelling period stretches from September to March (Andrews and Hutchings, 1980). In contrast, on the coasts of Namibia, winds have a less seasonal character and the upwelling is produced permanently, although its intensity varies seasonally (Shannon, 1985). Below 25ºS the upwelling reaches a maximum intensity during the spring-summer period and a minimum in autumn; northwards of this latitude, the upwelling intensity is maximum at the end of the winter and in spring (Stander, 1964; Schell, 1968). The main upwelling zone of the Benguela System is found around Lüderitz (27ºS) and represents a border for the migration of organisms. It divides the system into two parts: the southern zone and the northern zone (Shannon, 1985; Shannon and Pillar, 1986; Agenbag and Shannon, 1988). The more important upwelling areas of the northern zone of the Benguela System are located at Conception Bay (24º S), Palgrave Point (between 20º S and 21º S) and to the south of Cape Frio (between 18º S and 19º S). The area between Walvis Bay and Palgrave Point represents a transitional zone characterised by the low intensity of the upwelling (Fig. 4).

The northern limit of the Benguela System, between 15º S and 20º S, is an oceanographically complex zone due to the interaction between the Benguela and Angola Currents. The convergence zone of the surface waters of both these currents is located around 17ºS near the coast, and penetrates to the ocean in a south-west direction (Fig. 4). At the surface level, the differences of temperature and salinity between the two water masses are 4ºC and 0.4‰ respectively (Shannon, 1985). According to this author, the latitudinal position of this front also changes seasonally between 15ºS (winter) and 18ºS (March), which causes a warming of the coast of the extreme north of Namibia in autumn. However, when the atmospheric conditions are favourable in the south Atlantic, the warm and relatively more saline waters from the Angola Current may reach higher latitudes, which causes a warming in the northern part of the Benguela System comparable to the one that the phenomenon El Niño produces on the coasts of Peru (Shannon *et al.*, 1986). These warm water intrusions normally take place in autumn, when the intensity of the upwelling is lower (Shannon, 1985). The last great warm water intrusions in the Benguela System took place in 1963, 1984 and April 1986. During the last one, the intrusion of warm water from Angola reached the nearing zones of Cape Cross (Boyd *et al.*, 1987).

Concentration of oxygen and nutrients. One of the main characteristics of the Benguela System, and particularly of the Namibian coasts, is the existence, at depth, of zones where the oxygen concentration in the water is very low (Copenhagen, 1953; Stander, 1964; Calvert and Price, 1971; Chapman and Shannon, 1985). This fact has been related to the death of fishes and other organisms (Stephenson, 1948; Copenhagen, 1953; De Decker, 1970; among others). According to Chapman and Shannon (1985), the anoxic water may have a local origin, as a result of the decomposition of organic material (the Benguela System is one of the most productive on Earth), or it may have originated in the centre of formation of anoxic water facing Angola (Bubnov, 1972). In the first case, the anoxic water is located over the continental shelf, while in the second, the water flows to the south following a deep current that normally reaches 25º S, forming a tongue at roughly 300 m depth, more or less parallel to the coastline and near the continental shelf, where it can settle after being elevated because of the upwelling. This anoxic water may reach oxygen concentrations of 1 ml·l^{-1} or lower, which contrast with the 4.8-5.2 ml·l^{-1} (80-85% saturation) of the south Atlantic central water (Chapman and Shannon, 1985). The oxygen concentration is higher near the coast due to the aeration that waves produce (Copenhagen, 1953). The production and consumption of oxygen and the concentration of nutrients do not show a clear sea-

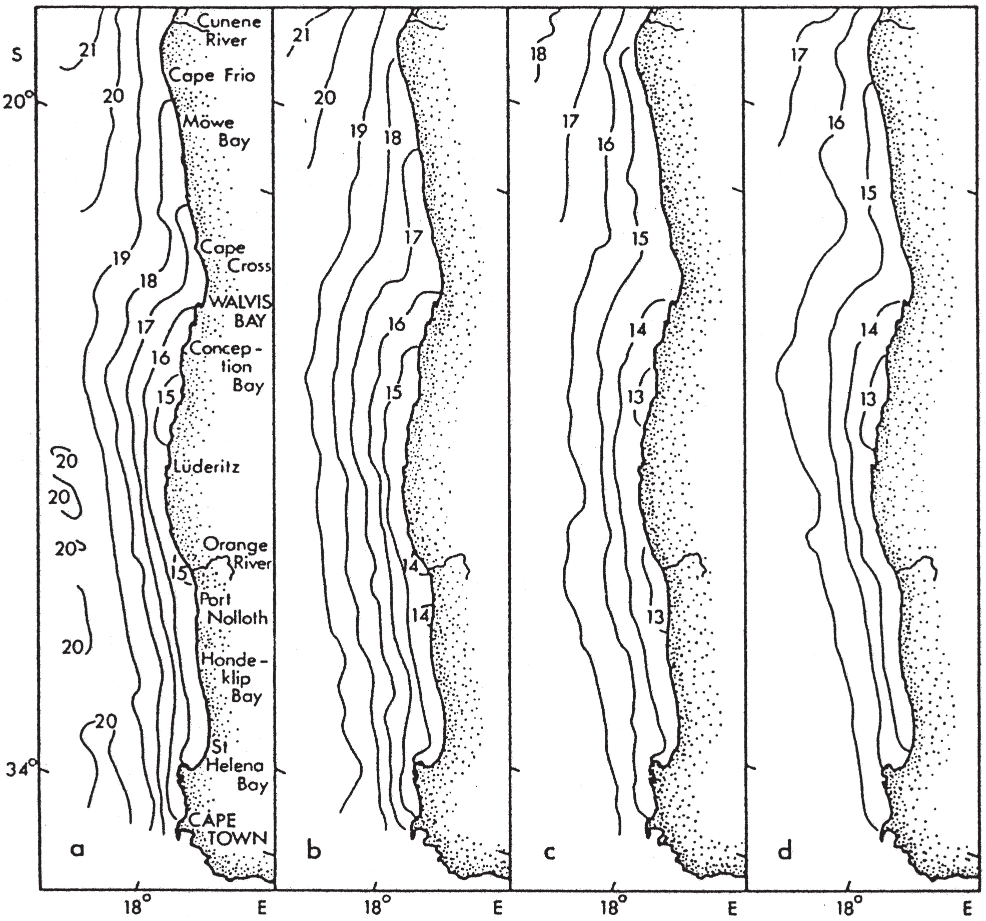

FIG. 5. – Average seasonal sea surface temperature (ºC) in the Benguela system: a: summer; b: autumn; c: winter; d: spring. (After Shannon, 1985).

sonal variation, but they depend mainly on the existence and intensity of the upwelling (Chapman and Shannon, 1985).

The concentration of nutrients is relatively high and similar to that of other upwelling areas. According to Chapman and Shannon (1985), the coastal waters of Namibia have nitrate and phosphate concentrations that generally fluctuate between 10 and 30 µM and between 2 and 3 µM respectively. These values are higher than those of the south Atlantic central water (10-18 µM of nitrate and 0.8-1.5 µM of phosphate).

Water temperature. As a result of the upwelling, the mean seawater temperature of Namibia is relatively low, especially considering that the tropic of Capricorn crosses the middle of the country. At Lüderitz, where the upwelling is intense and persistent all year round, the mean annual temperature is 13.7ºC and the mean temperatures of the coldest and warmest months during the period 1973-1982 were 12.7ºC and 14.8ºC respectively (Bolton, 1986). Northwards, at Walvis Bay, the upwelling is less intense and the temperatures slightly higher (15.8ºC mean annual temperature, 14.4ºC mean temperature for the coldest month and 17.9ºC mean temperature for the warmest one; Bolton, 1986). O'Toole (1980) produces surface water temperature data for the northern area of the Benguela System that fluctuate between 12ºC (water from the upwelling) and 22ºC (water from Angola). Seasonally (Boyd and Agenbag, 1985; Shannon, 1985), the surface water temperature of the Benguela System shows its lowest values in winter and spring, the period when the upwelling is most intense on the Namibian coasts; at this time, temperatures along the whole of the coast, and up to 300 km to the open sea, are lower than 16°C. In summer and autumn the cold water area (temperature below 16°C) is narrower and contracts southerly, reaching only to Walvis Bay (Fig. 5). These seasonal variations, based on data for the period 1968-1980, reflect the changes in insolation, upwelling, vertical mixing and the intrusion of warm water from Angola, but dilute the specific effect of the coastal upwelling (Shannon, 1985). In addition, we must bear in mind that in the periods when considerable intrusions of warm water occur, the distribution of temperatures along the coast may be different, especially in Namibia (Fig. 6).

Other parameters. In Namibia, as on the rest of the south Atlantic African coast, tides follow a semi diurnal pattern, with two periods of high tide and two periods of low tide within 24 hours. The amplitude of the tide is not great and generally varies between under 1.5 m (very seldom 1.8 m) during spring tide and just over one meter during the neap tide (Lawson *et al.*, 1990).

In general, the coast of Namibia is subject to the direct and nearly constant action of the waves (Branch and Griffiths, 1988; Molloy 1990; Lawson *et al.*, 1990; Engledow *et al.*, 1992) although in the Lüderitz area, at Walvis Bay and at Swakopmund there are more or less sheltered zones. On the other hand, and partly due to the high productivity of the zone, which is made evident by the accumulation of brownish froth over the sand of some beaches (Campbell and Bate, 1997), the transparency of the water is low, especially along the coast of the northern half of the country (Engledow *et al.*, 1992).

Area of study

At the very beginning, when we were planning how to carry out this study, we intended to sample several places along the Namibian coast to be able to offer a general vision of the benthic marine flora of this country. During the first two campaigns samples were taken from the localities included in the Skeleton Coast National Park and during the third it was planned to sample the centre and south areas of the country. Nearly the whole coastline of the southern half of Namibia is a restricted passage area due to diamond mining. This limited our sampling zone to only the Lüderitz area, roughly 400 km south of Walvis Bay. As it was impossible to access this area from the coast, which obliged us to cover a distance of nearly 1000 km through the interior of the country before reaching this locality, and due to the campaign limitations, we decided to sample only the central zone, between Sandwich Harbour, a small bay located 40 km south of Walvis Bay, and the southern end of Skeleton Coast National Park.

Consequently, all samples used in making this work were collected in localities along the coast stretching between Walvis Bay and the Kunene River mouth, totalling roughly 700 km of coast mainly occupied by dunes and saltpans (Fig.7).

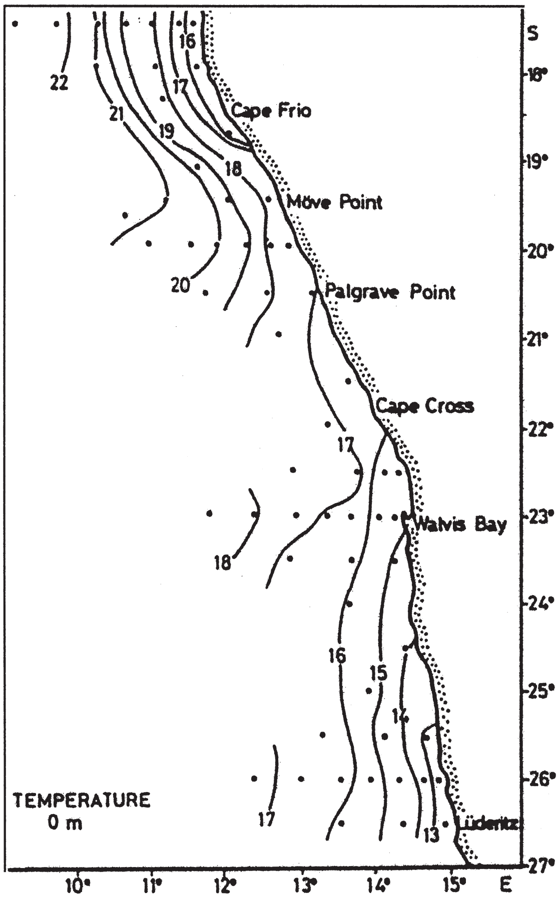

FIG. 6. – Distribution of the surface temperatures (ºC) in the northern Benguela region during the oceanographic survey carried out in April 1986. (After Pagès, 1991).

The coastal area between Walvis Bay and the entrance of Skeleton Coast National Park (roughly 200 km of coast) is a very popular area for anglers. Except for Swakopmund city, the colony of seals of Cape Cross and some inhabited areas, the only places that have an access to the sea are the zones where fishing is practised. In general, it is a very uniform sandy area, with scattered rocky outcrops of little importance.

The coast of Skeleton Coast National Park, from the mouth of the Ugab River (roughly 190 km north of Swakopmund) to the Kunene River mouth, about 500 km in a northward direction, is a restricted access zone, especially from Terrace Bay, from which a practically uninhabited coastal band of difficult access stretches. The southern part, up to Terrace Bay, is the most frequented zone, especially by anglers. On the whole, it is also a very uniform sandy area, with sparse rocky outcrops. The most relevant are the ones at Terrace Bay, Möwe Bay, Rocky point, Cape Frio, Angra Fria and some scattered small groups of rocks to the north.

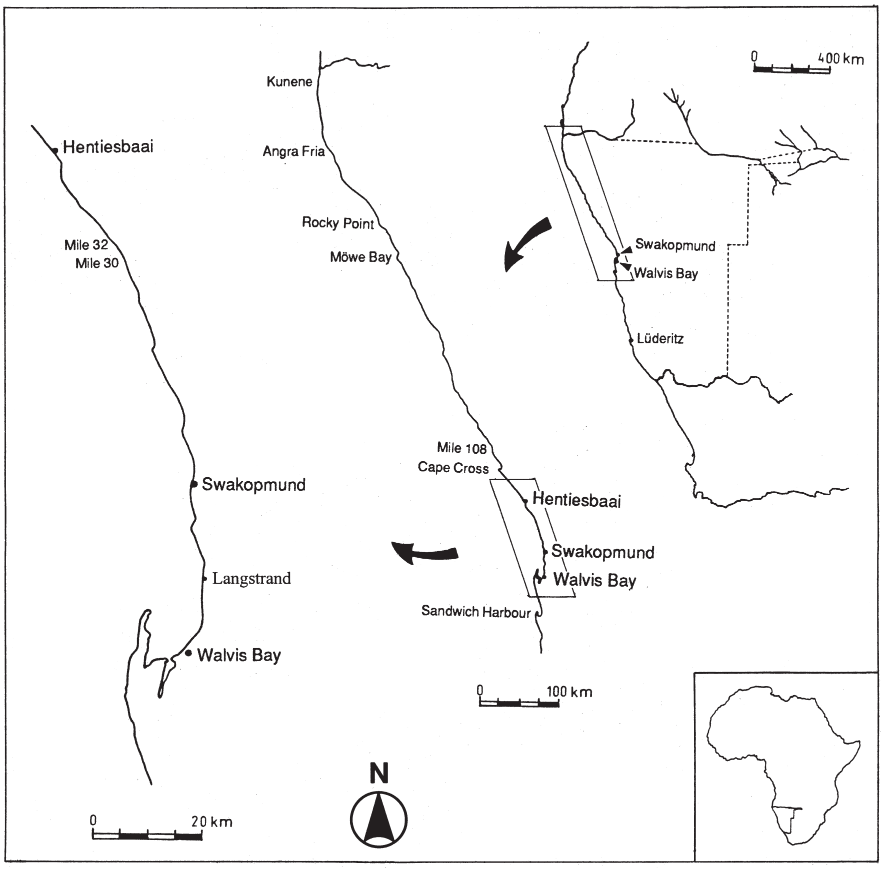

FIG. 7. – Map of Namibia and detail of the coast of the northern half of the country, showing the sampling localities.

Due to the scarcity of the rocky substrata that are liable to be colonised by vegetable species, we tried to sample in all the rocky outcrops that we were able to find. A lot of the sea incursions were unfruitful during the search, others only provided drift material samples, and sometimes we only found some isolated blocks totally devoid of macroscopic vegetation.

Sampled localities

We will now give a brief description of the sampling localities, indicating some of the more well represented species for each of them. To this end we have used the field observations carried out during the campaigns and the composition of the collected samples, although they were often collected at random and with a mainly floral aim. Thus, we do not pretend to describe the type of zonation, but we would like to give a tentative idea of the type of vegetation that was developing when we took the samples, although sometimes the available information allowed us to indicate the relative position of the species.

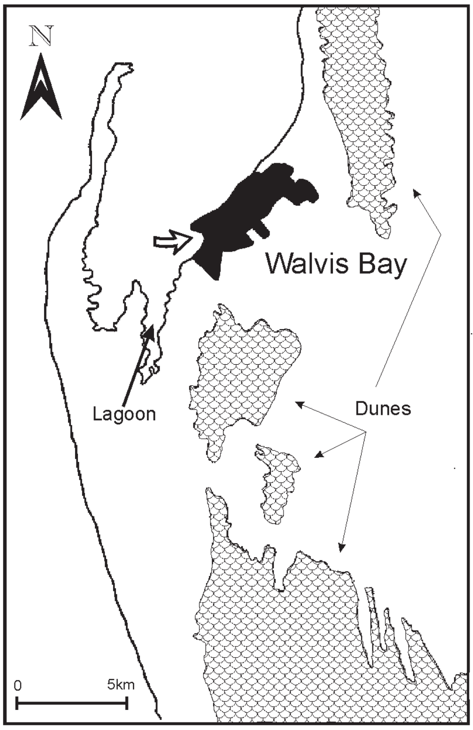

FIG. 8. – Coastal outline of Walvis Bay area. The white arrow shows the sampling site.

The Lagoon (Walvis Bay).(Figs. 7, 8). This is a small, elongated, shallow bay located at the end of the bay of Walvis Bay that is very frequented by a high number of aquatic birds. The scant samples from this locality were collected at the outermost part of the lagoon, in a very sheltered zone near the city of Walvis Bay. The bottom was constituted by free small rocks and the macroscopic vegetation was mainly formed by *Porphyra capensis, Ulva rigida, Streblocladia corymbifera* and *Polysiphonia nigra.*

Langstrand (Figs. 7, 9). This is a resort area located near the sea, about 20 km north of Walvis Bay. The zone is directly open to the sea and continuously beaten by the waves. The particular sampling place was at the south of a jetty and consisted of a flat rocky outcrop with some water inlets and some tide pools. Regarding the vegetation, the eulittoral zone was predominated by ulvaceae (*Ulva spp.* and *Enteromorpha spp.*), although *Porphyra capensis, Mazzaella capensis, Streblocladia corymbifera* and *Caulacanthus ustulatus* also were well represented; *Chaetomorpha aerea, Cladophora capensis* and *Codium decorticatum* were the most abundant species in the tide pools; the invertebrate fauna was very well represented, with a great quantity of mussels, sea anemones, limpets and barnacles, that practically covered all the substratum. *Laminaria pallida* was the most abundant species in the upper sublittoral zone.

Rocky outcrops 5 km south of Swakopmund (Figs. 7, 10). This is a rocky platform with water inlets and tide pools. It is similar to the Langstrand area, equally oriented to the open sea, but relatively more extensive, and with less abundant invertebrate fauna in the eulittoral zone, where the vegetation was better represented. *Porphyra capensis* appeared in a disperse way in the upper part of this zone; in the lower half, the substratum was almost completely covered by a dark carpet formed, among other species, by *Ahnfeltiopsis glomerata* and *Caulacanthus ustulatus; Ulva fasciata, U. rigida, Nothogenia erinacea, Mazzaella capensis, Acrosorium cincinnatum, Gymnogongrus* sp., *Codium fragile* subsp. *capense* and *Chaetomorpha aerea* were also fairly abundant; at the lowest level, *Chondria capensis, Corallina* sp., *Rhodymenia obtusa* and *Pterosiphonia complanata* were also well represented. The upper sublittoral zone was dominated by a population of *Laminaria pallida*, a species that often bears *Carpoblepharis minima* as an epiphyte; in this zone,

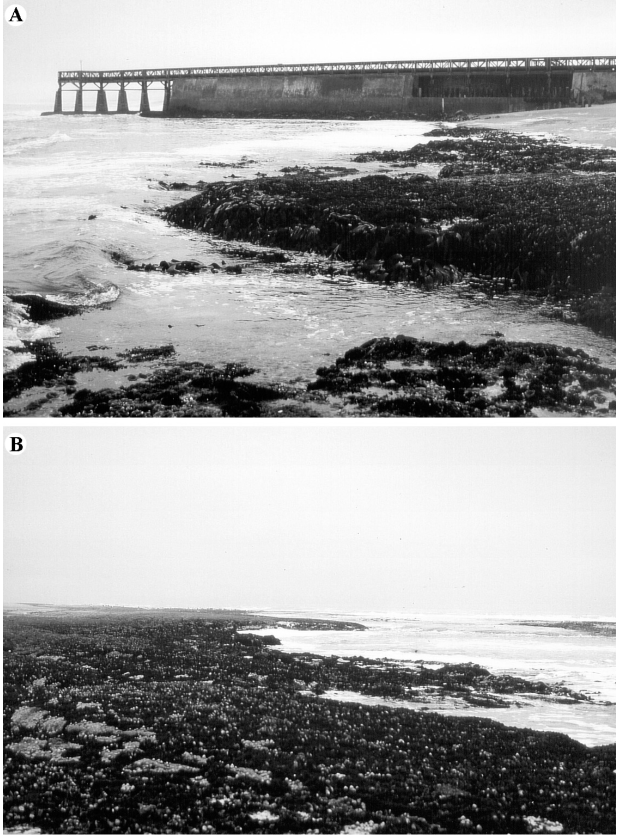

FIG. 9. – Langstrand. Two aspects of the sampling site. A. Northwards view. B. Southwards view.

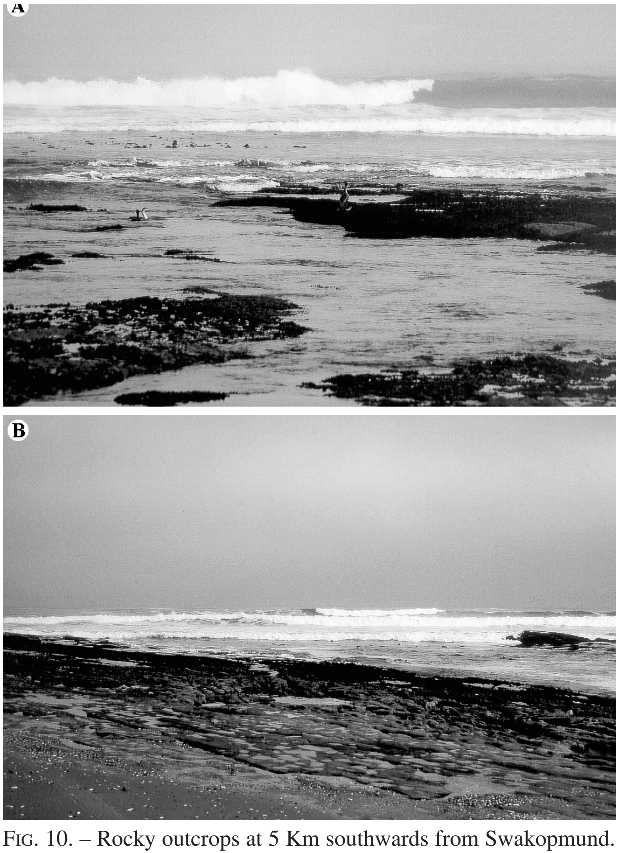

FIG. 10. – Rocky outcrops at 5 Km southwards from Swakopmund. A-B. Two aspects of the sampling site.

FIG. 11. – Rocks sampled at Swakopmund beach.

FIG. 12. – Cape Cross: zone northwards from the colony of seals, with the sampled rocks in the background.

among other species, there were also *Chondria capensis, Gymnogongrus dilatatus, Rhodymenia obtusa, Pterosiphonia complanata, Plocamium rigidum, Cladophora hospita, C. flagelliformis, Suhria vitatta* and *Hypnea ecklonii*, as well as isolated specimens of *Pachymenia carnosa* and *Schizymenia apoda*.

Swakopmund beach (Figs. 7, 11). This is the main beach of this small town completely surrounded by the desert. Samples were collected in a limited rocky zone consisting of dispersed rocks placed at a short distance north of the lighthouse. Among the main species found in the eulittoral zone were *Ahnfeltiopsis glomerata, Nothogenia erinacea, Mazzaella capensis, Codium decorticatum, Suhria vitatta* and *Chaetomorpha aerea.* A population of *Laminaria pallida* dominated the upper sublittoral zone.

Mile 30 (Fig. 7). This is a sandy coastal zone, often frequented by anglers, located about 44 km north of Swakopmund. In this locality only drift material was collected, mainly represented by *Ahnfeltiopsis vermicularis, Gigartina bracteata, Gracilariopsis longissima, Hypnea ecklonii, Rhodymenia spp.* and *Laminaria pallida*, the latter bearing *Carpoblepharis minima, Suhria vitatta* and *Plocamium rigidum* as epiphytes.

Mile 32 (Fig. 7). This is a not very extensive rocky zone located about 3 km north of Mile 30. It consists of a small group of fairly isolated blocks with sparse macroscopic vegetation, that were in general quite covered with sand. The most abundant species include *Gracilariopsis longissima, Ahnfeltiopsis vermicularis, A. glomerata, Chondria capensis* and *Hypnea ecklonii; Gelidium pusillum, Streblocladia camptoclada, Ophidocladus simpliciusculus* and *Polysiphonia scopulorum* were also well represented and, as a whole, they formed grass coverings partially covered with sand.

Cape Cross (Figs. 7, 12). This is a rocky zone completely occupied by one of the biggest colonies of seals of the Namibian coasts. The particular sampling site was at a short distance north of the colony. It was a small rocky outcrop that in certain places was almost totally covered by little mussels. The vegetation was not abundant, but included *Porphyra capensis, Mazzaella capensis, Gracilariopsis longissima, Ahnfeltiopsis vermicularis* and *Hildenbrandia rubra.*

Mile 108 (Figs. 7, 13). Located roughly 165 km north of Swakopmund, Mile 108 is another of the main coastal resort zones especially frequented by anglers. The sampling place consisted of a group of low rocks that outcrop at the coastal sand. They were generally incrusted with barnacles and sparsely covered with vegetation. *Mazzaella capensis* and *Nothogenia erinacea* were the most visible vegetable species over the emerging rocks, while in the pools, partially covered with sand, there were *Ahnfeltiopsis vermicularis, Gracilariopsis longissima, Chaetomorpha aerea, Enteromorpha spp., Tayloriella tenebrosa* and *Streblocladia camptoclada*, among other species.

Terrace Bay (Fig. 7). This is one of the most visited zones of the Skeleton Coast National Park. Samples were collected at a small rocky outcrop where the most abundant species include *Porphyra capensis, Mazzaella capensis, Nothogenia erinacea, Ahnfeltiopsis vermicularis, Caulacanthus ustulatus, Chordariopsis capensis* and *Pachymenia carnosa*.

Möwe Bay (Fig. 7). This is a small bay located approximately in the central zone of the Park, about 415 km north of Swakopmund.

During the 1986 campaign sampling was carried out at a rocky outcrop slightly sloping to the sea. The lower eulittoral zone was dominated by *Nothogenia erinacea, Mazzaella capensis, Aeodes orbitosa, Caulacanthus ustulatus* and *Corallina* sp.; further up, *Porphyra capensis* was the most abundant vegetal species; in the tide pools, the vegetation was mainly represented by *Corallina* sp., *Ahnfeltiopsis vermicularis, Chaetomorpha robusta* and *Ulva capensis*. The upper sublittoral zone was dominated by a population of *Laminaria pallida*, among whose specimens, apart from other species, *Plocamium rigidum, Pterosiphonia complanata, Tayloriella tenebrosa, Corallina* sp., *Gymnogongrus* sp., *Griffithsia confervoides, Platysiphonia miniata, Antithamnion diminuatum* and *Heterosiphonia crispella* developed.

The fauna was the main purpose of the 1988 campaign and sampling focused basically on the upper sublittoral zone at three particular places of this locality. A population of *Laminaria pallida* dominated the sampling zone at the three sites. *Streblocladia camptoclada, Cladophora hospita* and *Aristothamnion collabens* were the algal species best represented among the specimens of *Laminaria*, apart from those mentioned for the population of *Laminaria pallida* sampled in 1986.

Rocky Point (Figs. 7, 14). This represents one of the main rocky outcrops of the north coast of Namibia. It is a small basaltic promontory that penetrates into the sea in a north-west direction forming, at its northern side, a slightly more sheltered area than the one facing south. Samples were taken from two places at the promontory, a beaten one, facing southwards, and a calmer one, facing north. At the beaten zone sampling was done in a very slightly sloped zone, with disperse tide pools. The more abundant algal species in the eulittoral zone include *Nothogenia erinacea, Aeodes orbitosa, Mazzaella capensis, Chondria capensis, Plocamium rigidum, Streblocladia camptoclada, Caulacanthus ustulatus, Centroceras clavulatum* and *Tayloriella tenebrosa.* In the sheltered area, samples were collected at a more sloped zone that produced similar vegetation to that

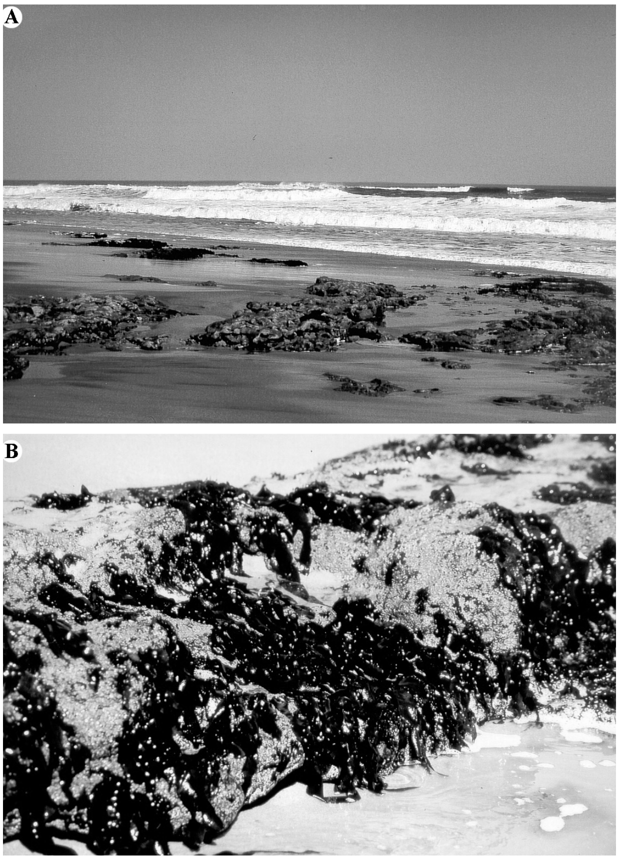

FIG. 13. – Mile 108. A. Sampling site. B. Detail of a rock with *Mazzaella capensis* and *Nothogenia erinacea*.

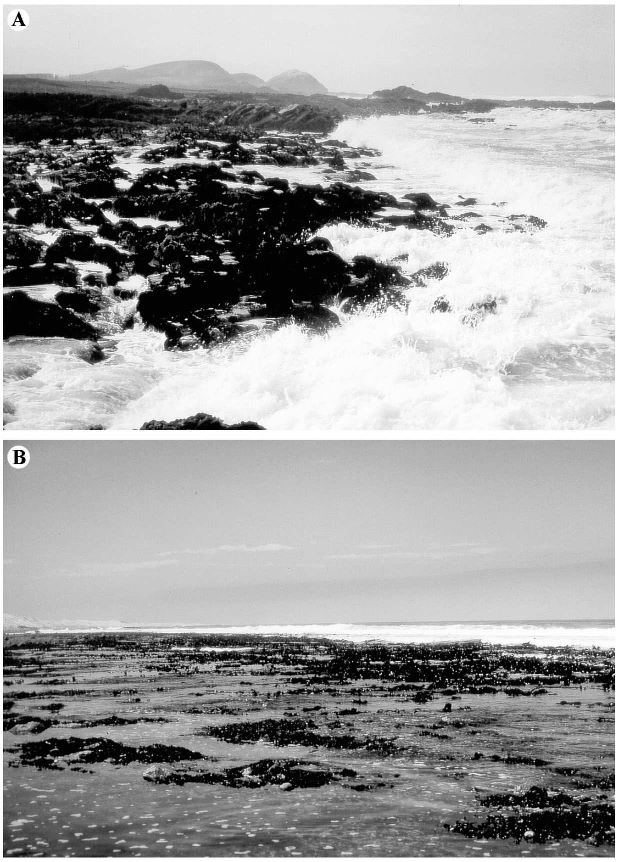

FIG. 14. – Rocky Point. A. Southwards view. B. *Laminaria pallida* population located northwards from the promontory.

of the southern area. *Nothogenia erinacea, Ahnfeltiopsis vermicularis, A. glomeratus* and *Gelidium pusillum* were the best represented species in the eulittoral zone; below there, already in the sublittoral zone, a population of *Laminaria pallida* stretched out, with *Chondria capensis, Pterosiphonia complanata, Suhria vitatta, Pachymenia carnosa* and *Streblocladia camptoclada* as the main species occurring among the specimens of *Laminaria*.

Cape Frio (Fig. 7). This is a rocky outcrop of basaltic nature occupied by a colony of seals. The samples were collected in a steep zone facing northwest. *Aeodes orbitosa, Mazzaella capensis, Streblocladia camptoclada, Hapalospongidion* sp. and *Cladophora capensis* were highlighting among the barnacles and mussels of the eulittoral zone; below, and partially covered by the sand, there were *Ahnfeltiopsis vermicularis, A. glomeratus, Streblocladia camptoclada, Hapalospongidion* sp. and *Cladophora capensis*, as well as other less abundant species such as *Mazzaella capensis, Gymnogongrus* sp. and *Grateloupia doryphora*. The substratum was sandy and devoid of macroscopic vegetation below that.

Angra Fria. (Figs. 7, 15). This is a rocky outcrop of granitic origin consisting of rocks of various sizes generally located over the eulittoral zone. The samples were collected at different blocks, one of which was relatively high and sloped towards the sea. Here, the vegetation was mainly represented by *Aeodes orbitosa, Pachymenia carnosa, Mazzaella capensis, Ahnfeltiopsis glomerata, Chondria capensis* and *Streblocladia camptoclada,* which were at the lowest part forming a band partially covered by sand. At the lower and not so sloping blocks, there was mainly *Porphyra capensis*.


FIG. 15. – Angra Fria. One of the sampled blocks, with *Mazzaella capensis*.

Rocky outcrop placed roughly 29 km south of the Kunene River mouth (Fig. 7). Between Angra Fria and the mouth of the Kunene River, the coast is mainly sandy although there are several not very important rocky outcrops distributed along this extension. One of them was sampled during the 1986 campaign. It is a rocky platform partially covered by the sand roughly 29 km south of the Kunene River mouth. In the eulittoral zone, the vegetation was dominated by *Nothogenia erinacea, Mazzaella capensis, Ahnfeltiopsis vermicularis, Gracilariopsis longissima* and *Hypnea* sp., and also by other smaller species *(Gelidium pusillum, Streblocladia camptoclada, Tayloriella tenebrosa, Centroceras clavulatum, Ophidocladus simpliciusculus* and *Polysiphonia scopulorum)* that formed grass coverings more or less covered by sand. Among the best represented species in the upper sublittoral zone were *Hypnea spicifera, Chondria capensis, Codium decorticatum, Plocamium glomeratum, Pachymenia carnosa, Hypnea ecklonii* and *Streblocladia camptoclada*.

METHODOLOGY

Sampling

This study was performed with samples collected in three sampling campaigns carried out between 1986 and 1989. They were included in the framework of a research programme of the Institut de Ciències del Mar of Barcelona (CSIC) about the "Fisheries in Austral Africa". During the first campaign, which took place in February 1986, the northern zone of Namibia was sampled, specifically the localities of Terrace Bay, Möwe Bay, Rocky point, Cape Frio, Angra Fria and South Kunene, all of them included in the Skeleton Coast National Park (Fig. 7). The second campaign was carried out in February 1988 by non-algal researchers and consisted in sampling only the Möwe Bay zone (Möwe Bay, Cala Poste and Suider Kust). Finally, we programmed and carried out the third campaign, which took place in July 1989, and in which the localities of Walvis Bay, Langstrad, Swakopmund, Mile 30, Mile 32, Cape Cross and Mile 108 were sampled. They are all located on the central coast of Namibia, between Walvis Bay and the southern end of the Skeleton Coast National Park (Fig. 7).

We followed the nomenclature proposed by Lüning (1990) for the zonation, which subdivides the euphotic zone into supralittoral, eulittoral and sublittoral, and the latter into upper sublittoral, midsublittoral and lower sublittoral.

Most of the samples used for the production of this work were collected in the eulittoral zone and in the upper part of the upper sublittoral zone of the different localities studied. The particular hydrodynamic conditions of the geographical area, as well as the high turbidity of the seawater, did not allow us to carry out an exhaustive sampling of the sublittoral zone. The rest of the samples were obtained by collecting the material deposited on the beaches (drift material).

Sampling was carried out, when the circumstances made it possible, during the low tide period. The samples were obtained by the collection of isolated specimens or by scraping an indeterminate and variable surface of the substratum, using a hammer and a chisel when the kind of substratum required such a process. At Rocky Point it was possible to sample up to approximately 2 m depth, using in that case goggles, snorkel and a neoprene suit. Notes were taken about the general ecological conditions of the zone and the placement and the description of the particular sampling sites, in addition to the habitual field data, such as locality, date, etc. Samples were introduced in plastic bags, fixed with formalin, labeled, and stored in hermetic containers for transport to the laboratory, where they were processed and studied.

Sample processing

Each sample was divided into several subsamples according to the taxonomic group (genus, or less frequently family) to which the specimens belonged. This selection required some knowledge of the local flora, which was partly acquired through the global study of some samples from the first campaign. This was done in a macroscopic manner or with the use of a stereomicroscope, generally without separating the epiphytes from the supporting plant. In some cases, though, the amount and size of epiphytes made the separation possible. Then, the supporting plant was noted in the subsample. For each subsample (identified by a code comprising its origin sample number) the locality, the date, and when considered necessary, the type of microhabitat where they were found, were specified. Consequently, on several occasions, this selection originated subsamples constituted by groups of little abundant species that were difficult to separate, as well as subsamples with specimens that could not be assigned to any genus or family. A database was created with all this information in order to classify the several subsamples in taxonomic groups. This is the way the subsamples were later studied.

The study of the subsamples consisted of the description of the morphological, anatomical and, in some cases, the reproductive structures of the different taxa. The first step was to make a detailed morphological description of enough specimens to be able to assess their variation, using the light microscope or the stereoscopic one when necessary. Subsequently, the most representative specimens (size, preservation, type of reproductive structures) were chosen for a detailed microscopic observation and to carry out a study of their anatomy and their reproductive structures. The anatomic study consisted of the analysis of the transversal and longitudinal sections made at the medium zone of the plant. As a general rule, the sections were either done at freehand and with the help of the stereomicroscope or by means of a freezing microtome. However, for the crustose corallinaceae, decalcified fragments of the plant were included in resin to obtain blocks, from which sections were made by means of an ultramicrotome. A solution of 10% nitric acid was used to decalcify the material. We used the following protocol to obtain the blocks:

- Fixation of the sample in a solution of 2.5% glutaraldehyde/seawater at room temperature.
- Washing the sample in seawater in order to eliminate the glutaraldehyde.
- Post fixation of the sample with a solution of 2% OsO_4/seawater at room temperature.
- Dehydration of the sample by immersing it for 10-15 minutes in successive solutions of increasing acetone concentrations in distilled water: 50%, 70%, 90%, 96% and 100%.
- Infiltration with Spurr resin by immersion of the sample in successive acetone/Spurr solutions with a increasing proportion of Spurr: 5 hours in acetone:Spurr (3:1); 24 hours in acetone:Spurr (2:2); 24 h in acetone:Spurr (1:3); 3 days in pure resin. The whole infiltration process was done at 4°C.
- Preparation of blocks by means of silicone moulds placed in a heater at 60°C for 48 hours.

In general, the microscopy slides were observed without adding colouring, although lugol or methylene blue were used to highlight some structures. The different kinds of cells, the reproductive structures and other anatomical features were measured. In each case, and as a general rule, ten measures were taked and the final result was expressed as a variation interval. In addition, certain morphological or anatomical characteristics of the studied specimens were drawn by means of a camera lucida or photographed. Permanent microscopy slides were made for some species, using glycerogelatin as a mounting medium to which a small amount of formalin was added when the slide was made.

The main part of the studied material was pressed and stored as a herbarium sheet. The small-sized species that could not be pressed and some specimens or representative fragments of the large species were stored in labelled and numbered vials, in 4% formalin/seawater. Some microscopic species were kept as permanent microscopy slides. The larger *Laminaria pallida* specimens were immersed in a solution of 50% formalin/seawater (4%) and glycerine for some months; later, they were left to dry in the fresh air and were stored in plastic bags. All this material is deposited at the Herbarium of the Botany Laboratory of the Faculty of Pharmacy of the University of Barcelona (BCF-A). However, some duplicates were given to researchers from other institutions.

As a result of the study of each subsample, a card was created for each taxon to record the provisional name of the taxon, the subsample number, the locality, the date, the data to find it in the future (herbarium, photograph, microscopy slide, and container numbers), habitat and morphological, anatomical and reproduction data. This information has been compiled in a database.

A final description was made with the information from the several cards of each taxon. It was structured in the following sections: habit and vegetative structure, reproduction, habitat, Namibian distribution, selected specimens, world distribution and references. The first two sections included the morphological and anatomical variation of the species at the different localities where we collected it; when we considered that the specimens from a locality differed significantly in some aspect from the ones of other localities, we made a remark at the end of the description. The habitat description was done in a rough way, because the coastal morphology (very homogeneous) and the width of the eulittoral zone (relatively small due to the sparse amplitude of the tide) did not define many different types of habitat.

The ultimate identification of the species was generally a slow task, mainly due to the fact that the marine benthic flora of Namibia, and until recently the South African one, were sparsely documented. This made us often resort to the classical works or the original descriptions of the species and, in general, to bibliography from other geographical areas. This allowed us to obtain a wider concept of the species, which made us realise, in many cases, the need to carry out worldwide taxonomical revisions. All the determinations were revised with the study of Stegenga *et al.* (1997), a monographic work about the seaweeds of the South African west coast. We only used herbarium material to corroborate our determinations in some exceptional occasions. In this sense, we borrowed some material from BOL herbarium (Herbarium of the Botany Department of the University of Cape Town) and MICH herbarium (Herbarium of the University of Michigan, Ann Arbor). Likewise, we have sent material of some taxonomic groups (corallinaceae and *Codium*) to specialists, so that they would revise our identifications.

CATALOGUE OF MARINE BENTHIC ALGAE OF NAMIBIA

In this section we produce the catalogue of marine benthic algae of Namibia that correspond to the classes Rhodophyceae, Phaeophyceae, Ulvophyceae, Cladophorophyceae and Bryopsidophyceae. We have followed the same criteria used at the systematic treatment (page 31) for the nomenclature and taxon order. We only indicate the correct names according to the current taxonomy. When a taxon was cited using another name, a note at the end of the catalogue indicated so.

The catalogue was made from the bibliographic citations and the data shown in the systematic section of this study. The study of Lawson *et al.* (1990) is the most outstanding one among the bibliographic references. In this work, the authors produce the first list of marine seaweeds of Namibia. It is a list of taxa made from data originating from both bibliography and the collection of the authors. For each taxon, the authors indicate the localities where it had been cited and if such is the case the study referred in the citation. Apart from the work of Lawson *et al.* (1990), that was the basis for the elaboration of the catalogue, we also took into account the following studies: Molloy (1990), Anderson and Bolton (1990), Rull Lluch and Gómez Garreta (1993), Chamberlain (1994, 1996), Chamberlain and Keats (1994, 1995), Keats and Chamberlain (1995), Lawson *et al.* (1995), Molloy and Bolton (1995), Stegenga *et al.* (1997), Keats and Maneveldt (1997) and Engledow (1998).

In the study by Lawson *et al.* (1990), a considerable number of taxa are identified only at a genus level. Although the authors indicate that the specimens referred to in their citations are deposited at the BOL herbarium, they neither specify the herbarium number nor refer to the description of the material assigned to these taxa. We have, therefore, preferred not to include them in the catalogue. However, we took into account the taxa indicated at a genus or family level from other bibliographic resources or from our own data, when they were supported by herbarium sheets or more or less extensive descriptions.

The taxa from Namibia that had not been previously cited appear in bold letters in the catalogue. In addition, the cited species from Namibia that we did not identify in the material from our collections were marked with an asterisk (*) in the catalogue. Finally we wrote a number into brackets after a taxon's name when we considered it necessary to add an explanation or a comment. This number refers to a note at the end of the catalogue.

Our catalogue of marine benthic algae has 242 taxa (180 Rhodophyceae, 28 Phaeophyceae, 16 Ulvophyceae, 9 Cladophorophyceae and 9 Bryopsidophyceae), 14 of which (13 Rhodophyceae and 1 Phaeophyceae) were only identified at a genus or family level and 7 (6 Rhodophyceae and 1 Phaeophyceae) tally with species for which there are neither indications of their local distribution (the authors only point out that they were found in Namibia) nor references to any work from which the citations could be made. These 7 taxa are: *Gelidium pteridifolium, Leptophytum ferox, Mesophyllum engelhartii, Spongites discoideus, Plocamium corallorhiza, Bostrychia mortiziana* and *Myriogloea papenfussii*. We have also included the following 22 species, the presence of which must be confirmed, in the catalogue: *Erythrocladia* cf. *polystromatica*, *Gelidium* cf. *latifolium*, *Gelidium micropterum, Gelidium* cf. *reptans, Cryptonemia hibernica* prox., *Euhymenia schizophylla, Lomentaria patens, Rhodymenia* cf. *holmesii*, *Ceramium capense, C. obsoletum, Haraldiophyllum bonnemaisonii* prox., *Platysiphonia delicata, Pterosiphonia* cf. *dendroidea, Asteronema* cf. *rhodochortonoides*, *Ectocarpus* cf. *acutus*, *?Zonaria tempta, Chordaria flagelliformis, Laminaria digitata* f. *ensifolia*, *L. ochroleuca*, *Stromatella* cf. *monostromatica*, *Cladophora* cf. *dalmatica* and *Cladophora* cf. *sericea*. Finally we also took *Onikusa pristoides, Chaetomorpha linum* and *Codium duthieae* into account when we made this catalogue. As far as we are concerned, these three species should be excluded from the flora of benthic seaweeds of Namibia, (see the notes referring to these taxa in the catalogue). All these taxa (totalling 46) were included in the catalogue only for the sake of providing information, but we think that they should not be taken into account in biogeographic studies that use the species as a unity, at least until their identification is completed or their presence in Namibia confirmed.

Consequently, if we do not count these 46 taxa, the marine benthic flora of Namibia would be represented, at least in biogeographical terms, by 196 taxa distributed as follows: 147 Rhodophyceae (75%), 20 Phaeophyceae (10.2%), 15 Ulvophyceae (7.6%), 6 Cladophorophyceae (3.1%) and 8 Bryopsidophyceae (4.1%). From these 196 taxa, 21 (14 Rhodophyceae, 4 Phaeophyceae, 2 Ulvophyceae and 1 Bryopsidophyceae; a 10.7%) had not been previously cited from the Namibian coasts and 91 (67 Rhodophyceae, 11 Phaeophyceae, 7 Ulvophyceae, 1 Cladophorophyceae and 5 Bryopsidophyceae; a 46.4%) were not identified among our samples. From this last group, 41 (the 45.1%) have been only cited hitherto in the south of the country (from Elisabeth Bay to Hottentot Bay). This area includes the most extensive rocky zone of the coasts of Namibia and is the place with the greatest variety of habitats. From the remaining 50 taxa, *Gracilariopsis lemaneiformis, Gracilaria gracilis, Grateloupia longifolia, Sarcothalia radula, Chylocladia capensis, Antithamnion eliseae, Heterosiphonia crispa, Polysiphonia urbana, Pterosiphonia cloiophylla, Endarachne binghamiae* and *Bryopsis plumosa* are very similar species to others that were identified among our samples (*Gracilariopsis longissima, Gateloupia doryphora, Gigartina bracteata, Gastroclonium reflexum, Antithamnion diminuatum* var. *polyglandulum, Heterosiphonia crispella, Polysiphonia nigra, Pterosiphonia complanata, Petalonia fascia* and *Bryopsis hypnoides*, respectively) with which they could be mistaken (see comments referring to these species at the systematic section of this study). In addition, *Ahnfeltiopsis complicata* and *Basispora africana* (these species has not been identified among our samples) and the specimens described in the present study as *Gymnogongrus* sp. (page 88) and *Hapalospongidion* sp. (page 166) respectively, will probably represent the same taxa.

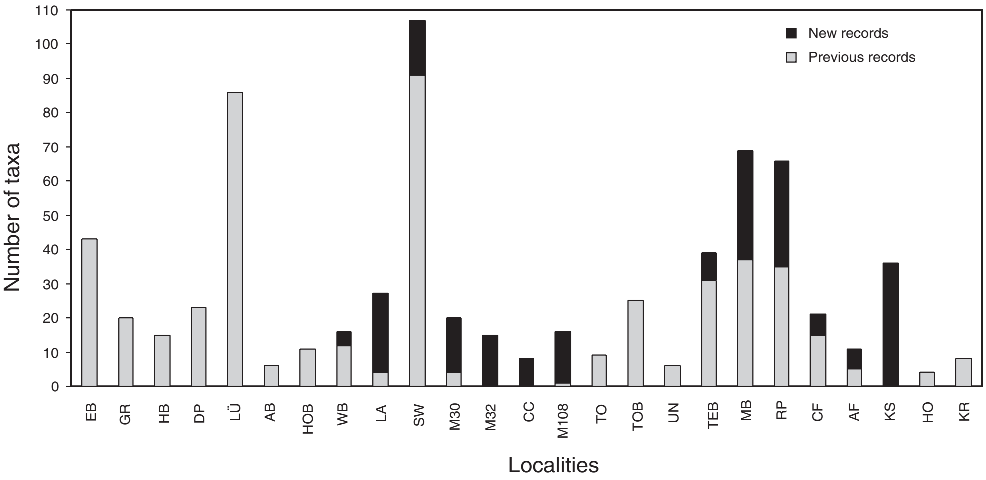

FIG. 16. – Number of taxa along the Namibian coast. Localities arranged from south (left) to north (right). EB: Elizabeth Bay; GR: Grossebucht; HB: Halifax Bay; DP: Diaz Point; LÜ: Lüderitz; AB: Agate Beach; HOB: Hottentots Bay; WB: Walvis Bay; LA: Langstrand; SW: Swakopmund; M30: Mile 30; M32: Mile 32; CC: Cape Cross; M108: Mile 108; TO: Toscanini; TOB: Torra Bay; UN: Unjab; TEB: Terrace Bay; MB: Möwe Bay; RP: Rocky Point; CF: Cape Frio; AF: Angra Fria; KS: South Kunene; HO: Honolulu; KR: Kunene River. GR, HB, DP, LÜ and AB: Lüderitz area.

The fact that our study area was the northern half of the country could partly explain why we did not find some species among our samples. In addition, the fact that we sampled nearly exclusively the eulittoral zone, and only did so at certain periods of the year (summer and winter), and also the possibility that Namibia's marine flora varies depending on the year as a result of the oscillation of the confluence of the Benguela and Angola currents, may help to explain why we did not find all the species cited hitherto from Namibia.

In Figure 16 the distribution of the number of taxa along the coasts of Namibia can be seen. The proportion of the taxa that had been previously cited to the ones that account for the new citations is indicated at the sampled localities. As can be seen, Swakopmund is the area with the largest specific richness, with 108 taxa (the 55.1% of the flora). This locality, placed at the central coast of Namibia, has been from ancient times the most important tourist coastal zone of the country and probably the most easily accessible one. In addition, it comprises a zone with relatively calm waters and two quite extensive rocky outcrops. It is highly probable that the combination of these factors accounts for the high specific richness observed at this locality. Other localities that produce a comparatively high number of taxa are: Lüderitz (86 taxa; 43.9% of the flora), Möwe Bay (69 taxa; 35.2% of the flora) and Rocky Point (66 taxa; 33.7% of the flora). Lüderitz and Rocky Point are the most important rocky areas of the coasts of Namibia. On the south coast, Lüderitz is located at the most extensive rocky area of the country, which includes small islands and several bays (Fig. 2). Although nowadays it is a vastly studied area from the exploitation of the marine vegetable resources point of view (Rotmann, 1987; Critchley *et al.*, 1991; Molloy and Bolton, 1995; Molloy, 1998), the main part of the flora data from this locality arises from a field excursion carried out in 1957. It is important to point out, however, that new records have been recently added to this area by Engledow (1998). The ecological features of this zone (colonisable substratum and relatively important habitat diversity) makes one think that future studies will possibly enlarge the number of taxa in this area. On the other hand, the high number of taxa observed at Rocky Point and Möwe Bay could be explained not only because of the relative importance of the rocky substratum but also by the fact that the upper sublittoral zone of these localities was relatively more sampled. Elisabeth Bay (at the south of Lüderitz) and Terrace Bay and South Kunene (at the northern coast of Namibia) also have relatively high species richness (18-22% of the flora) while at the rest of the localities the number of taxa does not go over the 15% of the flora.

In general, the distribution of the number of taxa at the coasts of Namibia does not seem to be significantly conditioned by the latitude, but would probably be more limited by the availability of colonisable substratum, the habitat diversity and the intensity of the study. Consequently, the localities with larger species richness correspond to the areas where the rocky substratum is better represented and allows differentiating relatively calmer zones. At the

Lüderitz area (Grossebucht, Halifax Bay, Diaz Point, Lüderitz and Agate Beach) the variation in the number of species may be the result of a different sampling intensity at the several localities, most probably related to the environmental conditions and the possibilities of access.

Namibia has a relatively poor marine benthic flora with 196 taxa. In this sense it is more comparable to that of Angola (123 taxa) than to that of the Atlantic coast of South Africa (357 taxa once the doubtful taxa and the taxa recorded at supraspecific level have been deducted). It is important to point out, however, that the South African Atlantic coast includes the transitional zone between the flora of Benguela and that of Agulhas (Cape Agulhas to Cape of Good Hope), which increases considerably the number of taxa in this area. This poverty is probably due to the scarcity of colonisable substratum and to the sparse habitat diversity that an extremely homogeneous coast, like the one of Namibia, offers to the species. In addition, the reduced tide width (between 1 and 1.5 meters) is another factor to take into account when explaining the flora poorness, because it limits the extension of the eulittoral zone, from where most citations originate. On the other hand, the kinds of coast and the particular environmental conditions involved have not permitted a sufficient exploration of the sublittoral zone. In addition, although in some places it has anoxic conditions as a result of the prevailing high production, its study would certainly enlarge in a substantial way the number of flora species. Finally, the convergence of the cold waters from Benguela and the warm waters from Angola must also be taken into account. It changes in latitude depending on the period of the year and also depending on the year itself, affecting the coastal water temperature, and possibly the flora composition. Thus, when the front has a southern position, the northern coast of Namibia may have a greater number of species with tropical affinity, and a lot of the temperate species (more common when the front has a northern position) would remain at depth or as in a resting phase (perennial stages as a crust or filaments). Something similar happens at North Carolina where, during winter the Gulf Stream withdraws from the coast, but comes closer during summer. Consequently, the flora is dominated by cold-temperate species during winter and spring while in summer and autumn the dominant species are warm-temperate (P. Silva, pers. com.). Some authors have introduced the concept of *migrating floras* to refer to this fact. However, P. Silva (pers. com.) considers that floras do not migrate, but there is a third biogeographic dimension, the depth, where species take refuge during unfavourable periods.

Catalogue

Rhodophyta
Rhodophyceae

Bangiophycidae
Porphyridiales
Porphyridiaceae
Stylonema alsidii (Zanardini) K. Drew
Stylonema cornu-cervi Reinsch

Erythropeltidales
Erythrotrichiaceae
**Erythrocladia* cf. *polystromatica* Dangeard (1)
**Erythrotrichia boryana* (Montagne in Durieu de Maisonneuve) Berthold
**Erythrotrichia welwitschii* (Ruprecht) Batters
**Sahlingia subintegra* (Rosenvinge) Kornmann (2)

Bangiales
Bangiaceae
Porphyra capensis Kützing
Porphyra saldanhae Stegenga, Bolton and Anderson
***Porphyra* sp.** (page 37)

Florideophycidae
Acrochaetiales
Acrochaetiaceae
Acrochaetium catenulatum Howe (3)
Acrochaetium daviesii (Dillwyn) Nägeli (4)
Acrochaetium endophyticum Batters (5)
**Acrochaetium moniliforme* (Rosenvinge) Børgesen
Acrochaetium reductum (Rosenvinge) Hamel
Acrochaetium secundatum (Lyngbye) Nägeli (6)
***Acrochaetium* sp.** (page 43)
**Audouinella hypneae* (Børgesen) Lawson and John (7)
**Colaconema plumosum* (Drew) Woelkerling (8)

Palmariales
Rhodothamniellaceae
Rhodothamniella floridula (Dillwyn) J. Feldmann

Nemaliales

Galaxauraceae
Nothogenia erinacea (Turner) Parkinson (9)
**Nothogenia ovalis* (Suhr) Parkinson

Gelidiales
Gelidiaceae
**Gelidium* cf. *latifolium* (Greville) Bornet and Thuret (10)
**Gelidium micropterum* Kützing (11)
Gelidium pusillum (Stackhouse) Le Jolis
**Gelidium pteridifolium* R. Norris, Hommersand and Fredericq (12)
**Gelidium* cf. *reptans* (Suhr) Kylin (10)
**Onikusa pristoides* (Turner) Akatsuka (13)
Suhria vittata (Linnaeus) Endlicher

Gracilariales
Gracilariaceae (14)
**Gracilaria gracilis* (Stackhouse) Steentoft, L. Irvine and Farnham
**Gracilariopsis lemaneiformis* (Bory de Saint Vincent) Dawson, Acleto and Foldvik
Gracilariopsis longissima (S. Gmelin) Steentoft, L. Irvine and Farnham

Halymeniales
Halymeniaceae
Aeodes orbitosa (Suhr) Schmitz
**Cryptonemia hibernica* Guiry and L. Irvine prox. (15)
Grateloupia doryphora (Montagne) Howe
Grateloupia filicina (Lamouroux) C. Agardh
**Grateloupia longifolia* Kylin (16)
Pachymenia carnosa (J. Agardh) J. Agardh
**Pachymenia cornea* (Kützing) Chiang (17)
Phyllymenia belangeri (Bory de Saint Vincent) Setchell and Gardner
**Polyopes constrictus* (Turner) J. Agardh

Hildenbrandiales
Hildenbrandiaceae
Hildenbrandia crouanii J. Agardh
Hildenbrandia rubra (Sommerfelt) Meneghini

Corallinales
Corallinaceae
**Arthrocardia carinata* (Kützing) Johansen
**Arthrocardia filicula* (Lamarck) Johansen (18)
**Arthrocardia palmata* (Ellis and Solander) Areschoug
***Corallina* sp.** (page 62)
**Corallina* sp. (19)
**Heydrichia groeneri* Keats and Chamberlain
**Leptophytum ferox* (Foslie) Chamberlain and Keats (20)
**Leptophytum foveatum* Chamberlain and Keats
Lithophyllum neoatalayense Masaki
Melobesia membranacea (Esper) Lamouroux
**Mesophyllum engelhartii* (Foslie) Adey (21)
**Spongites discoideus* (Foslie) Penrose and Woelkerling (22)
Synarthrophyton munimentum Keats and Maneveldt
Corallinaceae ind. (page 68)

Gigartinales
Caulacanthaceae
Caulacanthus ustulatus (Turner) Kützing
Heringia mirabilis (C. Agardh) J. Agardh

Cystocloniaceae
Rhodophyllis reptans (Suhr) Papenfuss

Gigartinaceae
**Chondracanthus teedei* (Mertens ex Roth) Kützing (23)
Gigartina bracteata (S. Gmelin) Setchell and Gardner
**Iridaea elongata* Suhr (24)
Mazzaella capensis (J. Agardh) Fredericq
**Sarcothalia radula* (Esper) Edyvane and Womersley (25)
**Sarcothalia scutellata* (Hering) Leister (26)
**Sarcothalia stiriata* (Turner) Leister (27)

Hypneaceae
Hypnea ecklonii Suhr (28)
**Hypnea musciformis* (Wulfen) Lamouroux
Hypnea spicifera (Suhr) Harvey
**Hypnea tenuis* Kylin
***Hypnea* sp.** (page 81)

Kallymeniaceae
**Euhymenia schizophylla* Kützing (29)
**Kallymenia agardhii* R. Norris
Kallymenia schizophylla J. Agardh
**Pugetia harveyana* (J. Agardh) R. Norris
**Thamnophyllis discigera* (J. Agardh) R. Norris

Peyssonneliaceae
**Peyssonnelia atropurpurea* P. Crouan and H. Crouan (30)

Phyllophoraceae

**Ahnfeltiopsis complicata* (Kützing) P. Silva and DeCew (31)
Ahnfeltiopsis glomerata (J. Agardh) P. Silva and DeCew (32)
**Ahnfeltiopsis polyclada* (Kützing) P. Silva and DeCew (33)
Ahnfeltiopsis vermicularis (C. Agardh) P. Silva and DeCew (34)
Gymnogongrus dilatatus (Turner) J. Agardh (35)
Gymnogongrus sp. (page 88)
**Schottera nicaeënsis* (Lamouroux ex Duby) Guiry and Hollenberg

Sarcodiaceae
**Trematocarpus flabellatus* (J. Agardh) De Toni
**Trematocarpus fragilis* (C. Agardh) De Toni

Schizymeniaceae
Schizymenia apoda (J. Agardh) J. Agardh (36)
Haematocelis epiphytica Baardseth “stadium”
**Haematocelis* sp. (37)

Plocamiales
Plocamiaceae
**Plocamium cartilagineum* (Linnaeus) Dixon (38)
**Plocamium corallorhiza* (Turner) J. Hooker and Harvey (39)
**Plocamium cornutum* (Turner) Harvey
Plocamium glomeratum J. Agardh
**Plocamium maxillosum* (Poiret) Lamouroux
Plocamium rigidum Bory de Saint-Vincent
**Plocamium suhrii* Kützing

Rhodymeniales
Champiaceae
**Champia lumbricalis* (Linnaeus) Desvaux
**Chylocladia capensis* Harvey
Gastroclonium reflexum (Chauvin) Kützing

Lomentariaceae
**Lomentaria patens* Kützing (40)

Rhodymeniaceae
Rhodymenia capensis J. Agardh (41)
**Rhodymenia* cf. *holmesii* Ardissone (42)
**Rhodymenia linearis* J. Agardh (43)
Rhodymenia natalensis Kylin
Rhodymenia obtusa (Greville) Womersley (44)
**Rhodymenia pseudopalmata* (Lamouroux) P. Silva
Rhodymeniaceae ind. (page 102)

Ceramiales
Ceramiaceae
Aglaothamnion hookeri (Dillwyn) Maggs and Hommersand (45)
**Anotrichium tenue* (C. Agardh) Nägeli
**Antithamnion densum* (Suhr) Howe (46)
**Antithamnion eliseae* R. Norris
Antithamnion diminuatum Wollaston
var. *diminuatum* Wollaston
var. *polyglandulum* Stegenga
Antithamnion secundum Itono
**Antithamnionella australis* Baardseth
Antithamnionella verticillata (Suhr) Lyle
Aristothamnion collabens (Rudolphi) Papenfuss
Ballia sertularioides (Suhr) Papenfuss
Bornetia repens Stegenga
**Carpoblepharis flaccida* (Lamouroux) Kützing
Carpoblepharis minima Barton
Centroceras clavulatum (C. Agardh) Montagne
Ceramium arenarium Simons
Ceramium atrorubescens Kylin
**Ceramium capense* Kützing (47)
**Ceramium diaphanum* (Lightfoot) Rhoth
Ceramium flaccidum (Kützing) Ardissone (48)
**Ceramium obsoletum* C. Agardh (47)
Ceramium planum Kützing
Ceramium sp. (page 120) (49)
**Euptilota pappeana* Kützing
Griffithsia confervoides Suhr
**Lomathamnion humile* (Kützing) Stegenga
Microcladia gloria-spei Stegenga
Pleonosporium filicinum (Harvey ex J. Agardh) De Toni
**Pleonosporium harveyanum* (J. Agardh) De Toni
Ptilothamnion polysporum Gordon-Mills and Wollaston (50)

Dasyaceae
**Dasya scoparia* Harvey
**Heterosiphonia crispa* (Suhr) Falkenberg (51)
Heterosiphonia crispella (C. Agardh) Wynne
var. ***crispella*** (C. Agardh) Wynne
var. *laxa* (Børgesen) Wynne
Heterosiphonia dubia (Suhr) Falkenberg
**Heterosiphonia pellucida* (Harvey) Falkenberg

Delesseriaceae
**Acrosorium acrospermum* (J. Agardh) Kylin
Acrosorium cincinnatum Wynne
**Acrosorium maculatum* (Sonder ex Kützing) Papenfuss

**Botryocarpa prolifera* Greville
**Botryoglossum platycarpum* (Turner) Kützing
**Cryptopleura calophylloides* (J. Agardh) Wynne
**Delesseria papenfussii* Wynne
**Haraldiophyllum bonnemaisonii* (Greville) Zinova prox. (52)
**Hymenena venosa* (Linnaeus) Krauss
Myriogramme livida (Hooker and Harvey) Kylin
**Neuroglossum binderianum* Kützing
**Platysiphonia delicata* (Clemente y Rubio) Cremades (53)
Platysiphonia intermedia (Grunow) Wynne
Delesseriaceae ind. 1. (page 135)
Delesseriaceae ind. 2. (page 136)

Rhodomelaceae
**Bostrychia moritziana* (Sonder ex Kützing) J. Agardh (54)
**Bostrychia scorpioides* (Hudson) Montagne ex Kützing (55)
Chondria capensis (Harvey) Askenasy
**Herposiphonia didymosporangia* Stegenga and Kemperman
**Herposiphonia heringii* (Harvey) Falkenberg
Ophidocladus simpliciusculus (P. Crouan and H. Crouan) Falkenberg
Placophora binderi (J. Agardh) J. Agardh
**Placophora monocarpa* (Montagne) Papenfuss
Polysiphonia incompta Harvey
Polysiphonia namibiensis Stegenga and Engledow
Polysiphonia nigra (Hudson) Batters (56)
Polysiphonia scopulorum Harvey
**Polysiphonia urbana* Harvey
Polysiphonia virgata (C. Agardh) Sprengel (57)
**Polysiphonia* sp. (58)
**Pterosiphonia cloiophylla* (C. Agardh) Falkenberg (59)
Pterosiphonia complanata (Clemente y Rubio) Falkenberg
Pterosiphonia* cf. *dendroidea (Montagne) Falkenberg (page 153)
Streblocladia camptoclada (Montagne) Falkenberg
Streblocladia corymbifera (C. Agardh) Kylin
Tayloriella tenebrosa (Harvey) Kylin

Rhodophyceae of uncertain position
Aiolocolax pulchellus Pocock

Chromophyta
Phaeophyceae
Ectocarpales
Ectocarpaceae
**Asteronema* cf. *rhodochortonoides* (Børgesen) D. Müller and Parodi (60)
**Ectocarpus* cf. *acutus* Setchell and Gardner (61)
Ectocarpus fasciculatus Harvey
**Ectocarpus siliculosus* (Dillwyn) Lyngbye
Feldmannia irregularis (Kützing) G. Hamel
Hincksia granulosa (J. E. Smith) P. Silva

Pilayellaceae
Bachelotia antillarum (Grunow) Gerloff

Ralfsiaceae
**Basispora africana* John and Lawson (62)
***Hapalospongidion* sp**. (page 166)
Ralfsia expansa (J. Agardh) J. Agardh
Stragularia clavata (Harvey) G. Hamel

Sphacelariales
Stypocaulaceae
**Stypocaulon funiculare* (Montagne) Kützing

Dictyotales
Dictyotaceae
**?Zonaria tempta* (63)

Chordariales
Chordariaceae
**Chordaria flagelliformis* (O. F. Müller) C. Agardh (64)
**Myriogloea papenfussii* Kylin (65)
**Papenfussiella gracilis* Kylin

Chordariopsidaceae
Chordariopsis capensis (C. Agardh) Kylin

Corynophlaeaceae
**Leathesia difformis* (Linnaeus) Areschoug

Splachnidiaceae
**Splachnidium rugosum* (Linnaeus) Greville

Scytosiphonales
Scytosiphonaceae
**Colpomenia sinuosa* (Mertens ex Roth) Derbès and Solier
**Endarachne binghamiae* J. Agardh
Petalonia fascia (O. F. Müller) Kuntze (66)
**Scytosiphon lomentaria* (Lyngbye) Link

Desmarestiales
Desmarestiaceae
**Desmarestia firma* (C. Agardh) Skottsberg (67)

Laminariales
Alariaceae
**Ecklonia maxima* (Osbeck) Papenfuss (68)

Laminariaceae
**Laminaria digitata* f. *ensifolia* (Kützing) Foslie (69)
**Laminaria ochroleuca* Pylaie (70)
Laminaria pallida Greville (71)

Chlorophyta
Ulvophyceae
Ulvales
Chaetophoraceae
Entocladia leptochaete (Huber) Burrows
**Entocladia vagans* (Børgesen) W.R. Taylor
**Entocladia viridis* Reinke
**Stromatella* cf. *monostromatica* (P. Dangeard) Kornmann and Sahling (72)
Ulvella lens P. Crouan and H. Crouan

Ulvaceae
**Enteromorpha atroviridis* (Levring) Wynne
**Enteromorpha bulbosa* (Suhr) Montagne
Enteromorpha flexuosa (Wulfen) J. Agardh (73)
Enteromorpha intestinalis (Linnaeus) Nees (74)
Enteromorpha linza (Linnaeus) J. Agardh
**Enteromorpha prolifera* (O.F. Müller) J. Agardh
Ulva capensis Areschoug
Ulva fasciata Delile
**Ulva nematoidea* Bory de Saint-Vincent (75)
**Ulva rhacodes* (Holmes) Papenfuss
Ulva rigida C. Agardh (76)

Cladophorophyceae
Cladophorales
Cladophoraceae
Chaetomorpha aerea (Dillwyn) Kützing
**Chaetomorpha linum* (O.F. Müller) Kützing (77)
Chaetomorpha robusta (Areschoug) Papenfuss
Cladophora capensis (C. Agardh) De Toni
**Cladophora contexta* Levring (78)
**Cladophora* cf. *dalmatica* Kützing (79)
Cladophora flagelliformis (Suhr) Kützing
Cladophora hospita (Mertens ex Chamisso) Kützing (80)
**Cladophora* cf. *sericea* (Hudson) Kützing (81)

Bryopsidophyceae
Bryopsidales
Bryopsidaceae
**Bryopsis cespitosa* Suhr ex Kützing (82)
Bryopsis hypnoides Lamouroux
**Bryopsis plumosa* (Hudson) C. Agardh
**Bryopsis tenuis* Levring (83)
**Pedobesia lamourouxii* (J. Agardh) Feldmann, Loreau, Codomier and Couté (84)

Codiaceae
Codium decorticatum (Woodward) Howe
**Codium duthieae* P. Silva (85)
Codium fragile (Suringar) Hariot subsp. *capense* P. Silva
**Codium isaacii* P. Silva

Remarks

Rodophyta

(1) Taxon only tentatively recorded from Lüderitz by Engledow (1998), who present a short description of it.

(2) Recorded by Engledow (1998) as *Erythrocladia subintegra* Rosenvinge.

(3) Stegenga *et al.* (1997) remark that this species occurs from Namibia (without reference to any locality) to the east of Cape Peninsula at South Africa. On the other hand, Engledow (1998) cites *Acrochaetium densum* (Drew) Papenfuss from Elizabeth Bay and Langstrand. According to Stegenga (1985) and Stegenga *et al.* (1997) *A. densum* is the name with which the tetrasporophytic fase of *A. catenulatum* is known.

(4) Recorded by Engledow (1998) as *Colaconema daviesii* (Dillwyn) Stegenga.

(5) Recorded by Engledow (1998) as *Audouinella endophytica* (Batters) Dixon.

(6) Stegenga *et al.* (1997) point out that this species stretches up to the Namibian coasts, but they do not refer to any locality.

(7) Only recorded from Swakopmund by Wynne (1986).

(8) Only recorded from Grossebucht by Engledow (1998).

(9) This species includes *Nothogenia magnifica* (Pilger) J. H. Price. See the remark at page 46.

(10) Taxon only tentatively recorded from Rocky Point by Engledow (1998).

(11) According to Stegenga *et al.* (1997), it is doubtful whether the West African and Namibian

records of this species actually belong to *Gelidium micropterum*.

(12) In a work on the economic interest of the species, Molloy (1990) remarks that this taxon occurs in Namibia (without reference to any locality), although it is not abundant enough to be considered in that work.

(13) Price *et al.* (1988) indicate the presence of this species in Namibia on the basis of an unpublished work mentioned in the references as Lawson and Isaac (1982). Subsequently, Lawson *et al.* (1990) include this citation in the list of algae of Namibia without mention of any locality and only referring to the work of Price *et al.* (1988). In both cases the taxon is recorded as *Gelidium pristoides* (Turner) Kützing. We hold that this species must be excluded from the Namibian flora.

(14) See the remark at page 51.

(15) Only recorded from Swakopmund by Wynne (1986), who identifies the plant with certain reservations since he lacks fertile specimens.

(16) Although Stegenga *et al.* (1997) include this species in *Grateloupia doryphora*, Engledow (1998) prefer to keep it separate due to its divergent form and ecology.

(17) Lawson *et al*. (1995) indicate the presence of this species in Namibia on the basis of the work of Simons and Hewitt (1976). According to these last authors, *P. cornea* occurs from East London (South African east coast) to Cape Frio (Namibia). However, Lawson *et al.* (1990) do not take into account this species in their list of marine algae of Namibia.

(18) This species includes *A. setchellii* Manza (Seagrief, 1984).

(19) Recorded from Swakopmund by Wynne (1986). This author points out that the material is reminiscent of the genus *Arthrocardia*, but Dr. H. W. Johansen identified it as *Corallina* sp. These specimens are deposited in the MICH Herbarium (Wynne 7541).

(20) Chamberlain and Keats (1994) include Namibia in the distribution of this species, but they do not mention any locality nor refer to any other work.

(21) Chamberlain and Keats (1995) include Namibia in the world distribution of *M. engelhartii*, but they do not mention any locality nor refer to any other work.

(22) Chamberlain (1994) includes Namibia in the distribution of this species, but he do not mention any locality nor refer to any other work.

(23) Recorded as *Gigartina teedii* (Roth) Lamouroux in Lawson *et al.* (1990). According to Silva *et al.* (1996) the correct epithet for this species is *teedei*.

(24) According to Delf and Michell (1921) this species occurs from Table Bay (South Africa) to Walvis Bay. Lawson *et al.* (1990) report Walvis Bay as the single locality in Namibia where the plant occurs and they refer to that work. Price *et al.* (1992) remark the possibility that this species was a synonym of *Mazzaella capensis*.

(25) Recorded as *Gigartina radula* (Esper) J. Agardh by Lawson *et al.* (1990). See the remark at page 74.

(26) Recorded as *Gigartina scutellata* (Hering) Simons by Lawson *et al.* (1990).

(27) Recorded as *Gigartina stiriata* (Turner) J. Agardh by Lawson *et al.* (1990).

(28) This species includes *Hypnea ceramioides* Kützing (Stegenga *et al.*, 1997).

(29) Price *et al.* (1986) and Lawson *et al.* (1990) report a single citation in Namibia of this species. This is a Lüderitz record coming from the work of Pilger (1908). Price *et al.* (1986) remark that the genus *Euhymenia* Kützing has not been generally accepted and that De Toni (1897) place this species as a synonym of *Kallymenia dentata* J. Agardh with a query. Delf and Michell (1921) cite *K. dentata* from South Africa and Silva *et al.* (1996) include one of these citations in *K. agardhii* R. Norris. Likewise, Silva *et al.* (1996) place *Euhymenia schizophylla*, as a misapplied name, in *Kallymenia agardhii*. In contrast, Stegenga *et al.* (1997) do not make any comment relative to *Euhymenia schizophylla* nor *Kallymenia dentata* in their work about the seaweeds of the South African west coast. We hold that the taxonomy of *Euhymenia schizophylla* should be clarified and its presence in Namibia confirmed before to include it in the catalogue.

(30) Only recorded from Diaz Point by Engledow (1998).

(31) Recorded as *Gymnogongrus complicatus* (Kützing) Papenfuss by Lawson *et al.* (1990). Among our material there are specimens morphologically very similar to this taxon, but having nemathecia instead of cystocarps. For this reason, we have assigned them to the genus *Gymnogongrus* without specifying the species. See the remark at page 89.

(32) Recorded as *Gymnogongrus glomeratus* J. Agardh by Lawson *et al.* (1990). This species includes *Gymnogongrus corymbosus* J. Agardh (Stegenga *et al.*, 1997).

(33) Recorded as *Gymnogongrus polycladus* (Kützing) J. Agardh by Anderson and Bolton (1990).

(34) Recorded as *Gymnogongrus vermicularis* (C. Agardh) J. Agardh by Lawson *et al.* (1990).

(35) This species includes *Actinococcus latior* Schmitz. With this name the tetrasporophytic structures of *Gymnogongrus dilatatus* were formerly known.

(36) Recorded as *S. obovata* (J. Agardh) J. Agardh by Lawson *et al.* (1990).

(37) Under the name *Haematocelis* sp., Stegenga *et al.* (1997) describe some specimens from the west coast of South Africa and they point out that this taxon also occurs in Namibia. However, the authors do not refer to any locality.

(38) Recorded as *P. vulgare* Lamouroux by Lawson *et al.* (1990).

(39) Recorded from northern Namibia (Kaokoveld) without specifying locality by Lawson *et al.* (1990) and Stegenga *et al.* (1997).

(40) This record, which is included in the works of Delf and Michell (1921) and Lawson *et al.* (1990), corresponds to a single specimen of the Tyson Herbarium collected at Walvis Bay. John *et al.* (1994) remark that it probably belongs to *Chylocladia capensis* Harvey. We hold that this record should be confirmed.

(41) Recorded as *Epymenia capensis* (J. Agardh) Papenfuss by Lawson *et al.* (1990).

(42) Only tentatively recorded from Mile 8 by Engledow (1998).

(43) Only recorded from Swakopmund by Wynne (1986). According to Stegenga *et al.* (1997) the South African (Cape Hangklip) and Namibian records of this species correspond to *Rhodymenia natalensis* Kylin. In contrast, Wynne (1986) points out that the Swakopmund material is similar to *R. capensis* J. Agardh. See the remark at page 98.

(44) Recorded as *Epymenia obtusa* (Greville) Kützing by Lawson *et al.* (1990).

(45) Recorded as *Callithamnion hookeri* (Dillwyn) S. Gray by Lawson *et al.* (1990).

(46) Only recorded from Swakopmund by Wynne (1986), as *Antithamnion leptocladum* (Montagne) Wynne, and included in the list of the marine algae of Namibia by Lawson *et al.* (1990). See Athanasiadis (1990).

(47) The Namibian records of *Ceramium capense* correspond to *C. obsoletum*, as may be deduced from the work of Lawson *et al.* (1990). Moreover, according to these authors, some records of *C. obsoletum* (in particular those included in the work of Simons (1966) as *C. capense*) do not belong to the genus *Ceramium*. On the other hand, Stegenga *et al.* (1997) remark that *C. capense* occurs from Lüderitz to Kommetjie (Cape peninsula), and *C. obsoletum* from Namibia to the east coast of South Africa.

(48) This taxon includes *Ceramium papenfussianum* Simons (Lawson *et al.*, 1990). See the remark at page 118.

(49) The material to which the records refer (see page 120) agree quite well with the one of Swakopmund described by Wynne (1986) as *Ceramium* sp. It is highly probable that both collections belong to the same taxon.

(50) Stegenga *et al.* (1997) remark that this species occurs on the south and east coasts of South Africa and in Namibia, but they do not refer to any specific locality in this last country.

(51) Recorded from Lüderitz and Möwe Bay by Engledow (1998). In our opinion, possibly conspecific with *Heterosiphonia crispella* (C. Agardh) Wynne. See the remark at page 128.

(52) Only tentatively recorded from Swakopmund by Wynne (1986), who remarks that the specimens show a great morphological variation.

(53) This species was known formerly as *P. miniata* (C. Agardh) Bρrgesen . It had been previously mistaken with *P. intermedia* (Grunow) Wynne (Stegenga *et al.*, 1997). It is probable that the Namibian records correspond to *P. intermedia*. See the remark at page 134.

(54) Price *et al.* (1986) and Lawson *et al.* (1990) indicate the presence of this species in Namibia without specifying any locality. According to the former authors, the material to which the record refers had been collected in freshwater conditions.

(55) Only recorded from Lüderitz by Engledow (1998). The author points out that the specimens were found in pools of the upper eulittoral zone.

(56) Recorded as *P. atrorubescens* (Dillwyn) Greville by Lawson *et al.* (1990).

(57) After an extensive taxonomic discussion, Silva (Silva *et al.*, 1996) suggests the genus *Carradoriella* for this taxon. However, Wynne (1998) prefers to retain it in the genus *Polysiphonia* on the basis of an earlier work (Wynne, 1986) in which he presented a number of morphological reasons supporting this opinion.

(58) Wynne (1986) points out the main features of an undetermined species of *Polysiphonia* from Swakopmund (MICH: Wynne 7529).

(59) It is probable that this species had been mis-

taken with *P. complanata* (Clemente y Rubio) Falkenberg. See the remark at page 152.

Chromophyta

(60) Only tentatively recorded from Mile 14 by Engledow (1998) as *Ectocarpus* cf. *rhodochortonoides* Børgesen.

(61) Species tentatively recorded by Engledow (1998).

(62) Only recorded from Möwe Bay by Engledow (1998). We have collected some specimens of a crustose Phaeophyceae from several localities of northern Namibia (Möwe Bay included) which agree more or less with the description of this species. However, some differences lead us to identify them as *Hapalospongidion* sp. See the remark at page 167.

(63) Lawson *et al.* (1990) cite this species with a query and without the taxon authorities from Halifax Bay. According to Price *et al.* (1978) the determination of the material to which the record refers is doubtful and it must be studied again. We hold that this species must be excluded from the Namibian flora until the record had been confirmed.

(64) Only recorded from Walvis Bay by Dinter (1919). Price *et al.* (1978) and Lawson *et al.* (1990) include the record and remark that it probably refers to *Chordariopsis capensis* (C. Agardh) Kylin.

(65) Stegenga *et al.* (1997) cite this species from the South African west coast and state that possibly it also occurs in Namibia.

(66) Lawson *et al.* (1990) cite this species as *P. debilis* (O.F. Müller) Kuntze. In agreement with Wynne (1969), Price *et al.* (1978) and Fletcher (1987) we consider *P. debilis* as a synonym of *P. fascia*, while Silva *et al.* (1996) consider it as a variety of this second species.

(67) Lawson *et al.* (1990) cite this species from Lüderitz and Stegenga *et al.* (1997) stating that it occurs from Möwe Bay to Betty's Bay (west coast of South Africa). On the other hand, Price *et al.* (1978) remark that it is highly probably that *D. firma* from the southern hemisphere and *D. ligulata* Lamouroux from the northern hemisphere was conspecific.

(68) Wynne (1986) remarks to have observed this species at Swakopmund (in the drift) and he states that the most northerly record for this species is at Rocky Point. However, according to Stegenga *et al.* (1997), *E. maxima* occurs from 10 km west of Cape Agulhas to north of Lüderitz, and it is absent from northern Namibia.

(69) Only recorded from Walvis Bay by Dinter (1922c) and included in the catalogues of Lawson *et al.* (1990) and Price *et al.* (1978). According to these last authors, it is possible that the record refers to *L. pallida* or *L. schinzii*.

(70) Price *et al.* (1978) indicate the presence of *Laminaria ochroleuca* in Namibia on the basis of the work of Delf and Michell (1921). These authors include a record of *L. pallida* from Walvis Bay (Barton, 1893), and Price *et al.* (1978) include it in *L. ochroleuca*. However, Price *et al.* (1978) cite *L. pallida* from Namibia on the basis of the same work, and remark that records appear to represent the most northerly extension of a species hitherto well known from the western coast of South Africa. Lawson *et al.* (1990) point out that the species occurs in Namibia and refers to the works of Delf and Michell (1921) and Price *et al.* (1978). It is highly probable that this record refers to *L. pallida* and, therefore, *L. ochroleuca* should be excluded from the flora of Namibia.

(71) According to Stegenga *et al.* (1997) this taxon includes *L. schinzii* Foslie. These authors remark that *L. pallida* is partially interfertile with European *L. ochroleuca*.

Chlorophyta

(72) Only tentatively recorded from Elizabeth Bay by Engledow (1998).

(73) Recorded by Lawson *et al.* (1990) as *E. tubulosa* Kützing.

(74) Lawson *et al.* (1990) cite *E. compressa* and not *E. intestinalis*. Some authors consider both taxa as different species, whereas others include *E. compressa* in the morphological variation range of *E. intestinalis*. In the present work we consider *E. intestinalis* in a broad sense.

(75) It is possible that the records of *U. nematoidea* and *U. fasciata* belong to the same taxon. See the remark at page 185.

(76) This taxon includes *Ulva uncialis* (Kützing) Montagne.

(77) Lawson *et al.* (1990) consider *C. aerea* as a synonym of *C. linum* and cite this last species on the basis of material from Swakopmund determined *as C. aerea* by Wynne (1986). In the present work, we consider *C. aerea* and *C. linum* as different entities, and therefore, the latter should be excluded from the Namibian flora.

(78) According to Stegenga *et al.* (1997) the northern distribution limit of *C. contexta* is Lüderitz,

although Lawson *et al.* (1990) also recorded this species from Swakopmund and Möwe Bay.

(79) Only tentatively recorded from Diaz Point by Engledow (1998).

(80) Recorded as *Cladophora mirabilis* (C. Agardh) Rabenhorst by Lawson *et al.* (1990) and Stegenga *et al.* (1997).

(81) Only tentatively recorded from Rocky Point by Engledow (1998).

(82) According to Silva *et al.* (1996) the correct epithet for this species is *cespitosa*.

(83) Stegenga *et al.* (1997) include *B. tenuis* in *B. africana* Areschoug pointing out that the latter is possibly synonymous with *B. cespitosa*.

(84) Species recorded by Lawson *et al.* (1990) as *Derbesia lamourouxii* (J. Agardh) Solier.

(85) According to P. Silva (pers. com.) the Namibian records of *C. duthieae* must be referred to *C. decorticatum*, although its populations would be more closely related to South African populations of *C. duthieae* than to Mediterranean populations of *C. decorticatum*. *C. duthieae* is a more characteristic species of the south and east coasts of South Africa than the west coasts (Stegenga *et al.*, 1997).

SYSTEMATIC TREATMENT

In this section we produce the description of the identified taxa in the material from our sampling campaigns (see page 18).

We followed the study of Silva *et al.* (1996) for the taxa nomenclature and its ordination in divisions, classes, subclasses, orders, families and genus, except for the Halymeniaceae and Kallymeniaceae families, which we arranged according to Saunders and Kraft (1996) in the orders Halymeniales and Gigartinales respectively. We did not consider the order Cryptonemiales. We did not use the study of Silva *et al.* (1996) when we ordered the green seaweeds into classes. In that case it seemed more accurate to us to follow the model of Guiry (1997), according to the classification proposed by Van den Hoek *et al.* (1995). However following the recommendations of the International Code of Botany Nomenclature, we preferred to use the descriptive names ending in *phyta* -instead of *phycota* as Silva *et al.* (1996) proposed- to designate the divisions. In any case, the species in each genus, family and order, appear in alphabetical order. For those species that do not appear in the catalogue by Silva *et al.* (1996) we used the most recent nomenclature that we were able to obtain.

For each specific or infraspecific taxon we indicated the name we considered correct, the basionym (if such was the case) and the synonyms with which the taxon was cited in South Africa. We also indicated the type material if we knew it. Then, we presented a list of selected specimens which support each description. Generally it was a representative specimen of each locality where we had found the taxon, and we indicated, in the following order, the locality, date of collection, herbarium number, and if such was the case, reproductive phase of the plant. The specimens were arranged by localities, following a south-to-north order. In addition, a series of bibliographic references containing a description or illustration of the plant were included, comprising as far as possible, all their distribution area. Since the flora of Namibia, and until recently that of South Africa, was scarcely documented, we tried to include as many references regarding these countries as possible. Next, we presented a detailed description of the habit and the vegetative structure of the plant, and of the reproductive structures of the plant if such was the case. Reproduction was not observed in most of the green algae species. Then, we supplied some data about the habitat, using the terminology proposed by Lüning (1990) for the zonation. In addition, we gave the distribution of the taxon on the Namibian coasts, and also its world-wide distribution. In the first case, the localities appeared in a south-to-north order, being the former ones the citations previous to this study. This information was also reflected in a distribution map, which was placed in an appendix at the end of the work. As for the world-wide distribution, and except for the cosmopolitan species or the most widespread species, we indicated the countries in which each taxon had been cited, with a south-to-north order for the Atlantic, Indian and Pacific oceans. We also signalled them when they were found in more reduced seas, such as the Mediterranean and the Red Sea. Finally, we also included a taxonomic commentary for most taxa. It often comprises a comparison between our material and previous descriptions or iconography of that particular taxon. When there were not any references or they were scant, or we considered that the differences were significant enough, we also indicated the similarities and the differences of our specimens with other taxa with a close morphology or anatomy. Apart from that, practically every taxon was illustrated with a picture or drawing of the plant habit, and also with pictures or drawings of some morphological or anatomical aspects.

In some cases we provided general taxonomic comments or other kind of explanations besides the species remarks. In addition, when a genus or species comprised in this study was represented by more than one taxon in Namibia, we supplied a determination key. We want to emphasise that these are guiding keys that must be used with caution, because sometimes they include species that we have not studied. When such was the case, we supplied complementary information that in many cases included bibliographic references where a description of these species could be found. Likewise, we indicated when we did not have enough information about some species to include them into the determination key. A general key to genera occurring in Namibia was also provided and placed in an appendix at the end of the work.

And last but not the least, we have to say that there were some specimens we were not able to assign to any species because they lacked well developed reproductive structures or they did not adjust to any description available to us. We have provided long accounts of these specimens, which were only determined at a genus or family level. It is possible that they represent a new species. However we think it is necessary to make a comprehensive and detailed comparative study of this material (which is not a part of the aims of the present work) before describing it as a new taxon.

Division RHODOPHYTA
Class RHODOPHYCEAE
Subclass BANGIOPHYCIDAE
Order PORPHYRIDIALES Kylin ex Skuja (1939)
Family PORPHYRIDIACEAE Kylin ex Skuja (1939)

Genus *Stylonema* Reinsch (1875)

Key to species of *Stylonema*:

1. Filaments uniseriate............................. *S. alsidii*
1. Filaments completely or partially pluriseriate..... ....*S. cornu-cervi*

Stylonema alsidii (Zanardini) K. Drew
(Fig. 17)

Bangia alsidii Zanardini (1840), p. 136.
Goniotrichum alsidii (Zanardini) Howe (1914), p. 75.
Stylonema alsidii (Zanardini) K. Drew (1956), p. 72.
Bangia elegans Chauvin (1842), p. 33.
Goniotrichum elegans (Chauvin) Zanardini (1847), p. 249.
Stylonema elegans (Chauvin) V. May (1965), p. 352.

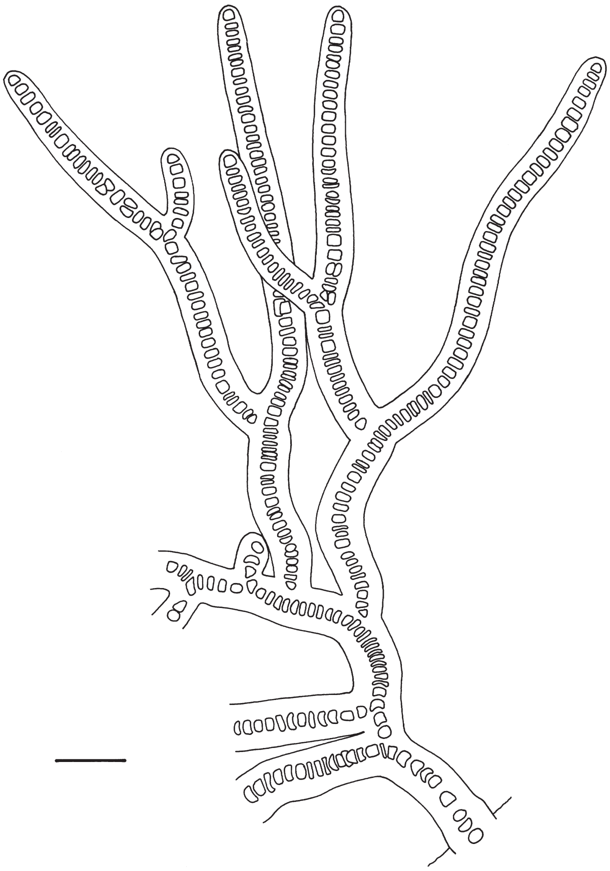

FIG. 17. – *Stylonema alsidii*. Habit (portion of an specimen). Scale bar = 50 µm.

Selected specimens: Rocky Point, 24-02-1986, BCF-A 12005.

References: Taylor (1960), Dawson *et al.* (1964), Abbott and Hollenberg (1976), Cordeiro-Marino (1978), Lawson and John (1987), Noda (1987), Desikachary *et al.* (1990), Womersley (1994), Coppejans (1983, 1995), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant 740 µm high, consisting of irregularly ramified uniseriate filaments, 30-36 µm in diameter in the middle part and 20-24 µm in diameter in the apical zone, attached to substratum by the basal cell. Cells square to rectangular in shape, generally more wide than high, 5-12 x 10-12 µm, arranged in rows within a thick mucilaginous sheath, especially in the middle and basal parts of the plant. Apical cell dome-shaped, 6-11 x 9-11 µm.

Reproduction: Reproductive structures not observed.

Habitat: Epiphytic on *Centroceras clavulatum* in the eulittoral zone.

Namibian distribution: Swakopmund (Wynne, 1986); Rocky Point (Map 1).

World distribution: Cosmopolitan (Lawson and John, 1987).

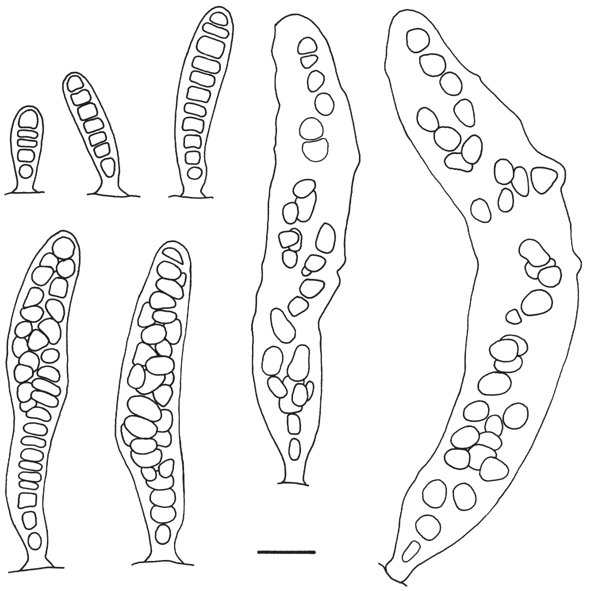

FIG. 18. – *Stylonema cornu-cervi*. Several development phases of the plant. Scale bar = 25 µm.

Stylonema cornu-cervi Reinsch
(Fig. 18)

Stylonema cornu-cervi Reinsch (1875), p. 40.
Goniotrichum cornu-cervi (Reinsch) Hauck (1885), p. 519.

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986, BCF-A 12003.

References: Hamel (1924), Newton (1931), Feldmann (1939), Dawson *et al.* (1964), Abbott and Hollenberg (1976), Coppejans (1983), Kajimura (1992), Womersley (1994).

Habit and vegetative structure: Plant to 260 µm high, consisting of a generally unbranched filament, at first uniseriate, 14-18 µm in diameter, later completely or partially pluriseriate, 22-52 µm in diameter, with the apical and basal cells unique; suprabasal region generally constricted as a short stalk, 10-12 µm in diameter. Cells of pluriseriate region rounded, elliptical or triangular, 8-16 x 7-12 µm, irregularly placed within a thick mucilaginous sheath; cells of uniseriate specimens or of uniseriate regions squarish or rectangular, generally more wide than high, 4-10 x 8-10 µm; basal cell elliptical or isodiametric, 6-12 x 6-7 µm; apical cell 7-10 x 8-12 µm. Plastid lobed, more or less stellate.

Reproduction: Reproductive structures not observed.

Habitat: Epiphytic on other algae, as *Ophidocladus simpliciusculus*, *Polysiphonia scopulorum* and *Tayloriella tenebrosa*.

Namibian distribution: South Kunene (Map 2).

World distribution: Atlantic Ocean: Namibia; Morocco (Dangeard, 1949); north of Iberian Peninsula, France, England (South and Tittley, 1986). Mediterranean Sea (Gallardo *et al.*, 1985). Pacific Ocean: Peru, California to northern British Columbia, Japan (Scagel *et al.*, 1986). Australia (Womersley, 1994). Indian Ocean: South Africa (Silva *et al.*, 1996); Australia (Womersley, 1994). Widespread in temperate seas (Womersley, 1994).

Remarks: Our specimens, although generally smaller and unbranched, are compatible with the *Stylonema cornu-cervi* descriptions consulted. This species, not much frequent in the southern hemisphere, have not been reported to date in the Namibian coasts.

Order BANGIALES Schmitz in Engler (1892)
Family BANGIACEAE Engler (1892) *nom. cons.*

Genus *Porphyra* C. Agardh (1824) *nom. cons.*

Key to species of *Porphyra*:

1. Blades 24-36 µm thick....................*Porphyra* sp.
1. Blades usually over 60 µm thick.......................2

2. Cells close to carposporangia fusiform in cross section, 3-7.5(-13) times longer than broad; car posporangia elongate, 2-4 times longer than broad; carpospores placed in horizontal and vertical rows ....*P. capensis*
2. Cells close to carposporangia elliptical in cross section, 1.5-3.5(-4) times longer than broad; carposporangia elliptical, 1-2 times longer than broad; carpospores usually placed in two groups ....*P. saldanhae*

Porphyra capensis Kützing
(Figs. 19-20)

Porphyra capensis Kützing (1843), p. 383.
Porphyra laciniata (Lightfoot) C. Agardh var. *capensis* (Kützing) Grunow (1867), p. 58.

Selected specimens: Walvis Bay, Lagoon, 9-07-1989, BCF-A 11555, with spermatangia; Langstrand, 6-07-1989, BCF-A 11559, specimen monoecious, with carposporangia and spermatangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11556, with carposporangia; Cape Cross, 7-07-1989, BCF-A 11557, with carposporangia; Terrace Bay, February, 1986, BCF-A 11558, with spermatangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11599, with carposporangia; Angra Fria, 20-02-1986, BCF-A 11832, with carposporangia.

References: Isaac (1957), Chamberlain (1965), Graves (1969), Simons (1969, 1976), Branch and Branch (1981), Anderson *et al.* (1989), Stegenga *et al.* (1997).

FIG. 19. – *Porphyra capensis*. Langstrand, 6-07-1989, BCF-A 11559. Scale bar = 5 cm.

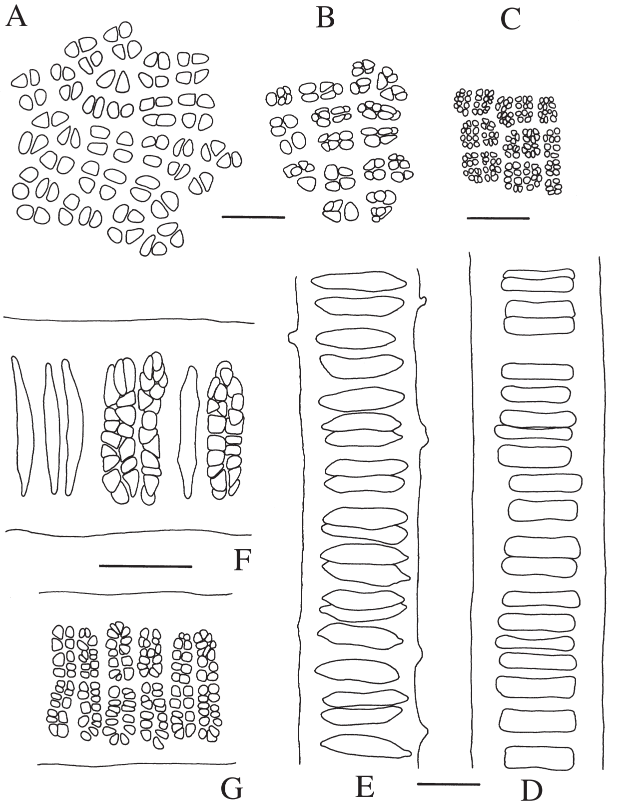

FIG. 20. – *Porphyra capensis*. A-C. Surface view. A. Vegetative cells. B. Carposporangia. C. Spermatangia. D-G. Cross section. D. Vegetative zone of the blade. E. Cells close to the carposporangia. F. Carposporangia. G. Spermatangia. Scale bar = 50 µm.

Habit and vegetative structure: Plant (gametophyte) foliose, rounded or more or less elongated, with undulate margins, up to 25(-40) cm high and to 25 cm broad, sometimes with lanceolate lobes; attached by a small discoid holdfast, 1-2 mm diameter; blade surface smooth, more or less perforated; cells in surface view oblong, triangular or rounded, 8-22 x 6-14 µm, irregularly arranged. In cross section, blade monostromatic, (60-)96-140 µm thick; vegetative cells rectangular, 2.7-7(-10.5) times longer than broad, (32-)40-68(-90) x (6-)8-24 µm, anticlinally arranged; plastid parietal, generally constricted in the central part; cells close to carposporangia more or less fusiform, 3-7.6(-13.7) times longer than broad, 48-84(-94) x 6-22 µm, containing two more or less stellate pastid. Sporophyte not seen.

Reproduction: Plant generally dioecious. Reproductive structures scattered along the blade margin, forming an irregular and usually ill-defined marginal band. In surface view, carpospores 8-14 x 6-12 µm, arranged in groups of 4-8(-10); spermatia 4-7 x 3-6 µm, arranged in groups of 12-16. In cross section, carposporangia elongate, 2.2-4.2 times longer than broad, 70-116 x 20-38 µm, arranged in 2-4 vertical rows of 8-12 carpospores; spermatangia elongate, (2.8-)4.3-5.8 times longer than broad, (44-)60-76 x 12-18 µm, arranged in 2 vertical rows of 8-16 spermatia.

Habitat: Epilithic or growing on mussel shells, in lower eulittoral and tide pools.

Namibian distribution: Elizabeth Bay, Grossebucht, Diaz Point, Lüderitz, Swakopmund, Unjab, Terrace Bay, Rocky Point, Cape Frio, Angra Fria, Honolulu (Lawson *et al.*, 1990); Walvis Bay, Langstrand, Cape Cross, Möwe Bat (Map 3).

World distribution: Atlantic Ocean: Argentina (Pujals, 1963); South Africa (Stegenga *et al.*, 1997); Namibia (Lawson *et al.*, 1990); Angola (Lawson *et al.*, 1975). Indian Ocean: St. Paul Island, South Africa (Silva *et al.*, 1996).

Remarks: Kützing (1943) described *Porphyra capensis* from the Cape of Good Hope (South Africa). This species is known at present from southern Angola to the South African east coast and from St. Paul Island. According to Isaac (1957) and Stegenga *et al.* (1997), this species is more abundant in the west coast than in the east coast of South Africa. Graves (1969) and Stegenga *et al.* (1997) point out the great morphological, anatomical and reproductive variations of this species in relation with the environmental conditions. Isaac (1957) and

Graves (1969) distinguish three environmental morphologic forms:

- A form associated with cold water and more or less exposed places: large specimens, cordate or reniform shaped, growing in the upper and mid-eulittoral zone, or epiphytes of *Aeodes orbitosa* (Suhr) Schmitz or *Ecklonia maxima* (Osbeck) Papenfuss in the upper sublittoral zone. In more exposed conditions the specimens are smaller and occur in higher eulittoral level. This form is the more usual in the west coast of South Africa.
- A warm water form from False Bay, in the south: thin and laciniated fronds.
- A form found in sheltered places: linear or lanceolate fronds.

Kützing (1843, 1849) and Delf and Michell (1921) consider these forms as different species, but J. Agardh (1883), Isaac (1957) and Graves (1969) hold that the morphology and structure of *Porphyra* are too simple to distinguish species.

Baardseth (1941) described *P. tristanensis* from Tristan da Cunha and pointed out that this species was similar to *P. capensis*, a species little known at that time. Chamberlain (1965) recorded *P. tristanensis* from Gough Island indicating the possibility that the specimens could correspond to *P. capensis.*

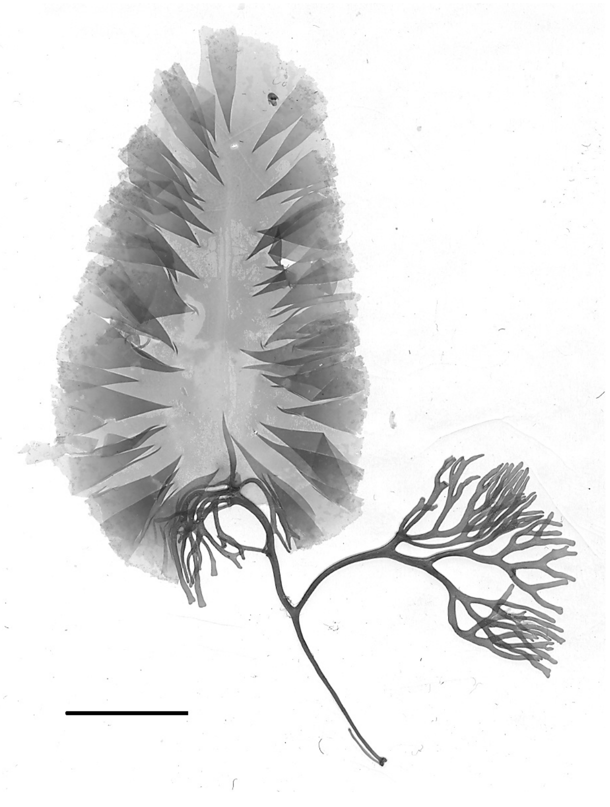

FIG. 21. – *Porphyra saldanhae*. Cape Frio, 23-02-1986, BCF-A 11831. Specimen epiphytic on *Ahnfeltiopsis vermicularis*. Scale bar = 2 cm.

Our specimens are quite uniform and are similar to the first form reported by Isaac (1957) and Graves (1969). Likewise, our material also agree with the *P. capensis* description of Stegenga *et al.* (1997), although the cells of our specimens are longer (2.7-7(-10.5) times longer than broad) than the cells of the South African material (up to 4 times longer than broad).

Stegenga *et al.* (1997) describe *P. saldanhae* from the west coast of South Africa, a species quite similar to *P. capensis* with which it could have been confused. This could affect the distribution of *P. capensis* and therefore the distribution showed here is only illustrative until new studies of the material from Angola and St. Paul Island, as well as the material of *P. tristanensis* are available.

Porphyra saldanhae Stegenga, Bolton and Anderson (Figs. 21-23)

Porphyra saldanhae Stegenga, Bolton and Anderson (1997), p. 227.

Selected specimens: Möwe Bay, 25-02-1986, BCF-A 11598, with carposporangia and spermatangia; Cape Frio, 23-02-1986, BCF-A 11831, with carposporangia and spermatangia.

Holotype: Stegenga Sa 2098 (BOL), Yzerfontein, Cape Province, South Africa.

References: Stegenga *et al.* (1997), Griffin *et al.* (1999).

Habit and vegetative structure: Plant (gametophyte) foliose, lanceolate, 8 cm high and 5 cm wide, or more or less orbicular, 6-7 cm in diameter, attached by a basal holdfast. Cells elliptic or more or less isodiametric in surface view, 12-20 x 8-14 µm. Blade monostromatic, 80-100 µm thick in cross section; vegetative cells more or less rectangular, 2.6-5(-6) times longer than broad, 38-50 x 10-16 µm, anticlinally arranged; cells elliptic in fertile areas of the blade, 1.6-3.6(-4.2) times longer than broad, 28-48 x 10-26 µm, with 2 more or less stellate plastids. Sporophyte not seen.

Reproduction: Plant monoecious. Reproductive structures arranged marginally in the blade. Carposporangia disperse in surface view, with carpospores 8-12 x 6-10 µm; spermatangia in compact angular patches, with spermatia 4-6 x 3-5 µm. Carposporangia elliptic in cross section, 1.4-2.3 times longer than broad, 58-80 x 28-44(-54) µm, with carpospores usually arranged in two groups, a upper group and a lower group; spermatangia elliptic, 2.2-3 times longer than broad, 38-50 x 14-22 µm, with 2 vertical rows of 4 spermatia.

Habitat: Epiphytic on *Ahnfeltiopsis vermicularis* and *Aeodes orbitosa*, in the lower eulittoral zone.

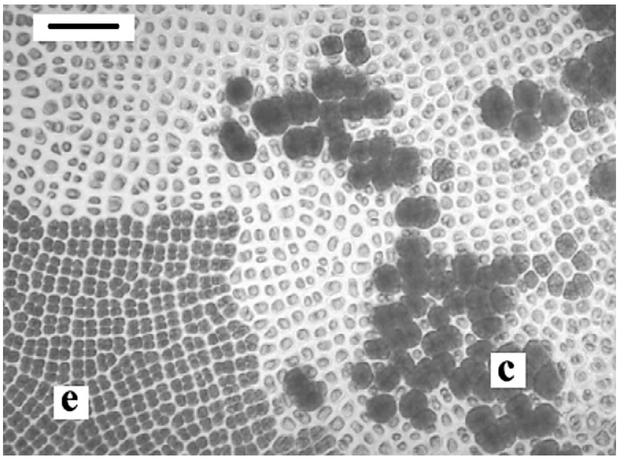

FIG. 22. – *Porphyra saldanhae*. Surface view of the blade fertile area with carposporangia (c) and spermatangia (e). Scale bar = 100 µm.

Namibian distribution: Möwe Bay, Cape Frio (Map 4).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997). Namibia.

Remarks: *Porphyra saldanhae* was described from the west coast of South Africa by Stegenga *et al.* (1997). From the descriptions and the key showed by these authors we can see that *P. saldanhae* is quite similar to *P. capensis*. The differences between the two species are: *P. saldanhae* is monoecious whereas *P. capensis* is usually dioecious; the blade of the former species is thinner than the blade of the latter (60-100 µm thick, in comparison with (50-)100-150 µm in *P. capensis*); in cross section, the cells of *P. saldanhae* are shorter than those of *P. capensis* (2-3 times longer than broad in comparison with up to 4 times in *P. capensis*). Likewise, both taxa seem to differ in the reproductive structures. In this way, spermatangia and carposporangia are ovoid in *P. saldanhae*, whereas these structures are elongated as the vegetative cells in *P. capensis*. Moreover, in *P. saldanhae* the carpospores (up to 32) are placed in two groups and the spermatia in two groups of four rows, whereas in *P. capensis* the carpospores (up to 32 also) are placed in columns of 8 and the spermatia in columns of up to 24.

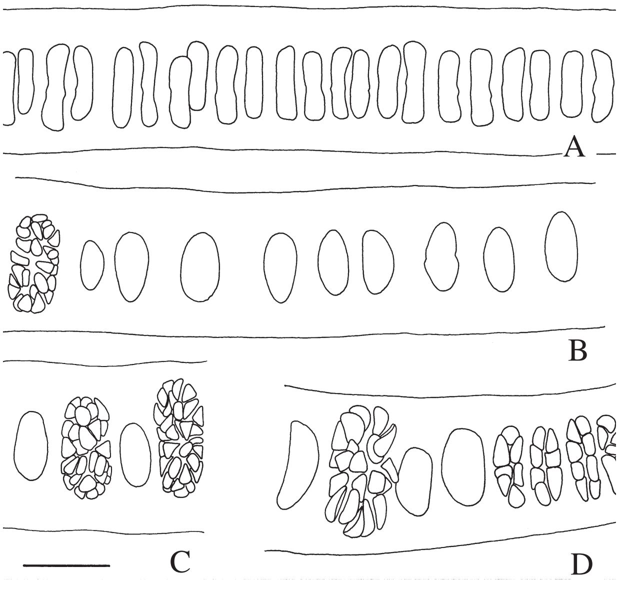

FIG. 23. – *Porphyra saldanhae*. A-D. Cross section of the blade. A. Vegetative area. B. Fertile area with one carposporangium. C. Carposporangia. D. Fertile area with spermatangia and one carposporangium. Scale bar = 50 µm.

In our specimens of *P. saldanhae*, the vegetative cells, although shorter than the cells of our specimens of *P. capensis*, are considerably longer (2.6-5(-6)) times longer than broad) than the cells of South African *P. saldanhae* (2-3 times). In this respect, our specimens of *P. saldanhae* are very similar to *P. capensis*. However, concerning the cells near to the carposporangia, the two species are different. In this way, in our specimens of *P. saldanhae* these cells are elliptic, 1.6-3.6(-4.2) times longer than broad and measure 28-48 µm in height, as in Stegenga *et al.* (1997), whereas these cells in *P. capensis* are larger (48-84(-94) µm in height) and longer (3-7.6(-13.7) times longer than broad). Concerning the reproductive structures, our specimens are consistent with *P. saldanhae*, although the spermatangia have fewer spermatia.

P. saldanhae is similar to *P. aeodis* Griffin, Bolton et Anderson, a species recently established by Griffin *et al.* (1999) from South Africa. According to these authors, the two species overlap morphologically and anatomically although there are some ecological and anatomical differences. *P. aeodis* is a summer annual species that grows on *Aeodes orbitosa* (Suhr) Schmitz or on several other macroalgae, while *P. saldanhae* is a winter annual species growing on hard substrata. Moreover, in *P. aeodis* spermatangia and carposporangia have eight to sixteen tiers of spermatia and carpospores respectively, while there are generally eight tiers of spermatia in the spermatangia of *P. saldanhae* and two tiers of carpospores in the carposporangia of this species. Our specimens agree anatomically better with the Stegenga *et al.* (1997) description of *P. saldanhae* than with Griffin *et al.* (1999) description of *P. aeodis*. However, some Namibian specimens are epiphytic on *Aeodes orbitosa*.

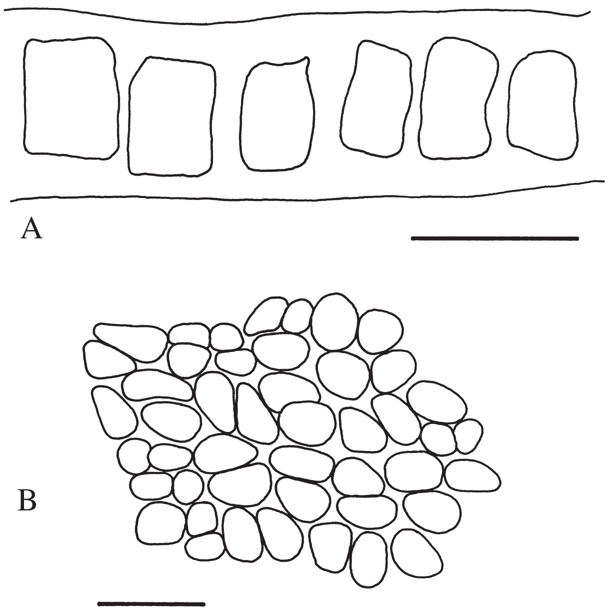

FIG. 24. – *Porphyra* sp. A. Cross section of the blade. B. Cells in surface view. Scale bar = 20 µm.

Porphyra sp.
(Fig. 24)

Selected specimens: Langstrand, 6-07-1989, BCF-A 11597.

Habit and vegetative structure: Plant (gametophyte) foliose, elongate or more or less orbicular, up to 4 cm long and 2.5 cm broad, with undulate margins, attached by a basal disc; blade surface smooth. Cells ovate, elliptic or isodiametric in surface view, 8-14 x 6-10 µm, not grouped, irregularly arranged. Blade thin, monostromatic in cross section, 24-36 µm thick; cells rectangular, 14-20 x 6-12 µm, anticlinally arranged, with a more or less stellate plastid. Sporophyte not seen.

Reproduction: Reproductive structures not observed.

Habitat: Epiphytic on *Mazzaella capensis* and *Chaetomorpha aerea* in the eulittoral zone.

Namibian distribution: Langstrand (Map 5).

Remarks: The correct identification of these specimens is impossible because all our material is not fertile. The blade is thinner than the blade of the other species of *Porphyra* recorded from Namibia.

Stegenga *et al.* (1997), in their study on the seaweeds of the South African west coast, described two *Porphyra* species with a blade of less than 60 µm in thickness. One of these species is *P. gardneri* (Smith and Hollenberg) Hawkes, that has a ribbon-shaped blade, 20-30 µm thick, consisting of rectangular cells 10-12 µm long in cross section. The other, *Porphyra* sp. ind., has a cordate or elongate blade 40-60 µm thick, consisting of rounded rectangular cells 20-25 µm long in cross section. Morphologically, our specimens agree better with *Porphyra* sp. than *P. gardneri*. In contrast, anatomically, our material has features between the two species.

Class FLORIDEOPHYCEAE
Order ACROCHAETIALES Feldmann (1953), *emend.* Garbary and Gabrielson (1987)
Family ACROCHAETIACEAE Fritsch ex W.R. Taylor (1957)

The taxonomy of this family, with more than 400 taxa (Lee and Lee, 1988), is very problematic (Dixon and Irvine, 1977; Garbary, 1979; South and Tittley, 1986; Lee and Lee, 1988; Silva *et al.*, 1996, etc.). In most cases life history is unknown and probably species described as different could correspond to different generations of the same species. Moreover, the systematic criteria used in this group depend on the authors which, in an attempt to clarify the taxonomy, often create new genera or amend the descriptions of the genera already existing, increasing the confusion. For this reason, the species distribution showed in this work can only be taken as illustrative.

On the taxonomy of Acrochaetiaceae, at present, authors are divided into two groups. The first group, according to Drew (1928), consider this family as monogeneric, although they believe that ultrastructural and biochemical studies, as well as knowledge of the life history could lead to establishing new genera following a more natural taxonomy. This is the case of Dixon and Irvine (1977), Garbary (1979), South and Tittley (1986), Garbary (1987), Bird and McLachlan (1992) and Woelkerling and Womersley (1994), who consider only the genus *Audouinella*. The second group of authors, composed among others by Papenfuss (1945), Kylin (1956) Feldmann (1962), Stegenga (1979, 1985a), Lee (1980),Woelkerling (1983), Jackelman *et al.* (1991) and Nielsen *et al.* (1995), using as a base the type of reproductive structures, the number and type of platids and the life history, distinguish different genera (between two and eigth). In this respect, Lee and Lee (1988) show the different classification systems proposed by these authors and propose a new system with 3 genera.

Until a study of Namibian Acrochaetiaceae was carried out, the easiest approach was to follow the monogeneric criterion and to consider only the genus *Audouinella*. Another, perhaps more correct, possibility was to follow the work of Stegenga (1985a) on the South African Acrochaetiaceae based in species cultures. This author, who described the taxa pointing out the development type of the initial cell and the differences between the distinct life-cycle generations, uses as main features to distinguish genera the number, morphology and arrangement of plastids (stellate or blade like, axial or parietal) and the presence or absence of pyrenoids. In our material the plastid morphology and arrangement are not always easy to discern. For this reason we have not followed Stegenga (1985a) but Silva *et al.* (1996). In agreement with Feldmann (1962), these last authors consider that *Acrochaetium* includes species with only one plastid, stellate or blade like, axial or parietal, whereas *Audouinella* includes species with several plastids without pyrenoids.

Finally, and as we has alredy pointed out, the confused taxonomy of this family does not allow us to assess the real distribution of species. For this reason, the distribution presented here is only illustrative and it is based upon literature records of the considered binomy. For the same reason we have not considered the synonyms in the taxa studied.

Genus *Acrochaetium*
Nägeli in Nägeli and Cramer (1858)

Key to species of *Acrochaetium*:

1. Plant endophytic, prostrate; filaments 4-6 μm in diameter ....*A. endophyticum*
1. Plant epiphytic 2

2. Plant consisting of prostrate filaments only; initial cell split into two similar cells, easily recognized in well-developed specimens ....*A. reductum*
2. Plant consisting of erect filaments only or prostrate and erect filaments; initial cell visible or not 3

3. Plant consisting of erect filaments only; initial cell visible..................................*A. moniliforme**
3. Plant consisting of prostrate and erect filaments; initial cell not visible 4

4. Erect filaments 8 μm or less in diameter...........5
4. Erect filaments usually more than 8 μm in diameter 6

5. Plant with monosporangia placed in chains ....*A. catenulatum*
5. Plant with tetrasporangia and polysporangia........ ....*A.* sp.

6. Filaments 8-14 μm in diameter; monosporangia unilaterally or opposite arranged in 3-4 cells long branches, the apical cell usually with 2 monosporangia ....*A. secundatum*
6. Filaments 12-20 μm in diameter; monosporangia in clusters ....*A. daviesii*

* *A. moniliforme* was not observed. More information about this taxon can be found in Stegenga (1985) and Stegenga *et al.* (1997).

Acrochaetium catenulatum Howe
(Fig. 25)

Acrochaetium catenulatum Howe (1914), p. 84.

Selected specimens: Rocky Point, 24-02-1986, BCF-A 12032, with monosporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 12269, with monosporangia.

References: Dawson *et al.* (1964), Chapman (1969), Stegenga and Vroman (1976), Stegenga (1985a), Noda (1987), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, 200-240 μm high, consisting of uniseriate erect filaments, (5-)6.5-8 μm in diameter, unbranched or sparingly branched, usually arcuate, arising from a prostrate system of filaments more or less loosely jointed. Erect filaments with secund laterals 1-3 cells long and/or chains of 1-3 monosporangia, usually placed on convex side of filaments. Cells of erect filaments cylindrical to slightly clavate, 1-2.1 times longer than broad, 7.2-13.6 x 4.8-8 μm; apical cell 4.8-10.4 x 4-6.4 μm. Plastid parietal, more or less H-shaped with one pyrenoid often obscure.

Reproduction: Monosporangia ovoid, elliptic or subspherical, 5.6-12.8 x 4-8.8 μm, arranged in terminal or lateral chains of 1-3 monosporangia. Other reproductive structures not seen.

Habitat: Epiphytic on *Pterosiphonia complanata* in the substratum of *Laminaria pallida* kelp bed.

Namibian distribution: Rocky Point (Engledow, 1998), South Kunene (Map 6).

World distribution: Atlantic Ocean: South Africa (Stegenga, 1985a); Namibia; (?)Western Baltic (South and Tittley, 1986); Argentina, Fuegia (Pujals, 1963, 1977). Pacific Ocean: Juan Fernández (Chapman, 1969); Peru (Dawson *et al.*, 1964); New Zealand (Chapman, 1969); Japan (Noda,

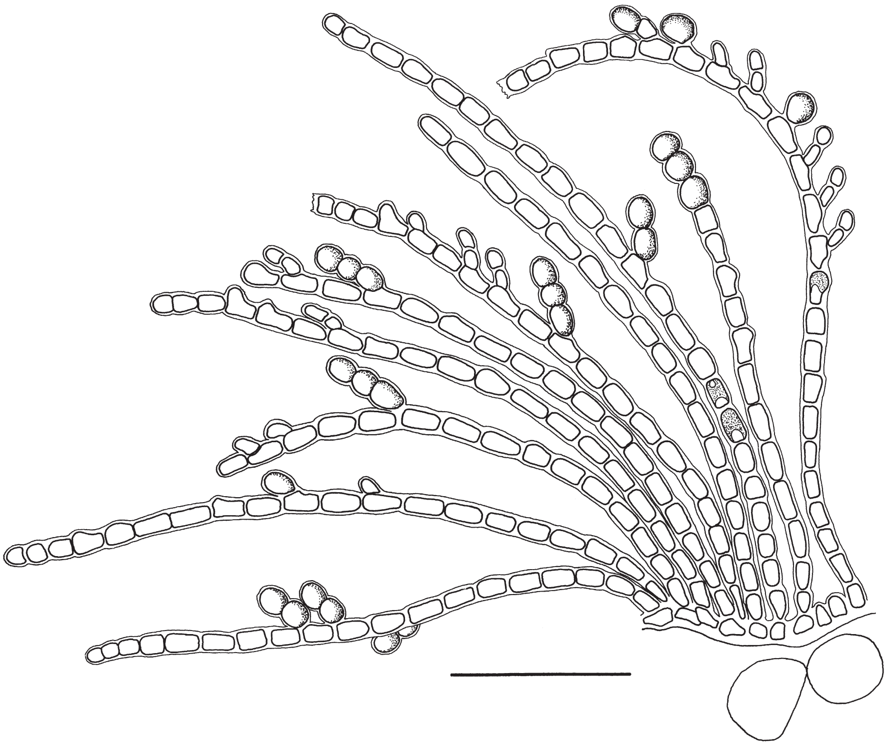

FIG. 25. – *Acrochaetium catenulatum*. Erect filaments with monosporangia. Plastid only showed in some cells. Scale bar = 50 µm.

1987). Indian Ocean: Australia (Silva *et al.*, 1996). Probably world-wide in temperate seas (Stegenga *et al.*, 1997).

Remarks: Stegenga (1985a), in his paper about the South African Acrochaetiaceae, describes *A. catenulatum* differentiating gametophytes and tetrasporophytes. The base is unicellular in the former and pluricellular and consisting of prostrate axes in the latter. This author states that in South Africa, the tetrasporophyte (formerly known as *Rhodochorton densum* Drew) is the usual generation in nature and gametophytes only are known from cultures. Moreover, Stegenga (1985a) points out that, althoug the relation between the two generations in South African material has not been demonstrated, it is probable because this material is very similar to the European material used by Stegenga and Vroman (1976) to study life history of this species.

Other consulted descriptions of *A. catenulatum* (Dawson *et al.*,1964; Chapman, 1969; Noda, 1987) possibly must correspond to gametophytes, because they agree better with Stegenga's (1985a) description of gametophytes than tetrasporophytes. *A. catenulatum* gametophytes are similar to *Acrochaetium microscopicum* (Nägeli ex Kützing) Nägeli (*Audouinella microscopica* (Nägeli ex Kützing) Woelkerling, according to some authors). Probably for this reason, Woelkerling (1972) included this species and other similar taxa in the «*Audouinella microscopica* complex». This opinion was shared by Cribb (1983) and Woelkerling and Womersley (1994). In contrast, other authors considered the two species separately (Stegenga, 1985a; South and Tittley, 1986; Silva *et al.*, 1996).

Our material is compatible with Stegenga (1985a) and Stegenga *et al.* (1997) descriptions of *Acrochaetium catenulatum* tetrasporophyte. However, in our specimens the plastid seems parietal and H shaped while according to Stegenga (1985a) the plastid is axial and stellate.

Acrochaetium daviesii (Dillwyn) Nägeli
(Fig. 26)

Conferva daviesii Dillwyn (1809), p. 73, pl. F.
Acrochaetium daviesii (Dillwyn) Nägeli (1862), pp. 405, 412.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 12027, with monosporangia; Swakopmund, beach, 8-07-1989, BCF-A 12028, with monosporangia; Mile 30, 7-07-1989, BCF-A 12029, with monosporangia; Mile 32, 7-07-1989, BCF-A 12030, with monosporangia; Möwe Bay, 4-02-1988, BCF-A 11826, with monosporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 12033, with monosporangia.

References: Dixon and Irvine (1977), Cribb (1983), Stegenga (1985a), Lawson and John (1987), Woelkerling and Womersley (1994), Coppejans (1995), Stegenga *et al.* (1997), as well as others.

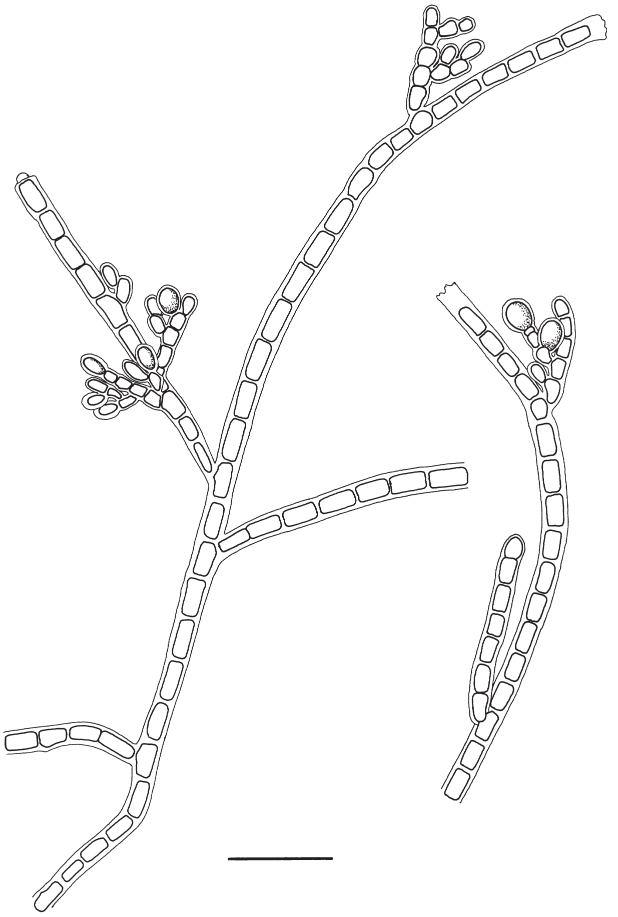

FIG. 26. – *Acrochaetium daviesii*. Erect filaments with monosporangia. Scale bar = 50 µm.

Habit and vegetative structure: Plant filamentous, caespitose, up to 3 mm high, consisting of several erect filaments arising from a pseudoparenchymatous basal disc; branched prostrate filaments sometimes visible. Erect filaments 12-20 µm in diameter, irregularly branched, frequently with clusters of small branches bearing monosporangia. Cells of erect filaments cylindrical, 0.7-2.4 times longer than broad, 10-36 x 12-20 µm; apical cell cylindrical, terminating in a rounded end, 10-42 x 8-16 µm. Plastid parietal.

Reproduction: Monosporangia in clusters, elliptic, pedicellate, 12-20 x 7-12 µm. Other reproductive structures not seen.

Habitat: Epiphytic on several algae such as *Centroceras clavulatum*, *Tayloriella tenebrosa* and *Plocamium rigidum*, in the eulittoral and the upper sublittoral zones.

Namibian distribution: Swakopmund (Engledow, 1998), Mile 30, Mile 32, Möwe Bay, South Kunene (Map 7).

World distribution: Almost cosmopolitan (Woelkerling and Womersley, 1994).

Remarks: Stegenga (1985a), in his paper about the South African Acrochaetiaceae, records *A. daviesii* (as *Colaconema daviesii* (Dillwyn) Stegenga) and points out its similarity to *A. nemalionis* (as *Colaconema nemalionis* (De Notaris) Stegenga). This author states that these species are different by the size of cells and monosporangia. Cells of *A. daviesii* are shorter (1-2 times longer than broad) than those of *A. nemalionis* (3-5 times longer than broad) and monosporangia are also smaller (12-13.5 x 8.5-9.5 µm in *A. daviesii* and 16.5-19.5 x 9.5-11 µm in *A. nemalionis*). Stegenga (1985a) also points out that the size variation rank of cells and monosporangia of *A. daviesii* in the literature is high and, for this reason, he thinks that this name could group several different species.

Concerning morphology and cellular dimensions our material agrees with Stegenga's (1985a) description of *A. daviesii*, but in monosporangia dimensions our specimens are similar to *A. nemalionis*. On the other hand, in our material, the diameter of the erect filaments is relatively larger than that indicated in most literature descriptions consulted (Dixon and Irvine, 1977; Stegenga, 1985a; Lawson and John, 1987; Coppejans, 1995), although it agrees with the dimensions stated by Woelkerling and Womersley (1994); the dimensions of monosporangia also agree with that stated by Woelkerling and Womersley (1994).

Acrochaetium endophyticum Batters
(Fig. 27)

Acrochaetium endophyticum Batters (1896), p. 386.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12037, with monosporangia.

References: Dixon and Irvine (1977), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, endophytic, spreading through cell walls of the host. Filaments 4-6.4 µm in diameter, alternately or irregularly branched, with cells usually cylindrical, 1.6-5.5 times longer than broad, 8.8-20 x 3.2-6.4 µm. Plastid parietal, apparently without pyrenoid.

Reproduction: Monosporangia usually sessile, more or less circular in surface view, 3.2-4.8 µm in diameter, included within the cell wall of the host or projecting outside slightly.

Habitat: Endophytic in *Pleonosporium filicinum*, in the lower eulittoral zone.

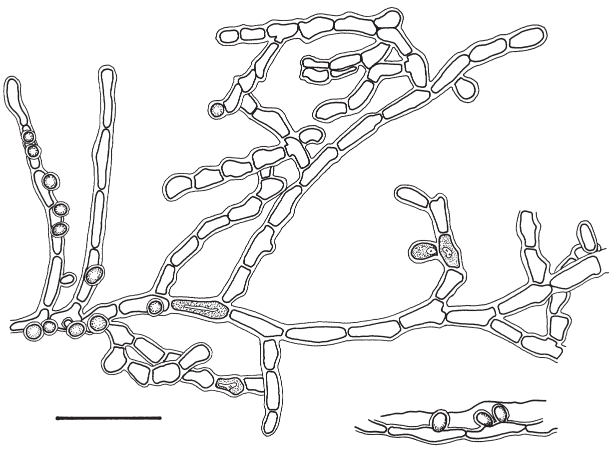

FIG. 27. – *Acrochaetium endophyticum*. A. Filaments with monosporangia in surface view; plastid only showed in some cells. B. Portion of a filament with monosporangia, in lateral view. Scale bar = 30 µm.

Namibian distribution: Mile 8 (Engledow, 1998); Swakopmund (Map 8).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia; France, British Isles (South and Tittley, 1986); South of Britsh Columbia (Scagel *et al.*, 1986).

Remarks: Our material agrees quite well with the Stegenga *et al.* (1997) description and iconography of *Audouinella endophytica* (Batters) Dixon. Likewise, it also agrees with Dixon and Irvine (1977) description of *Audouinella emergens* (Rosenvinge) Dixon, and with Taylor's (1957) description of *Acrochaetium emergens* (Rosenvinge) Weber van Bosse, although the filaments of the latter species are thinner. Garbary et al. (1983) consider *Audouinella endophytica* and *A. emergens* as conspecific. This possibility has been pointed out by Dixon and Irvine (1977).

Acrochaetium reductum (Rosenvinge) Hamel (Fig. 28)

Chantransia reducta Rosenvinge (1909), p. 120.
Acrochaetium reductum (Rosenvinge) Hamel (1927), p. 95

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12036.

References: Ercegovic (1957), Stegenga (1985a), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, prostrate, up to 100 µm long, consisting of branched filaments 3.2-4.8 µm in diameter, originating from a two-celled septate initial cell; bicellular structure 6-10 x 5-8 µm, easily recognized in well developed specimens. Cells cylindrical or irregular in shape, 1.2-2.3 times longer than broad, 5.6-7.2 x 3.2-4.8 µm. Plastid with one central pyrenoid clearly visible.

Reproduction: Reproductive structures not seen.

Habitat: Epiphytic on *Streblocladia camptoclada*.

Namibian distribution: Langstrand, Swakopmund, Wlotzkasbaken, Toscanini (Engledow, 1998) (Map 9).

World distribution: Atlantic Ocean: South Africa (Stegenga, 1985a); Namibia; Norway (South and Tittley, 1986). Western Baltic (Nielsen *et al.*, 1995). Mediterranean: Adriatic Sea (Ercegovic, 1957).

Remarks: Our material agrees very well with Stegenga's (1985a) description and iconography of *A. reductum* tetrasporophyte. This author points out that some species, like *A. pulchellum* Børgesen, *A. radiatum* Jao, *A. curtum* Baardseth or some of those included in the «*Audouinella microscopica* complex» could be conspecific with some generation of *A. reductum*. In this case, and according to Stegenga (1985a), this species could present a wide distribution in temperate, subtropical and tropical Atlantic areas. In this way, our specimens are quite similar to the material *of A. pulchellum* described by Børgesen (1915) and by Baardseth (1941), although they do not have hairs and the cells are slightly smaller.

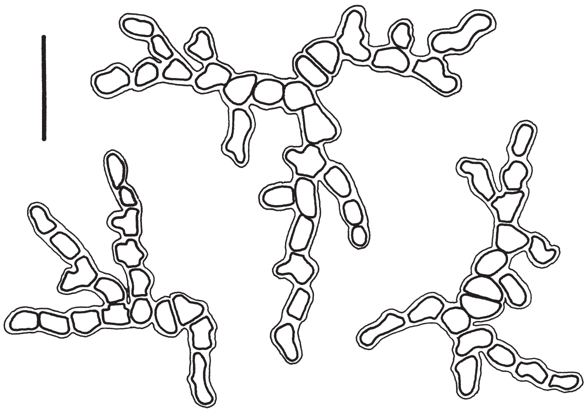

FIG. 28. – *Acrochaetium reductum* (three specimens). Scale bar = 20 µm.

Acrochaetium secundatum (Lyngbye) Nägeli in Nägeli and Cramer (Fig. 29)

Callithamnion daviesii (Dillwyn) Lyngbye var. *secundatum* Lyngbye (1819), p. 129.
Acrochaetium secundatum (Lyngbye) Nägeli in Nägeli and Cramer (1858), p. 532.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-

A 12035, with monosporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 12034, with monosporangia.

References: Zinova (1967), Dixon and Irvine (1977), Cribb (1983), Stegenga (1985a), Woelkerling and Womersley (1994), Coppejans (1995), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, up to 1 mm tall, consisting of many branched erect filaments, 8-14 µm in diameter, arising from an unistratose basal disc. Erect filaments alternately or irregularly branched, with some long branches and many short, 3-4 cells long, branches bearing monosporangia. Distal part of main axes and long branches usually simple and straight; short branches very numerous at central part of the plant, frequently opposite or secund. Cells of erect filaments cylindrical, 1.3-4.3 times longer than broad, 12-34 x 7-14 µm; apical cell cylindrical with a rounded end, 1.3-4.8 times longer than broad, 10-38 x 8-10 µm. Plastid parietal, more or less H-shaped in some cells, with one pyrenoid often obscure.

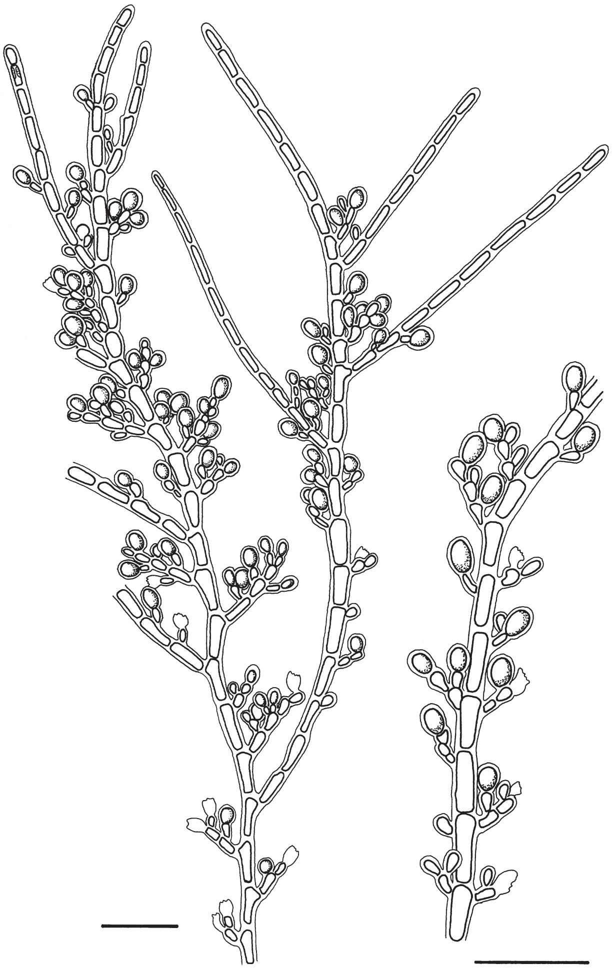

FIG. 29. – *Acrochaetium secundatum*. Detail of two filaments with monosporangia. Scale bar = 50 µm.

Reproduction: Monosporangia numerous, elliptic, 12-16 x 7-11 µm, sessile or pedicellate, generally in secund series on short branches, one in each cell except in apical cell that often bears two monosporangia; less frequently, monosporangia opposite or placed directly on main axis or long branches. Other reproductive structures not observed.

Habitat: Epiphytic on *Chondria capensis* and *Carpoblepharis minima*.

Namibian distribution: Swakopmund, South Kunene (Map 10).

World distribution: Atlantic Ocean: South Africa (Stegenga, 1985a); Namibia; widespread in North Atlantic Ocean (South and Tittley, 1986; Wynne, 1998; Price *et al.*, 1986). Mediterranean Sea (Conde, 1991). Black Sea (Zinova, 1967). Pacific Ocean: Korea (Lee, 1987). Indian Ocean: South Africa, Madagascar, Mauritius (Silva *et al.*, 1996); Australia, Tasmania (Woelkerling and Womersley, 1994).

Remarks: Woelkerling (1973), in his paper on the morphology and systematics of the «*Audouinella* complex» on the Atlantic coast of North America, remarks that the types of *A. secundata* (Lyngbye) Dixon, *A. virgatula* (Harvey) Dixon and *A. tenuissima* (Collins) Garbary correspond to the same taxon. This point of view is shared by Woelkerling and Womersley (1994) and Silva *et al.* (1996). In contrast, Stegenga (1985a) comments that morphological variation of South African material of *Acrochaetium secundatum* distinguishes this species from *A. virgatulum* (Harvey) Bornet as a variety, but that assigning individual plants to one or other is not always easy. In this way, Coppejans (1995) considers *A. virgatulum* as a form of *A. secundatum* (as *Chromastrum secundatum* f. *virgatulum* (Harvey) Papenfuss). On the other hand, Stegenga (1985a) considers *A. secundatum* and *A. tenuissimum* (Collins) Papenfuss as two different taxa pointing out that, although Woelkerling (1973) considers them synonymous, these species can be distinguished by the germination type and monosporangium size.

This diversity of opinions about taxonomy of this species prevents a definite knowledge of its real distribution, and hence the distribution reported in this paper is only illustrative. Stegenga (1985a) points out that *A. secundatum* is an Atlantic species and quite common in South African west coast. In contrast, according to Woelkerling and Womersley (1994), *A. secundatum* (*sensu latu*) occurs also in Indian and Pacific Oceans.

According to Stegenga's (1985a) work, our material agrees better with *A. secundatum* than *A. tenuissimum*, although in the former the plastid is axial and stellate and in our specimens it seems parietal, more or less lobulate and sometimes *H* shaped.

Concerning morphology, our specimens are similar to Wynne's (1986) photographs of *Audouinella hypneae* (Børgesen) Lawson and John and to Coppejans' (1995) iconography of *Chromastrum secundatum* f. *virgatulum*. Wynne (1986) records *A. hypneae* from Swakopmund (Namibia), showing two photographs but without present any description nor remark, except that this species is epiphyte on *Epymenia obtusa*. Accoding to Børgesen (1915), *Acrochaetium hypneae* Børgesen has a base endophyte in the cell wall of *Hypnea* sp. and erect axes scarcely branched, whereas our specimens and Wynne's specimens lack this endophytic base. Concerning *C. secundatum* f. *virgatulum*, our material agrees quite well with Coppejans' (1995) drawing, but does not agree so well with the description.

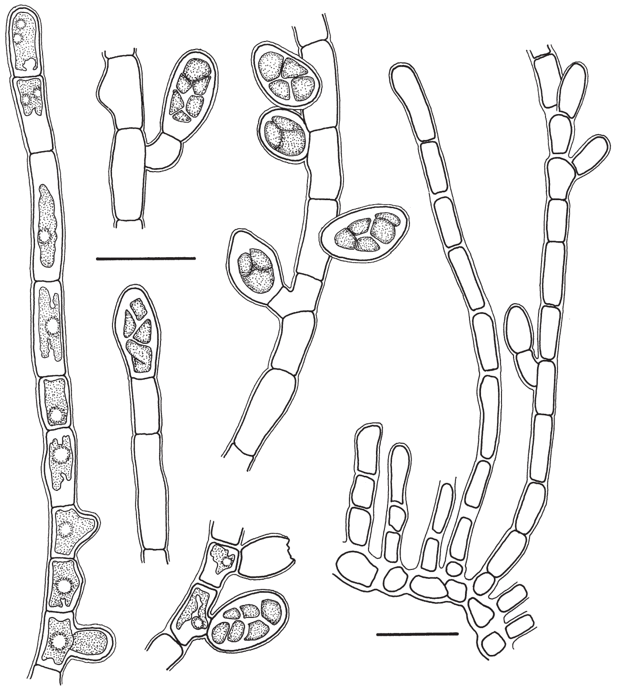

FIG. 30. – *Acrochaetium sp*. A. Upper part of an erect filament. B-E. Sporangia. F. Lower part of the plant. Scale bar = 20 µm.

Acrochaetium sp.

(Fig. 30)

Selected specimens: Cape Frio, 23-02-1986, BCF-A 12038, with tetrasporangia and polysporangia.

Habit and vegetative structure: Plant filamentous, caespitose, 1 mm high, consisting of prostrate and erect filaments. Prostrate filaments joined forming a monostromatic base; cells oblong, squarish or with a more or less sinuous outline, 5-14 x 4-6 µm in surface view. Erect filaments 6-8 µm in diameter, simple or scarcely branched, bearing numerous sporangia; cells of erect filaments generally oblong, 1.2-3.5 times longer than broad, 10-28 x 6-8 µm; apical cell cylindrical, with a rounded end, 1.5-3.7 times longer than broad, 12-26 x 6-8 µm. Plastid parietal, lobate, with 1-3 pyrenoids clearly visible.

Reproduction: Tetrasporangia numerous, elliptic, 15-20 x 9-11 µm, sessile, irregularly arranged along erect filaments, sometimes terminal; polysporangia with 6-8 spores usually frequent. Other reproductive structures not seen.

Habitat: Epiphytic on *Ahnfeltiopsis glomerata* in the lower eulittoral zone.

Namibian distribution: Cape Frio (Map 11).

Remarks: Concerning pyrenoid number our material could be similar to *Acrochaetium botryocarpum* (Harvey) J. Agardh (*Audouinella caespitosa* (J. Agardh) Dixon, according to some authors) or to *Acrochaetium dictyotae* Collins (*Audouinella dictyotae* (Collins) Woelkerling). *A. botryocarpum* has 1-6 pyrenoids per cell in a parietal and lobulate plastid (Chapman, 1969) or in 2-6 parietal, often fused, plastids (Stegenga, 1985a; Woelkerling and Womersley, 1994). In the same way, *A. dictyotae* has cells with one parietal lobulate plastid (sometimes divided in 2-4 plastids) and 1-4 pyrenoids (Woelkerling and Womersley, 1994). However, neither the habit, nor cellular dimensions of our specimens agree with these taxa. Moreover, Namibian material has tetrasporangia irregularly divided or polysporangia with 6-8 spores, whereas *A. botryocarpum* and *A. dictyotae* have monosporangia. In this way, our material agrees with *Acrochaetium polysporum* Howe, which has polisporangia with 8-12(-32?) spores (Dawson *et al.*, 1964), but in contrast to our specimens, this species has only one pyrenoid per cell.

Order PALMARIALES Guiry and Irvine in Guiry (1978)

Family RHODOTHAMNIELLACEAE Saunders in Saunders *et al.* (1995)

Genus *Rhodothamniella* J. Feldmann in Christensen (1978), *emend.* Saunders in Saunders *et al.* (1995)

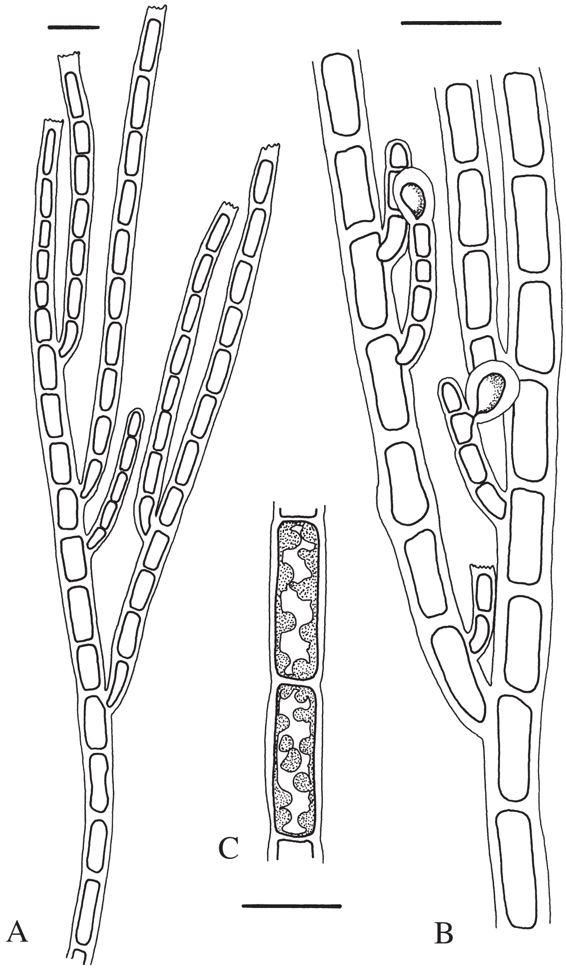

FIG. 31. – *Rhodothamniella floridula*. A. Upper part of an erect filament. B. Branches with few developed sporangia. C. Plastids. Scale bar = 50 µm.

Rhodothamniella floridula (Dillwyn) J. Feldmann in Christensen (Fig. 31)

Conferva floridula Dillwyn (1809), p. 73, suppl. pl. F.
Rhodochorton floridulum (Dillwyn) Nägeli (1862), p. 358.
Audouinella floridula (Dillwyn) Woelkerling (1971), p. 30.
Rhodothamniella floridula (Dillwyn) J. Feldmann in Christensen (1978), p. 67.

Lectotype: BM. Galway coast, Ireland.

Selected specimens: Rocky Point, 24-02-1986, BCF-A 12031, with monosporangia.

References: Hamel (1928), Baardseth (1941), Dixon and Irvine (1977), Stegenga (1985a), Woelkerling and Womersley (1994), Coppejans (1995), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, 12 mm high, consisting of some irregularly branched basal filaments, 20-24 µm in diameter, and one erect filament, also branched, 20-28 µm in diameter. Branches of basal filaments arising at right angle from the central part of the cells; cells with a more or less sinuous outline, 4.3-6.4 times longer than broad, 100-132 x 20-24 µm; apical cells of basal filaments usually longer, rounded to the apex and without plastids. Branches of erect filament secundly arranged, adaxial, fastigiate, arising from the upper third of the cells; cells cylindrical, 2.1-5 times longer than broad, 60-112 x 20-28 µm. Plastids numerous, parietal, with one pyrenoid; sometimes stellate or more or less fused between them forming a parietal lobulate or reticulate plastid.

Reproduction: Reproductive structures rare, little developed, resembling elliptic monosporangia, 30-34 x 22-24 µm, terminal or lateral on 4 celled branches, 16 µm in diameter.

Habitat: Specimen not attached, growing between *Hypnea ecklonii* axes in the lower eulittoral zone.

Namibian distribution: Rocky Point (Map 12).

World distribution: Atlantic Ocean: Tristan da Cunha (Baardseth, 1941); South Africa (Stegenga *et al.*, 1997); Namibia; Portugal to Norway, British Isles (South and Tittley, 1986). Mediterranean Sea: Italy (Conde, 1991). Pacific Ocean: Australia (Woelkerling and Womersley, 1994). Indian Ocean: South Africa (Silva *et al.*, 1996); South Australia (Woelkerling and Womersley, 1994).

Remarks: *Rhodothamniella floridula* was described by Dillwyn (1809) as *Conferva floridula*. Subsequently, Feldmann (1954) established the genus *Rhodothamniella* (later validated by Christensen, 1978) to include the Acrochaetiaceae having several parietal plastids with one pyrenoid each, and transferred *Conferva floridula* to the new genus. More recently, on the basis of molecular and morphologic data, Saunders *et al.* (1995) study the phylogenetic relations of some species of the «Acrochaetiales-Palmariales complex» and consider *R. floridula* as an early stage of Palmariales for which Saunders established the Rhodothamniellaceae.

The only specimen found in our study was a free living plant with little developed reproductive structures. In contrast, the vegetative features agree quite well with literature descriptions, although Stegenga (1985a) points out that the diameter of erect filaments is 19-21.5 µm, whereas in the Namibian specimen it is 20-28 µm.

Order NEMALIALES Schmitz in Engler (1892)
Family GALAXAURACEAE Parkinson (1983)
Genus *Nothogenia* Montagne (1843)

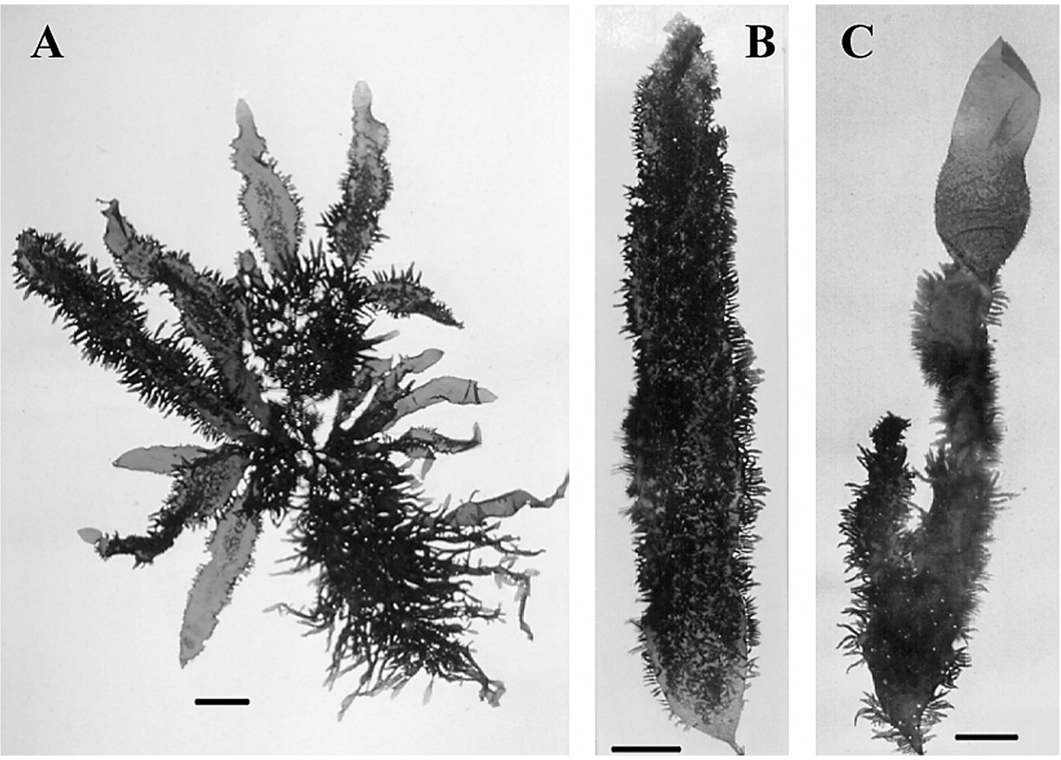

FIG. 32. – *Nothogenia erinacea*. A. 5 km south of Swakopmund, 6-07-1989, BCF-A 11560. B. Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11827. C. Swakopmund, beach, 8-07-1989, BCF-A 11563, specimen ending in a swollen vesicule. Scale bar = 2 cm.

Key to species of *Nothogenia*:

1. Plant foliose, proliferous, up to 30 cm high........ ....*N. erinacea*
1. Plant with vesicular structure, without proliferations, up to 5 cm high..........................*N. ovalis**

* *N. ovalis* was not observed. More information about this taxon can be found in Stegenga *et al.* (1997).

Nothogenia erinacea (Turner) Parkinson (Figs. 32-35; Plate I)

Fucus erinaceus Turner (1808), p. 55.
Chaetangium erinaceum (Turner) Papenfuss (1952), p. 173.
Nothogenia erinacea (Turner) Parkinson (1983), p. 609.
Chaetangium ornatum sensu Kützing (1843), p. 392. Non *Fucus ornatus* Linnaeus (1771), p. 312 (=*Suhria vittata* (Linnaeus) Endlicher (1843), p. 41).
Chaetangium magnificum Pilger (1908), p. 181.
Nothogenia magnifica (Pilger) J. H. Price in John *et al.* (1994), p. 80.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11560; Swakopmund, beach, 8-07-1989, BCF-A 11563, with carposporangia; Mile 108, 13-07-1989, BCF-A 11561, with carposporangia; Terrace Bay, February-1986, BCF-A 11564, with carposporangia; Möwe Bay, 5-02-1988, BCF-A 11830, with carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11828, with carposporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11827, with carposporangia; Rocky Point, 24-02-1986, BCF-A 12039, with carposporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11562, with carposporangia.

References: Schmidt (1957), Simons (1969, 1976), Branch and Branch (1981), Anderson and Stegenga (1985), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant (gametophyte) foliose, stipitate, up to 30 cm high, attached to the substratum by a basal disc. Blade more or less papery, elongate, usually lanceolate, (1-)1.5-6 cm broad, simple or divided, proliferous, sometimes truncate and more or less perforate, occasionally ending in a cylindro-conical swollen vesicula; proliferations abundant, digitate, 5-25 x 1-3 mm, or foliose and more or less lanceolate, 1-9 cm long and 3-10 mm broad, simple or divided, originating both from the margin and the blade surface; sometimes blade surface smooth with only marginally arranged proliferations; stipe terete, short, 1-10 mm long and 1-2 mm in diameter. Cortical cells more or less isodiametric in surface view, 1-3 µm in diameter, compactly arranged. Blade 200-300 µm thick; in cross section, cortex consisting of branched and entangled anticlinal filaments, with elongate cells, 2-16 x 1-3 (-4) µm, the inner usually bigger than the outer; medulla compact, consisting of slender branched filaments, 4-6 µm in diameter (the lumen 1-2 µm in diameter), irregularly arranged; cells of the transitional zone between cortex and medulla often with proliferations.

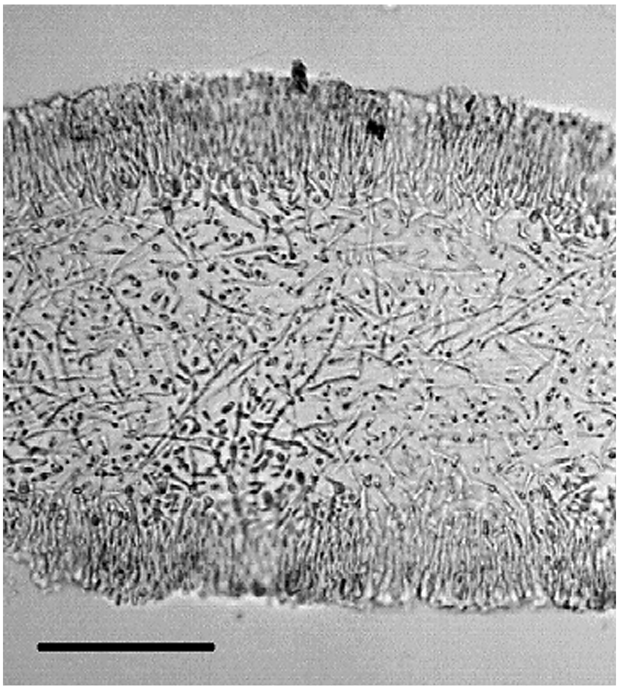

FIG. 33. – *Nothogenia erinacea*. Cross section of the blade. Scale bar = 80 µm.

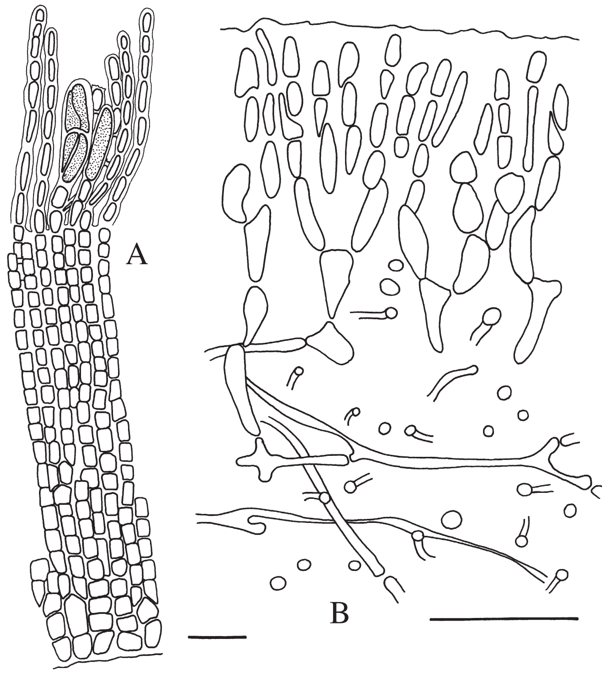

FIG. 34. – *Nothogenia erinacea*. A-B. Cross section. A. Tetrasporophyte. B. Cortical zone of the blade (gametophyte). Scale bar = 20 µm.

Tetrasporophyte crustose, completely attached to the substratum. Cells elliptic or more or less isodiametric in surface view, 3-5 µm in greater diameter. Crust 140-237 µm thick in cross section, consisting of a basal layer of cells giving rise to strongly joined, simple or sparingly branched erect filaments, 20-25 cells long; cells of basal layer usually higher than broad, 6-14 x 3-8 µm; cells of erect filaments squarish or rectangular, 5-10 x 2-7 µm, the lower cells slightly larger than the upper.

Reproduction: Tetrasporangia cruciately or decussately divided, elliptic, 28-40 x 10-14 µm, terminal on erect filaments and placed between paraphyses in nemathecia more or less gelatinous; paraphyses 68-111 µm long, laxly joined between them, consisting of 8-10 elongate cells, 6-18 x 2-3 µm. Carposporangia in spherical or lobulate cavities resembling conceptacles, 172-600 µm in diameter, placed in simple or branched digitate proliferations and opening to the exterior by a pore; carposporangia clavate, 14-30 x 5-12 µm, terminal on branched filaments. Spermatangia not seen.

Habitat: Epilithic in the lower eulittoral zone, forming a more or less wide belt together with *Caulacanthus ustulatus*, *Centroceras clavulatum* and *Chaetomorpha aerea*. Gametophytes often bearing *Caulacanthus ustulatus* and *Streblocladia camptoclada* as epiphytes.

Namibian distribution: Lüderitz, Walvis Bay, Swakopmund, Torra Bay, Möwe Bay, Rocky Point, Cape Frio (Lawson *et al.*, 1990); Mile 108, Terrace Bay, South Kunene (Map 13).

FIG. 35. – *Nothogenia erinacea*. A. Cross section of a fertile proliferation. Scale bar = 1 mm. B. Portion of a conceptacle with carposporangia, in cross section. Scale bar = 80 µm.

World distribution: Atlantic Ocean: South Africa, Namibia (Anderson and Stegenga, 1985). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Nothogenia erinacea* was described by Turner (1808), as *Fucus erinaceus*, from the Cape of Good Hope and at present this species is known only from South Africa and Namibia.

Anderson and Stegenga (1985), from carpospore culture, showed the existence of an incrustant tetrasporophyte phase in the life cycle of *Nothogenia erinacea* and *N. ovalis*. These authors point out, moreover, that tetrasporophytes of the two species are similar and these incrustant plants could be found in nature, between *Nothogenia* gametophytes. In this way, we have observed some incrustant plants that are consistent with the description of the tetrasporophyte of *Nothogenia* species of Anderson and Stegenga (1985), and as we have found them between *N. erinacea* gametophytes, we consider these incrustant plants as the tetrasporophyte of this species.

In addition to *N. erinacea*, Lawson *et al.* (1990) and John *et al.* (1994) recorded from Namibia *N. magnifica* (Pilger) Price and *N. ovalis* (Suhr) Parkinson.

N. magnifica was described by Pilger (1908), as *Chaetangium magnificum*, from Swakopmund specimens similar to *N. erinacea*, but with a gas vesicle in the apex. Later, Papenfuss (1940b), after a study of the type material, pointed out that *C. magnificum* was a synonym for *C. ornatum* (Linnaeus) Kützing (at present *Nothogenia erinacea*). Nevertheless, Price (in John *et al.*, 1994) questioned this conspecificity and transferred *C. magnificum* to the genus *Nothogenia*. According to references cited in Lawson *et al.* (1990) and John *et al.* (1994), in most cases on the basis of Pilger (1908), *Nothogenia magnifica* has been recorded only from Swakopmund. Concerning our material, and as we do not know what are the reasons to not consider these species as conspecific, we prefer to follow Papenfuss (1940b) and to consider only *N. erinacea*.

Concerning *N. ovalis*, which was not present in our samples, the only records from Namibia correspond to the Lüderitz area (Grossebucht and Lüderitz) and Möwe Bay (Lawson *et al.*, 1990).

Order GELIDIALES Kylin (1923)
Family GELIDIACEAE Kützing (1843)
Genus *Gelidium* Lamouroux (1813) *nom. cons.*

In addition to the species referred to in the present study, *G. micropterum* and *G. pteridifolium* were also recorded from Namibia. The information that we have on these species is not sufficient to establish a reliable key to permit their identification. See remarks in *G. pusillum*.

Gelidium pusillum (Stackhouse) Le Jolis
(Figs. 36, 37)

Fucus pusillus Stackhouse (1795), p. 16.
Gelidium pusillum (Stackhouse) Le Jolis (1863), p. 139.

Selected specimens: Mile 32, 7-07-1989, BCF-A 11572; Rocky Point, 24-02-1986, BCF-A 11916, with carposporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11571, with tetrasporangia.

References: Feldmann and Hamel (1936), Dixon and Irvine (1977), Schnetter and Bula-Meyer (1982), Lawson and John (1987), Desikachary *et al.* (1990), Fredriksen *et al.* (1994), Womersley and Guiry (1994), Coppejans (1995), Lee and Kim (1995).

Habit and vegetative structure: Plant 1-3 cm high, consisting of prostrate and erect axes, the latter arising from the former. Prostrate axes terete, 160-340 µm in diameter, branched, ending in acute apices and bearing attachment pads. Erect axes

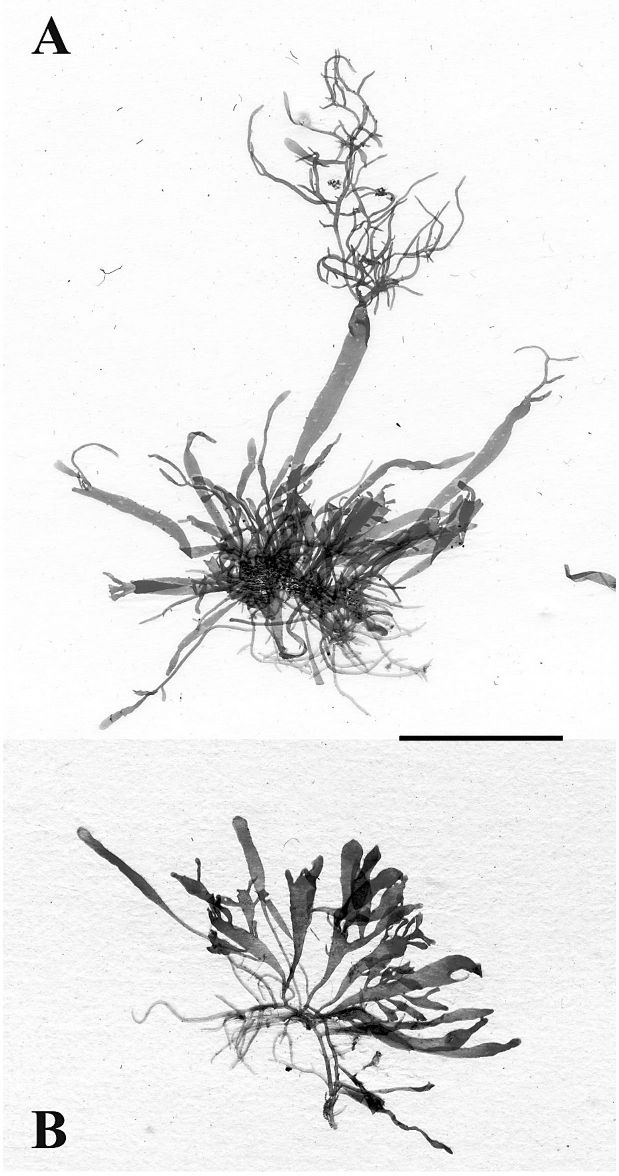

FIG. 36. – *Gelidium pusillum*. A. Mile 32, 7-07-1989, BCF-A 11572. – B. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11571. Scale bar = 1 cm.

cylindrical at the base, 160-340 µm in diameter, progressively flattened upwards, forming narrow lanceolate blades, 700-1500 µm broad, simple or with laterally and more or less distichously arranged proliferations, sometimes arising from the blade surface; apex obtuse, often truncate and proliferous, with flattened or terete proliferations. Outer cortical cells of erect axes polygonal, isodiametric or elongated in surface view; those of the lower part of the axes 8-22 x 8-12 µm, arranged in a continuous layer, and those of the median part of the axes 4-12 x 3-8 µm, more laxly arranged. Plastid parietal. Medulla and cortex differentiated in cross section; medullar cells elliptic or more or less isodiametric, thick-walled, those of the prostrate axes 12-18 x 10-16 µm and those of the median part of the erect axes 10-18 x 8-14 µm; cortex 4-5 cells thick in the terete part of the erect axes and 2-3 cells thick in the flattened part; cortical cells pigmented, elliptic or isodiametric, 5-10 x 4-8 µm, the inner ones with some protuberance, especially in fertile branches; rhizines 4-5 x 2-4 µm, abundant throughout the medulla of erect axes, less frequent in prostrate ones.

Reproduction: Tetrasporangia elliptic, 42-56 x 24-34 µm, cruciately-decussately divided, arranged in sori in spatulate proliferations. Cystocarps elliptic, 600-700 µm long and 560 µm wide, divided into two cavities by a longitudinal wall, each cavity with a visible pore; carposporangia 34-82 x 16-28 µm, arranged in clusters in both sides of the dividing wall, between bifurcate filaments joined with the cortical cells of cystocarp. Spermatangia not seen.

Habitat: In the lower eulittoral zone, together with *Nothogenia erinacea*, *Gastroclonium reflexum*, *Hypnea* sp., *Gracilariopsis longissima* and *Ahnfeltiopsis vermicularis*; also in the upper sublittoral together with *Pterosiphonia complanata*.

Namibian distribution: Swakopmund (Lawson *et al.*, 1990); Mile 32, Rocky Point, South Kunene (Map 14).

World distribution: Widely distributed (Womersley and Guiry, 1994). The world distribution of *G. pusillum* should be taken with some caution, since this name usually refers to short specimens of *Gelidium* that probably belong to different species.

Remarks: According to Lawson *et al.* (1990) and Molloy (1990) the species of *Gelidium* present in Namibia are *G. micropterum* Kützing, *G. pristoides* (Turner) Kützing (at present *Onikusa pristoides* (Turner) Akatsuka), *G. pusillum* (Stackhouse) Le Jolis and *G. pteridifolium* R. Norris, Hommersand and Fredericq, in addition to a number of *Gelidium* spp. from Möwe Bay, Rocky Point and Namibia (without locality).

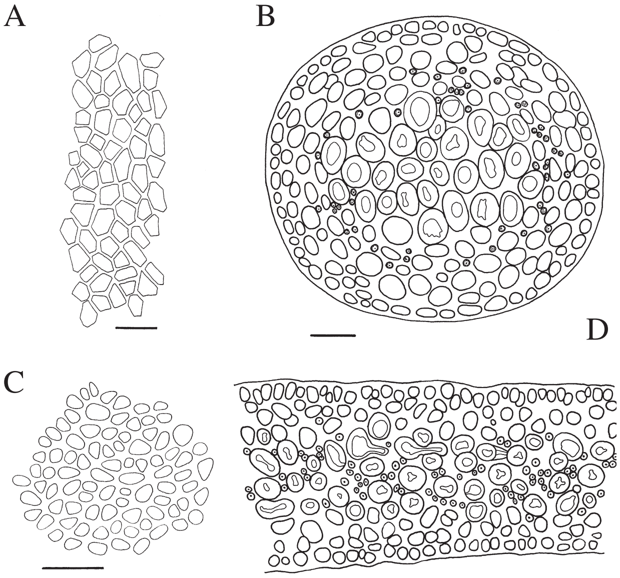

FIG. 37. – *Gelidium pusillum*. A, C. Cortical cells of an erect axis in surface view. A. Basal zone (terete). C. Median zone (flattened). B, D. Cross section of an erect axis. B. Cylindrical part. D. Flattened part. Scale bar = 25 µm.

Onikusa pristoides is an endemism from South Africa, especially abundant on the east coast (Carter, 1985; Akatsuka, 1986; Anderson *et al.*, 1989, 1991; Stegenga *et al.*, 1997), mainly differing from *Gelidium* by the presence of a midrib (Akatsuka, 1986). Lawson *et al.* (1990) record *G. pristoides* without locality on the basis of Price *et al.* (1988). In this paper, the authors record this species from Namibia from an unpublished paper cited as Lawson and Isaac (1982). As this record is not clear, and it is very distant from the distribution area of the species, we do not consider this species in Namibian marine flora.

Concerning *Gelidium micropterum*, Jaasund (1976) points out that this species and *G. pusillum* are similar, but the former is larger and shows a more regular growth model than the latter. Freshwater and Rueness (1994) also show this similarity on the basis of DNA sequentiation of different *Gelidium* species. These authors distinguish a homogeneous group of species formed by specimens of *G. pusillum* from the Canary Islands and Brazil and specimens of *G. micropterum* from South Africa. Stegenga *et al.* (1997) record *G. micropterum* from the south coast of South Africa and they comment on the possibility that the specimens from Namibia and the South African west coast did not correspond to the same taxon.

Gelidium pteridifolium is a South African species, more abundant on the eastern coast than the western coast (Norris *et al.*, 1987; Stegenga *et al.*, 1997). This species has been recorded from Namibia, without locality, by Molloy (1990). *G. pteridifolium* differs from *G. pusillum* mainly by its habit, since it is an erect plant reaching up to 50 cm in height, and consists of up to 4 times pinnately branched, flattened axes (2 mm broad).

Gelidium reptans (Suhr) Kylin, a species from the south and east coasts of South Africa and Mozambique (Norris, 1992a; Stegenga *et al.*, 1997), is also quite similar to *Gelidium pusillum*. According to Norris (1992a), the former species differs from the latter in its anatomy and by having a more defined sori of tetrasporangia. In contrast, Børgesen (1943) and Price *et al.* (1988) consider *G. reptans* and *G. pusillum* var. *pulvinatum* as the same taxon.

G. pusillum is part of a group of small or medium-sized species with great morphological variation, which complicates specimen identification (Fredriksen *et al.*, 1994). As a result, the genus *Gelidium* is one of the most confused genera in terms of both taxonomy and nomenclature (Dixon, 1967). In a first attempt to clarify the taxonomy of European *Gelidium*, Feldmann and Hamel (1936) recognise several species and varieties among small and medium-sized *Gelidium*. These authors have been followed by Lawson and John (1987), Echegaray (1988), Lee and Kim (1995) and Coppejans (1995). Dixon and Irvine (1977), on the basis of the studies of specimens in nature, reduce to only two species the small or medium-sized *Gelidium* occurring in British Isles: *G. pusillum* [including *G. crinale* (Turner) Lamouroux and *G. pulchellum* (Turner) Kützing] and *G. latifolium* (Greville) Bornet and Thuret [including *G. attenuatum* (Turner) Thuret]. Several authors in different parts of the world have followed this initiative, which has increased the confusion in this genus, since recent studies of *G. pusillum* specimens from different geographical areas show that these specimens do not relate to the European taxon (Freshwater and Rueness, 1994). On the other hand, Fredriksen *et al.* (1994), on the basis of electrophoresis and growth curves, have shown that *G. pusillum* and *G. pulchellum* are different species. Moreover, preliminary studies point out that *G. crinale* is probably also a different species (Fredriksen *et al.*, 1994).

Our specimens consist of cylindrical prostrate axes and flattened erect axes, simple or irregularly branched, and often bearing filiform proliferations. According to these features our material agrees with *G. pusillum* var. *pulvinatum* (C. Agardh) J. Feldmann, which differs only from var. *pusillum* by having flattened axes (Feldmann and Hamel, 1936). In this way, our material agrees with Lawson and John (1987), Lee and Kim (1995) and Coppejans (1995) descriptions, although Namibian specimens are higher (up to 3 cm opposite to 1-2 cm according to other authors) and have outer cortical cells relatively larger in surface view (4-12 µm of greater diameter opposite to 3-6 µm according to other authors).

Following Freshwater and Rueness (1994), we believe that morphological studies of material considered as *G. pusillum* in different parts of the world should be carried out, and the results should be checked by molecular methods.

Genus *Suhria*
J. Agardh ex Endlicher (1843) *nom. cons.*

Suhria vittata (Linnaeus) Endlicher
(Figs. 38, 39)

Fucus vittatus Linnaeus (1767), p. 718.
Suhria vittata (Linnaeus) Endlicher (1843), p. 41.
For the synonyms see Seagrief (1984).

Selected specimens: Langstrand, 6-07-1989, BCF-A 11567, with carposporangia and spermatangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11566, with bisporangia and carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11568, with bisporangia, carposporangia and spermatangia; Rocky Point, 24-02-1986, BCF-A 11565, with bisporangia.

References: Fan (1961), Simons (1976), Branch and Branch (1981), Anderson and Bolton (1985), Anderson *et al.* (1989), Molloy (1990), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 24 cm high, consisting of simple or branched stipitate and cuneate blades, (0.5-)1-2 cm broad and 180-240 µm thick, that bear numerous short marginal proliferations and a midrib. Midrib especially prominent in the median and lower parts of the plant, 760-1300 µm thick, but scarcely visible in the upper; stipe terete, 1-10 mm long and 1-2 mm in diameter. Attachment by a basal disc. Blade surface smooth, sometimes perforate, with laminar proliferations up to 16 cm long and 1-1.5 cm broad arising from the midrib, and occasionally with some scattered short proliferations morphologically similar to marginal ones; marginal proliferations compressed, more or less spatulate, 1-4 mm long and about 500 µm broad, simple or more or less pinnately branched, with the apical cell sunken. Outer cortical cells usually elongate in surface view, 5-10 x 3-8 µm. In cross section, blades differentiated into cortex and medulla, the

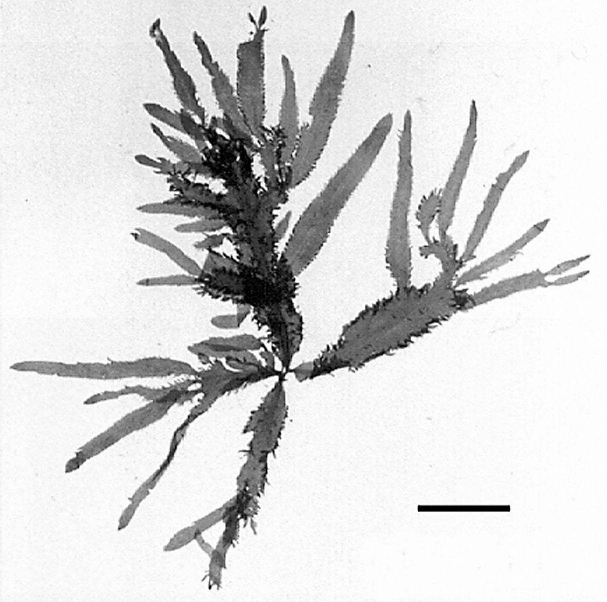

FIG. 38. – *Suhria vittata*. Rocky Point, 24-02-1986, BCF-A 11565. Scale bar = 3 cm.

latter more compact in the midrib than in the flattened portion of the blade and consisting of cells and rhizines; medullar cells rounded, sinuous in outline; rhizines quite abundant, especially in the outer medulla of the midrib, 4-8 µm in diameter, irregularly arranged; cortex 2-3 cells thick, the outer cells 4-12 x 4-8 µm and the inner ones rounded and larger, 10-12(-16) x 8-12 µm.

Reproduction: Reproductive structures placed in the marginal proliferations of the blade, sometimes also in superficial short proliferations. Bisporangia ovoid or elliptic, 30-42 x 18-30 µm. Plant dioecious. Cystocarps 320-600 µm in surface external diameter, protrude from both sides of the proliferations, each with a pore 20-100 µm in diameter, and internally divided into two cavities by a monostromatic longitudinal wall that bears the carposporangia; carposporangia claviform or more or less cylindrical, 32-68 x 10-24 µm. Spermatangia 2-3 µm in diameter in surface view.

Habitat: In the upper sublittoral zone, between *Laminaria pallida* haptera; on *Patella* sp. shells, in drift material.

Namibian distribution: Elizabeth Bay, Lüderitz, Swakopmund, Möwe Bay (Lawson *et al.*, 1990); Langstrand, Rocky Point (Map 15).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); (?)Ghana (Lawson and John, 1987); Argentina (Pujals, 1963). Indian Ocean: St. Paul Island, South Africa, Mauritius, Oman (Silva *et al.*, 1996).

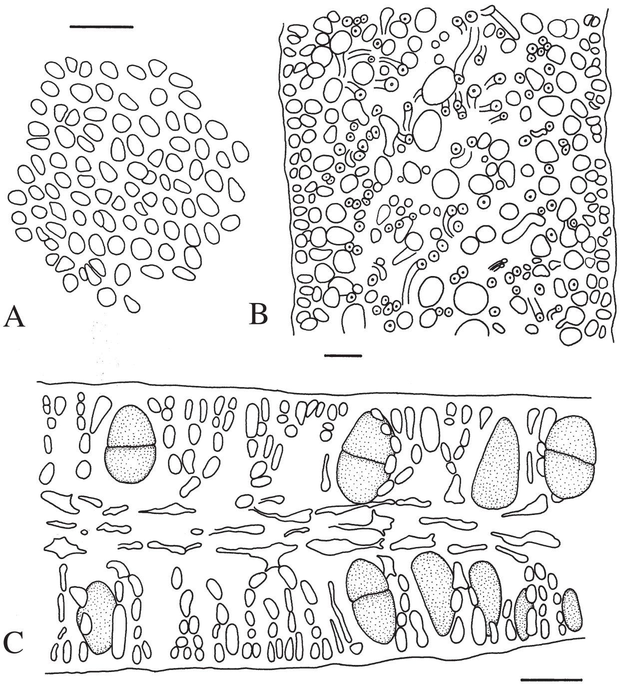

FIG. 39. – *Suhria vittata*. A. Cortical cells in surface view. B. Cross section of the blade margin. C. Cross section of a fertile proliferation with bisporangia. Scale bar = 20 µm.

Remarks: According to Anderson and Bolton (1985), Anderson *et al.* (1989) and Stegenga *et al.* (1997), *Suhria vittata* is a Southern African endemic species that occurs from Möwe Bay (Namibia) to Cape Agulhas (south of South Africa). Anderson and Bolton (1985) also remark that in South Africa this species is more abundant on the west coast of the Cape Peninsula than at east of the Cape Point. This suggests that the species has a greater affinity to cold waters than warm waters. Nevertheless, in the Indian Ocean catalogue, Silva *et al.* (1996) also record *S. vittata* from St. Paul Island, Mauritius and Oman. Likewise, in the Argentina catalogue, Pujals (1963) compile some ancient records of this species from the south of the country. *S. vittata* has also been recorded from Ghana by Hornemann (1819), but Lawson and John (1987) question the record of this cold affinity species from Ghana, and point out that it is impossible to verify since the material was partially destroyed in 1807 by fire.

Order GRACILARIALES Fredericq and Hommersand (1989a)
Family GRACILARIACEAE Nägeli (1847)
Genus *Gracilariopsis* Dawson (1949)

Molloy and Bolton (1995) and Engledow (1998) report *Gracilariopsis lemaneiformis* from Namibia. This species is morphologically and anatomically very similar to *G. longissima*, from which it can be distinguished by molecular techniques. See remarks on this species.

Gracilariopsis longissima (S. G. Gmelin) Steentoft, L. Irvine and Farnham (Figs. 40, 41)

Fucus longissimus S. G. Gmelin (1768), p. 134.
Gracilariopsis longissima (S. G. Gmelin) Steentoft, L. Irvine and Farnham (1995), p. 117.
Fucus verrucosus Hudson (1762), p. 470, *nom. rejic. prop.* (Irvine and Steentoft, 1995).
Gracilaria verrucosa (Hudson) Papenfuss (1950), p. 195.

Neotype: OXF, Dillenius Herbarium: 51, n. 53.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 11665; Mile 30, 7-07-1989, BCF-A 11666, with carposporangia; Mile 32, 7-07-1989, BCF-A 11667, with carposporangia; Cape Cross, 7-07-1989, BCF-A 11668, with carposporangia; Mile 108, 13-07-1989, BCF-A 11669; Rocky Point, 24-02-1986, BCF-A 11670; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11671.

References: Fredericq and Hommersand (1989b), Steentoft *et al.* (1995).

Habit and vegetative structure: Plant up to 45 cm high, consisting of subulate erect axes, (0.5-)1-2(-3) mm in diameter in the median part, slightly constricted basally, irregularly branched, sometimes proliferous from break zones, joined in a caespitose base; branches generally long, some short and more or less spiniform, usually curved at base and more or less laterally arranged. Outer cortical cells elongate or isodiametric in surface view, 6-15 x 4-10 µm. In cross section, medullary cells elliptic, rounded or irregularly polygonal, 55-553 x 40-427 µm, thick-walled and colourless; cortical cells pigmented, more or less cylindro-conical, 8-22 x 4-12 µm, anticlinally arranged; subcortical cells ovate or elliptic, 10-74 x 8-48(-70) µm, anticlinally arranged forming a well differentiated band. In a longitudinal section, subcortical cells usually elongate, 2.5-5.2 times longer than broad, 38-130 x 12-36 µm, periclinally arranged.

Reproduction: Cystocarps wart-like, subspherical or longitudinally elongated, 1.5-2.5 mm in great external diameter, ostiolate, sessile, more or less constricted basally and sometimes mucronate; young cystocarps hemispherical and not basally constricted; in a longitudinal section, pericarp consisting of several layers of elongate cells, the outermost of which are arranged anticlinally and the remainder periclinally in anticlinal rows; pericarp apparently not joined by any kind of cells with the gonimoblast; carposporangia ovate or almost isodiametric, 24-50 x 18-36 µm, more or less arranged in chains. Other reproductive structures not seen.

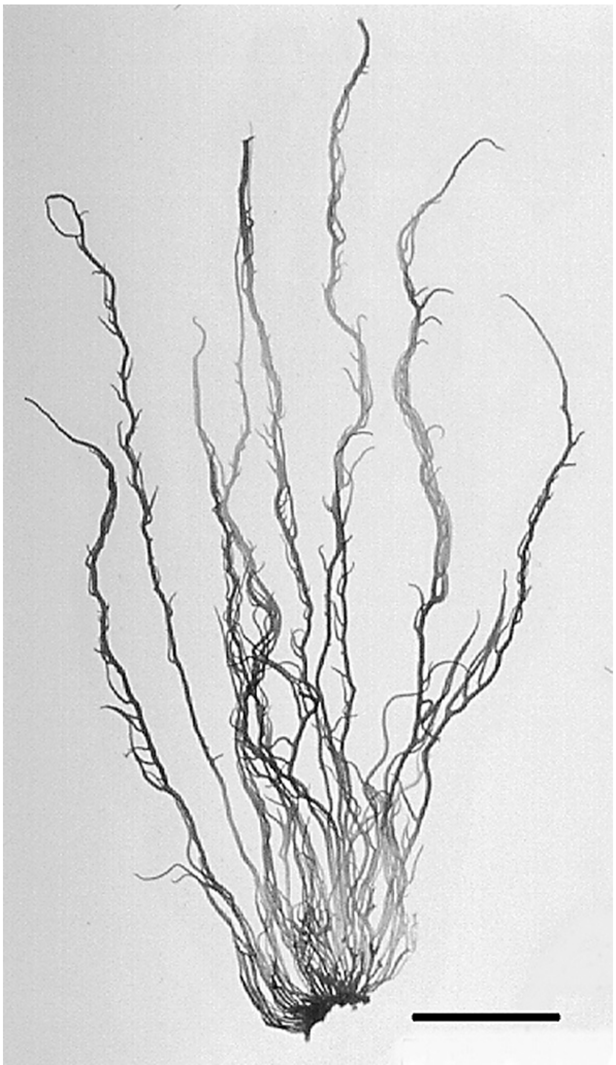

FIG. 40. – *Gracilariopsis longissima*. Mile 32, 7-07-1989, BCF-A 11667. Scale bar = 3 cm.

Habitat: Epilithic in the lower eulittoral or in tide pools, often associated with sand cover; also present in drift material.

Namibian distribution: Swakopmund, Mile 30, Mile 32, Cape Cross, Mile 108, Rocky Point, South Kunene (Map 16).

World distribution: Atlantic Ocean: Namibia; European Atlantic coasts, from northern Iberian Peninsula to British Isles (Steentoft *et al.*, 1995).

Remarks: Dawson (1949) segregated *Gracilariopsis* from *Gracilaria* on the basis of the structure of the cystocarp and later Papenfuss (1966) merged them again and considered *Gracilariopsis* as a synonym of *Gracilaria*. Fredericq and Hommersand (1989a), on the basis of a detailed study on *Gracilaria verrucosa* (Hudson) Papenfuss in British Islands, established the order Gracilariales and remarked that in this geographical area two species of different genus have been confused: *G. verrucosa* (at present, *G. gracilis* (Stackhouse) Steentoft, L. Irvine et Farnham) and a species that Fredericq and Hommersand (1989b) assigned to the genus *Gracilariopsis*. In this latter paper the authors carried out a detailed morphological and anatomical study of the reproductive structures of *Gracilariopsis lemaneiformis* (Bory de Saint Vincent) Dawson, Acleto et Foldvik, the type species of the genus, and resurrected the genus *Gracilariopsis*. Moreover, the authors enlarged the distribution of *G. lemaneiformis*, mainly a Pacific species, to the Atlantic European coasts. In addition, Fredericq and Hommersand (1989b) stated that the morphological similarity between this taxon and *Gracilaria verrucosa*, as well as the possibility that the two taxa occur together, is why these taxa had not been considered formerly as two different species. On the other hand, the reduction of *Gracilariopsis* to a synonym of *Gracilaria* proposed by Papenfuss (1966) has been generally accepted (Abbott and Hollenberg, 1976; Scagel *et al.*, 1986; Kapraun, 1980; Gargiulo *et al.*, 1992; Price *et al.*, 1988; Cordero, 1981; etc.), a fact that has contributed to increase the confusion, since the specimens composed of irregularly branched terete axes have often been included in the genus *Gracilaria* (Rice and Bird, 1990).

Steentoft *et al.* (1995) carried out a detailed study of material of the British Islands in order to find vegetative differences between the two species and confirm that a species of *Gracilaria* and another of *Gracilariopsis* had been previously confused. Concerning *Gracilariopsis*, the authors consider the possibility that the species identified as *G. lemaneiformis* by Fredericq and Hommersand (1989b) was, in fact, another species of this genus that agrees with *Fucus longissimus* S. G. Gmelin and that Steentoft *et al.* (1995) combine as *G. longissima*. In this way, molecular studies have demonstrated that *G. longissima* (as *Gracilariopsis* sp.) and *G. lemaneiformis* are two different species of the same genus (Bird *et al.*, 1990). Concerning *Gracilaria*, the material had been usually assigned to *G. verrucosa* (Dixon and Irvine, 1977; Fredericq and Hommersand, 1989a; Rice and Bird, 1990; etc), a species whose controversial taxonomy has been recently clarified, being the correct name *G. gracilis* (see Silva *et al.*, 1996). In this regard, only to state that *G. verrucosa* (Hudson) Papenfuss had been considered the type species of the genus (Fredericq and Hommersand, 1990), but that the lectotype [*«Fucus marinus purpureus parvus caule et ramulis seu foliolis teretibus»*, t. 50, No. 50, Herb. Dillenius (OXF)] designated by Irvine and Steentoft (1995) to replace *Fucus verrucosus* Hudson, was, in fact, representative of *Gracilariopsis*. This fact supports the decision of Steentoft *et al.* (1991) to designate *G. compressa* (C. Agardh) Greville as the conserved type of genus *Gracilaria*.

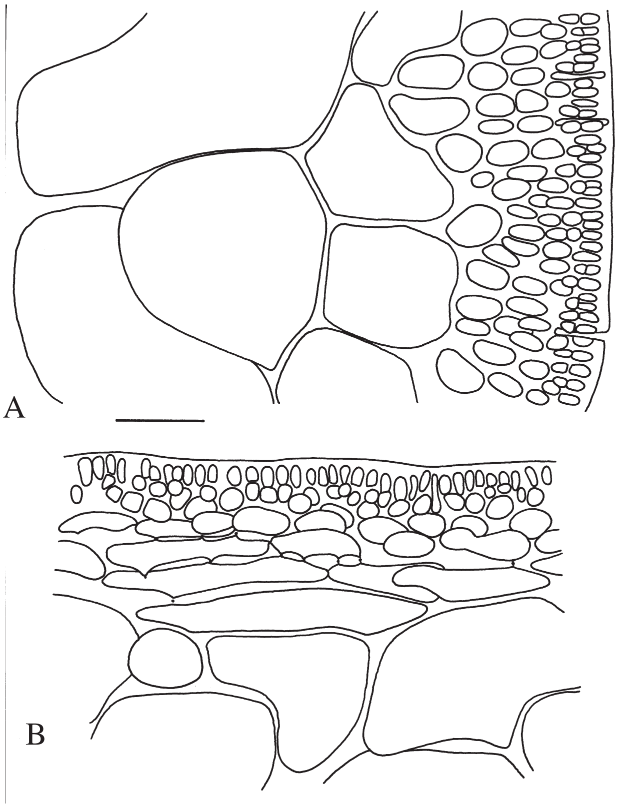

FIG. 41. – *Gracilariopsis longissima*. A-B. Outer part of the section of an axis. A. Cross section. B. Longitudinal section. Scale bar = 50 µm.

In conclusion, the specimens known until now on the Atlantic European coasts (and maybe in other geographical areas) as *Gracilaria verrucosa* include, in fact, two different taxa: *Gracilaria gracilis* and *Gracilariopsis longissima*.

Although Gargiulo *et al.* (1992) were reluctant to distinguish *Gracilaria* and *Gracilariopsis*, Bird *et al.* (1992), on the basis of molecular studies, confirmed that they are two different genus and thus, corroborate the morphological and anatomical differences observed by Fredericq and Hommersand (1989a, 1989b) and Steentoft *et al.* (1995).

Gracilaria and *Gracilariopsis* differ in cystocarp structure and spermatangia development (Fredericq and Hommersand, 1989a; 1989b), as well as in vegetative morphology and anatomy (Steentoft *et al.*, 1995).

In our Namibian material, concerning cystoscarps, we have not observed connecting cells between gonimoblast and pericarp, being consistent with *Gracilariopsis*. However, we must remark that, in some cases, we could neither observe if gonimoblast and pericarp were or were not connected by cells nor the spermatangia disposition, because we had no fertile male specimens. For this reason, we think that to assign our specimens to *Gracilariopsis* is a bit risky. Nevertheless, concerning vegetative features, our specimens agree better with the description of *Gracilariopsis longissima* by Steentoft *et al.* (1995) than that of *Gracilaria gracilis*. For this reason, we prefer to consider our specimens as *Gracilariopsis longissima*. However, new studies on reproductive structures of the Namibian material are needed.

Until now, only *Gracilaria verrucosa* had been recorded from Namibia (Lawson *et al.*, 1990). Scholfied *et al.* (1991) and Bird *et al.* (1994), on the basis of molecular data, pointed out that sterile specimens of *Gracilaria* from Lüderitz are consistent with *Gracilaria verrucosa* (now, *G. gracilis*) instead of with *Gracilariopsis*. *Gracilaria gracilis*, the main agar producing species of Namibia (Rotmann, 1987; Anderson *et al.*, 1989), is especially abundant in the Lüderitz area, where it is responsible for an important industry (Molloy and Bolton, 1995). In addition to Lüderitz, this species has been also recorded in Namibia from Walvis Bay, Swakopmund and Terrace Bay (Lawson *et al.*, 1990). On the other hand, Molloy and Bolton (1995) remarked that near Swakopmund they have found fertile specimens that could belong to *Gracilariopsis lemaneiformis*. This determination was later confirmed by Stegenga *et al.* (1997) and Engledow (1998), the latter also recording this species from Rocky Point.

Gracilariopsis lemaneiformis, species to which Fredericq and Hommersand (1989b) attributed the England plants, occurs mainly in the Pacific, although it has been recorded also from the northwestern Atlantic (Dawson, 1953; Wynne, 1998) and the western coasts of tropical Africa (Price *et al.*, 1988). Steentoft *et al.* (1995) remarked that the presence of *Gracilariopsis lemaneiformis* on the English coast has not been confirmed and that it is probable that, in this area, the species had been confused with *G. longissima*. Although these taxa can be distinguished by molecular methods, separation using morphological and anatomical features is difficult. Moreover, as Bird and Oliveira (1986) stated that off Pacific records could be mistaken, we prefer to tentatively assign our specimens to *Gracilariopsis longissima.*

Finally, we think that a profound systematic revision of *Gracilaria* and *Gracilariopsis* should be carried out to clarify its worldwide distribution.

Order HALYMENIALES Saunders and Kraft (1996)
Family HALYMENIACEAE Bory de Saint Vincent (1828)
Genus *Aeodes* J. Agardh (1876)

Aeodes orbitosa (Suhr) Schmitz
(Figs. 42-43; Plate II)

Iridaea orbitosa Suhr (1840), p. 276.
Aeodes orbitosa (Suhr) Schmitz (1894), p. 630.

Selected specimens: Möwe Bay, 25-02-1986, BCF-A 11605, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11607, with tetrasporangia; Cape Frio, 23-02-1986, BCF-A 11606, with tetrasporangia; Angra Fria, 20-02-1986, with tetrasporangia (specimen gived to R. E. Norris).

References: Simons (1969, 1976), Chiang (1970), Simons and Hewitt (1976), Branch and Branch (1981), Anderson *et al.* (1989), Molloy (1990), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliaceous, more or less orbicular in shape, up to 40 cm in diameter, irregularly lobed, without stipe, attached by a fleshy discoid holdfast; texture elastic. Blade surface finely granulate and with some isolated perforations. Blade and perforations margins entire or irregularly divided, with minute warts or more or less denticulate, often two-lipped. Outer cortical cells rounded in surface view, 3-7 µm in diameter. In cross section, blade 330-600 µm thick, differentiated into cortex and medulla; cortex (60-)80-140 µm thick, consisting of dichotomous divided filaments, (6-)8-13 cells long, anticlinally arranged; cortical cells fusiform or elliptic, 4-18 x (2-)3-10 µm, the outermost usually conical and the inner ones bigger and occasionally with lateral protuberances; medulla filamentous, 260-380(-560) µm thick; medullary filaments branched, 8-16 µm in diameter (the lumen (1-)2-4 µm), irregularly arranged, some crossing obliquely; transitional zone between cortex and medulla with more or less stellate cells that connect with medullary filaments. In a section parallel to the blade surface, medullary filaments irregularly arranged, and stellate cells occur in the transitional zone between medulla and cortex.

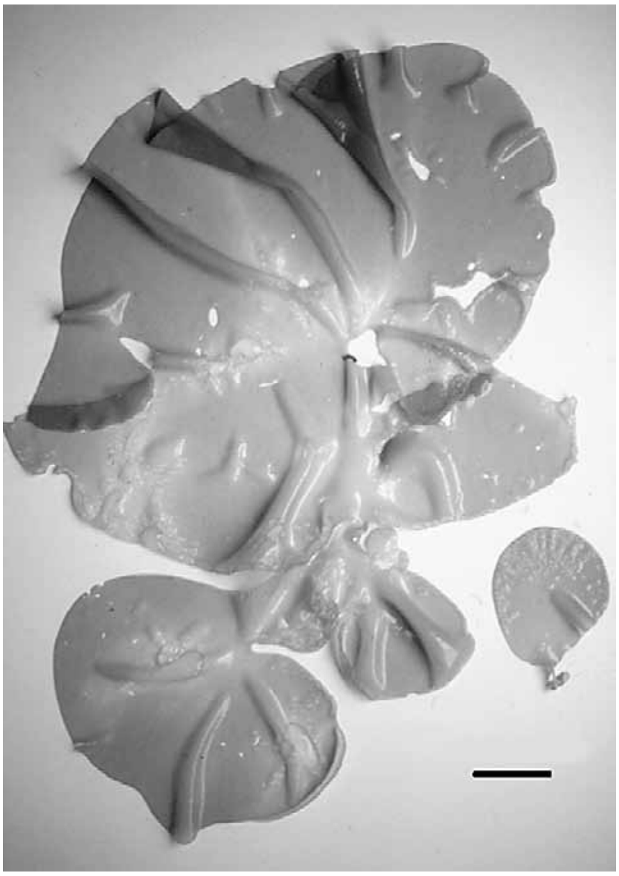

FIG. 42. – *Aeodes orbitosa*. Angra Fria, 20-02-1986. – Specimen given to R.E. Norris. Scale bar = 5 cm.

Reproduction: Tetrasporangia cruciately or decussately divided, ovate or elliptic, 26-46 x 8-18 µm, immersed in the cortex. Plant dioecious. Cystocarps internal, pear-shaped, 200-240 x 160-220 µm, placed in the transition zone between cortex and medulla, in both sides of the blade; carposporangia ovate, elliptic or more or less isodiametric, 10-16 x 9-13 µm. Spermatangia clavate, 8-10 x 2-3 µm, arising from outer cortical cells.

Habitat: Epilithic in the lower eulittoral zone; occasionally bearing *Porphyra saldanhae* as epiphyte.

Namibian distribution: Elizabeth Bay, Grossebucht, Halifax Bay, Diaz Point, Lüderitz, Unjab, Möwe Bay, Rocky Point, Cape Frio, Angra Fria, Kunene River (Lawson *et al.*, 1990) (Map 17).

World distribution: Atlantic Ocean: South Africa, Namibia (Levitt *et al.*, 1995). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Aeodes orbitosa* was described as *Iridaea orbitosa* by Suhr (1840) from material of the Cape of Good Hope and, at present, its distribution is mainly restricted to the Atlantic coasts of Namibia and South Africa. In Namibia, this species occurs in the south, between Elizabeth Bay and Lüderitz, and in the north, from Torra Bay to the border with Angola (Lawson *et al.*, 1990). However, Molloy (1990) points out that, although *Aeodes orbitosa* has been recorded from several localities of northern Namibia, this species occurs only as far as Swakopmund. On the contrary, our material, that agrees quite well with the descriptions of Chiang (1970) and Simons and Hewitt (1976), corroborate the presence of this species in the north of Namibia.

In addition to this species, an *Aeodes* sp. has been also recorded from Namibia (Price *et al.*, 1986; Lawson *et al.*, 1990). These authors, that do not give any locality, base the record on an unpublished paper (Simon, 1973).

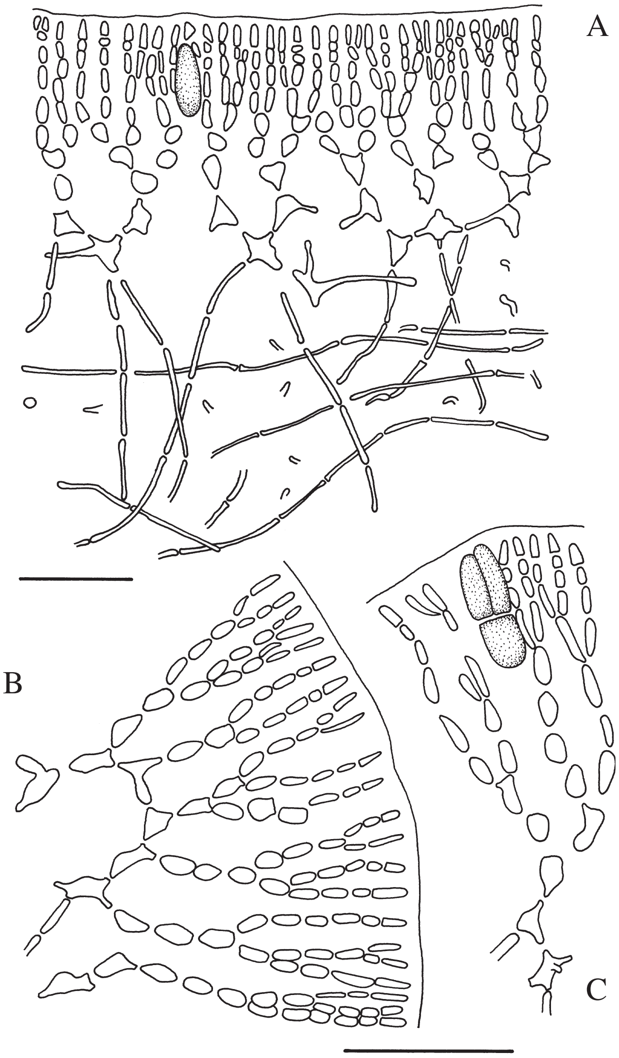

FIG. 43. – *Aeodes orbitosa*. A-C. Cross section. A. Portion of a cross section of the blade. B. Detail of the cortical zone. C. Detail of the cortical zone with one tetrasporangium. Scale bar = 50 µm.

Aeodes orbitosa is similar to *A. ulvoidea* Schmitz, a species of the Indian coasts of South Africa, from which it differs by the blade structure (Chiang, 1970). Thus, according to this author, in *A. orbitosa* the transitional zone between cortex and medulla is more extensive and less defined than in *A. ulvoidea*. Likewise, lateral protuberances in the inner cortical cells are more abundant in *A. orbitosa* than in *A. ulvoidea*. Moreover, in the latter species, the medullary filaments are less abundant than in the former.

Genus *Grateloupia* C. Agardh (1822) *nom. cons.*

Key to species of *Grateloupia*:

1. Plant foliaceous, 1-4 cm broad, with or without lateral proliferations ....*G. doryphora*
1. Plant consisting of compressed axes, up to 3 mm broad, with abundant lateral proliferations ....*G. filicina*

In addition to the species referred to in the present study, *G. longifolia* Kylin has been also recorded from Namibia (Engledow, 1998). This species is very similar to *G. doryphora* and possibly conspecific.

Grateloupia doryphora (Montagne) Howe (Fig. 44)

Halymenia (?) doryphora Montagne (1839), p. 21.
Grateloupia doryphora (Montagne) Howe (1914), p. 169.

Holotype: PC (Herb. Montagne). Peru (Callao).

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11640, with tetrasporangia and carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11819, with tetrasporangia.

References: Ardré and Gayral (1961), Dawson *et al.* (1964), Abbott and Hollenberg (1976), Irvine (1983), Afonso-Carrillo *et al.* (1984), Riouall *et al.* (1985), Ben Maiz *et al.* (1986), Lawson and John (1987), Santelices (1989), Pérez-Cirera *et al.* (1989a), Rull Lluch *et al.* (1991), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliaceous, consisting of a more or less lanceolate, cuneate, shortly stipitate blade, 12-14 cm high and 1.5-4 cm broad, often truncate, with or without marginal proliferations; blade surface smooth. Attachment by a basal disc. Outer cortical cells oblong or more or less isodiametric in surface view, 4-7 µm in longer diameter. In cross section, blade 280-440 µm thick, differentiated into cortex and medulla; cortex 40-80 µm thick, consisting of dichotomously divided filaments, 5-7 cells long, anticlinally arranged; the outer cortical cells elongate, 6-12 x 3-6 µm, and the inner ones elliptic, 5-18 x 4-12 µm, some with lateral protuberances; medulla 200-260 µm thick, consisting of branched filaments, 4-8 µm in diameter (the lumen 3-6 µm), irregularly arranged; transitional zone between cortex and medulla with more or less stellate cells, some of them with a cell body 18-20 µm in longer diameter and arms up to 70 µm long.

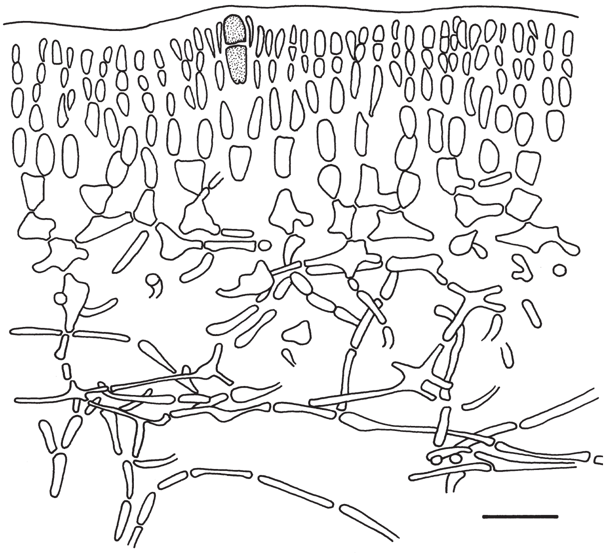

FIG. 44. – *Grateloupia doryphora*. Portion of a blade cross section. Scale bar = 30 µm.

Reproduction: Tetrasporangia cruciately or decussately divided, oblong or elliptic, 22-38 x 12-18 µm, immersed in the cortex and evenly spread over all of the blade. Cystocarps internal, spherical or slightly piriform, 158-182 x 158 µm, placed in the medulla and opening to the exterior via a pore; carposporangia elliptic or almost isodiametric, 12-18 x 10-12 µm. Spermatangia not seen.

Habitat: Epilithic in the lower eulittoral zone.

Namibian distribution: Lüderitz, Saddle Hill North (Engledow, 1998); Swakopmund, Möwe Bay (Map 18).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia; Angola, from Ghana to Portugal (Irvine, 1983; Price *et al.*, 1988); Canary Islands (Afonso-Carrillo *et al.*, 1984); northwest of the Iberian Peninsula (Pérez-Cirera *et al.*, 1989a); British Isles (Irvine, 1983; South and Tittley, 1986); Uruguay (Coll and Oliveira, 1999); tropical and subtropical western Atlantic (Wynne, 1998). Mediterranean Sea: Iberian Peninsula, France, Italy (Rull Lluch *et al.*, 1991). Pacific Ocean: Chile (Santelices, 1989); from Peru to south of British Columbia (Scagel *et al.*, 1986).

Remarks: *Grateloupia doryphora* was described, as *Halymenia? doryphora*, by Montagne (1839) based on material from Peru. Later, Howe (1914) transferred the species to the genus *Grateloupia*. Years later, Ardré and Gayral (1961) carried out a comparative study of several Atlantic and Pacific species of this genus including *G. doryphora*. As a result, these authors state that *G. lanceola* J. Agardh, *G. cuneifolia* J. Agardh and *G. gibbesii* Harvey (Atlantic species) and *G. cutleriae* Kützing, *G. schizophylla* Kützing and *G. californica* Kylin (Pacific species) are not more than forms of the same species, for which they retain the name *G. lanceola.* Ardré and Gayral (1961) modified the original description of this species to include the morphological diversity observed. Concerning *G. doryphora*, these authors hold it as a different species, although they do not discard the possibility that future studies will include this species in the same group. Dawson *et al.* (1964), in a paper on the algae of Peru, remarked that *G. lanceola* is a synonym of *G. doryphora*. This synonymy has been adopted by different authors, like Irvine (1983), Afonso-Carrillo *et al.* (1984), Riouall *et al.* (1985), Ben Maiz *et al.* (1986), Price *et al.* (1988), Rull Lluch *et al.* (1991) and Wynne (1998). In contrast, other authors, like Pérez-Cirera *et al.* (1989a), preferred to consider as *G. lanceola* all the foliaceous species from the eastern Atlantic and Mediterranean, until new studies did not confirm the conspecificity of *G. lanceola* and *G. doryphora*. More recently, Barbara and Cremades (1997) carried out a morphological and anatomical study on the foliaceous species of *Grateloupia* occurring in Galicia (north-west of Iberian Peninsula) and established some features, in our opinion rather arbitrary, to distinguish *G. lanceola* and *G. doryphora*. The confused taxonomy of this genus do not allow for a knowledge of the real distribution of this species.

Jackelman *et al.* (1991) recorded *G. doryphora* from Cape Hangklip (south coast of South Africa), and remarked that the specimens showed such morphological variation that they could include *G. longifolia* Kylin, a quite well known species from the South African west coast. In this way, Stegenga *et al.* (1997) state that *G. doryphora* was formerly known as *G. longifolia*. However, Engledow (1998) recorded *G. longifolia* from several localities in Namibia (Halifax Bay, Diaz Point, Lüderitz, Mile 4 and Wlotzkasbaken) and pointed out that this species differs morphologically and ecologically from *G. doryphora*.

G. doryphora is similar to *Phyllymenia belangeri* (Bory de Saint-Vincent) Setchell and Gardner, a species occurring in the cold waters of Namibia and South African west coast. According to Chiang (1970), the main difference between *Grateloupia* and *Phyllymenia* is the cortex structure, so that the latter has inner cortical cells with numerous lateral protuberances whereas in the former the inner cortical cells lack protuberances. However, Pérez-Cirera *et al.* (1989a) hold that this argument is not solid. Regarding our material, the specimens that we have assigned to *G. doryphora* have inner cortical cells with some lateral protuberance, but these protuberances are much less abundant than in the specimens that we have assigned to *P. belangeri* (see this species in page 59).

Since our specimens are morphologicaly and anatomically consistent with the literature descriptions of *G. doryphora* we have assigned them to this species. However, we think that a comparative study, using molecular methods, on *G. doryphora* from different geographical areas, as well as on other foliaceous species, like *G. longifolia,* or close genera, like *Phyllymenia*, *Pachymeniopsis* and *Prionitis*, are needed.

Grateloupia filicina (Lamouroux) C. Agardh
(Figs. 45-46)

Fucus filicinus Wulfen in Jacquin (1791), p. 157, *nom. illeg.*
Delesseria filicina Lamouroux (1813), p. 125.
Grateloupia filicina (Lamouroux) C. Agardh (1822), p. 223.
Chaetangium zeyheri Kützing (1849), p. 793.

Lectotype: Original illustration (Wulfen in Jacquin, 1791, pl. 15: fig. 2). Trieste, Italy.

Selected specimens: Terrace Bay, February 1986, BCF-A 11641, with carposporangia.

References: Abbott and Hollenberg (1976), Simons (1976), Cordeiro-Marino (1978), Kapraun (1980), Cordero (1981), Irvine (1983), Tseng (1984), Lawson and John (1987), Noda (1987), Coppejans (1995) Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 10 cm high, consisting of one compressed axis, terete at base, usually dichotomous divided, with several marginal proliferations more or less distichously arranged; attachment by a basal disc; axes 2-3 mm broad in the middle part, tapering towards the apex; proliferations generally marginal, 2-30 mm long, constricted at base and progressively ending in an acute apex, a few longer and also proliferous. Outer cortical cells elongated or isodiametrical in surface view, 2-4 µm in greater diameter. In cross section, axes differentiated into cortex and medulla. Cortex

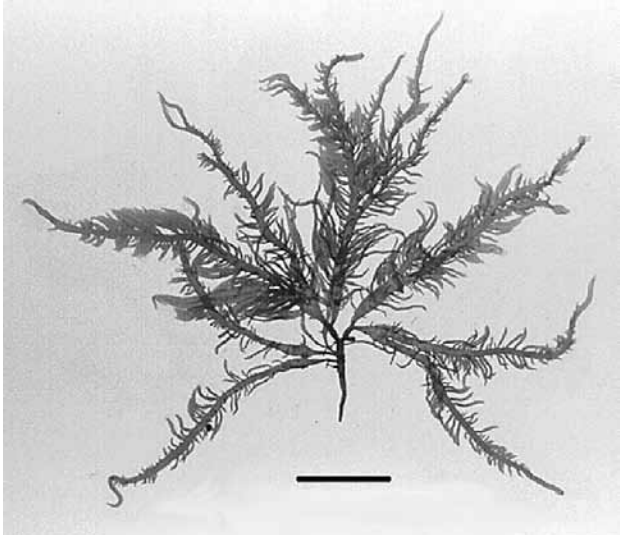

FIG. 45. – *Grateloupia filicina*. Terrace Bay, February 1986, BCF-A 11461. Scale bar = 2 cm.

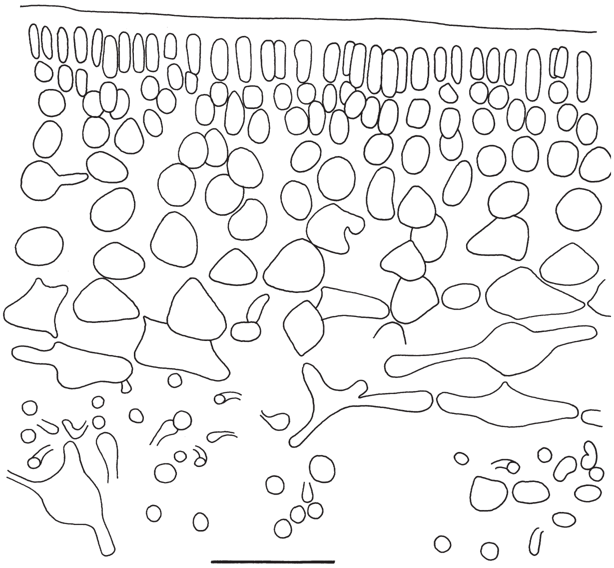

FIG. 46. – *Grateloupia filicina*. Portion of a blade cross section. Scale bar = 25 µm.

consisting of anticlinally arranged dichotomously divided filaments; outer cortical cells elongated, 6-9 x 3 µm; inner cortical cells more or less isodiametric, 7-11 µm in greater diameter, occasionally with some lateral protuberance. Medulla of loosely arranged filaments 4 µm in diameter. Transition zone between medulla and cortex with more or less stellate cells.

Reproduction: Cystocarps placed in both main axes and proliferations, more or less spherical, 200 µm in diameter, immersed, slightly prominent, opening to the exterior by a pore; carposporangia elliptic, ovate or more or less isodiametric, 12-18 x 10-14 µm. Tetrasporangia and spermatangia not seen.

Habitat: Epilithic in the lower eulittoral zone.

Namibian distribution: Elizabeth Bay, Halifax Bay, Lüderitz (Lawson *et al.*, 1990); Terrace Bay (Map 19).

World distribution: Widespread in warm temperate and tropical seas (Lawson and John, 1987).

Genus *Pachymenia* J. Agardh (1876)

Key to species of *Pachymenia*:

1. Blades elongated, with the margin generally entire; cortical cells ellipsoid or fusiform in shape ....*P. carnosa*
1. Blades orbicular, with the margin generally toothed and two-lipped; cortical cells more or less spherical ....*P. cornea**

* *P. cornea* was not observed. You can find more information about this taxon in Chiang (1970), Simons and Hewitt (1976) and Stegenga *et al.* (1997).

Pachymenia carnosa (J. Agardh) J. Agardh
(Figs. 47-49; Plate III)

Platymenia carnosa J. Agardh (1848), p. 48.
Iridaea carnosa (J. Agardh) Kützing (1849), p. 729.
Schizymenia carnosa (J. Agardh) J. Agardh (1851), p. 173.
Pachymenia carnosa (J. Agardh) J. Agardh (1876), p. 145.

Type: Agardh Herbarium n. 22451. Camps Bay, Cape Peninsula.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11600, with tetrasporangia; Swakopmund, beach, 8-07-1989, BCF-A 11601, with tetrasporangia; Terrace Bay, February 1986, BCF-A 11604; Rocky Point, 24-02-1986, BCF-A 11602; Angra Fria, 20-02-1986, BCF-A 622, with carposporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11603, with tetrasporangia.

References: Chiang (1970), Simons and Hewitt (1976), Simons (1969, 1976), Branch and Branch (1981), Lawson *et al.* (1990), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant consisting of several elongated, simple or divided, thick and tough blades, 23-90 cm long and 5-13(-27) cm broad, attached to the substratum by a thick and fleshy basal disc; some blades basally attenuated forming a flat and twisted stipe. Blade surface smooth with some isolated perforation, slightly granulate in cystocarpic specimens, occasionally with scattered dark patches up to 1 cm in diameter; blade margin entire or very little granulate or denticulate, occasionally slightly two-lipped or squared in cross section, especially in the lower part of the

FIG. 47. – *Pachymenia carnosa*. Angra Fria, 20-02-1986, BCF-A 622. Scale bar = 5 cm.

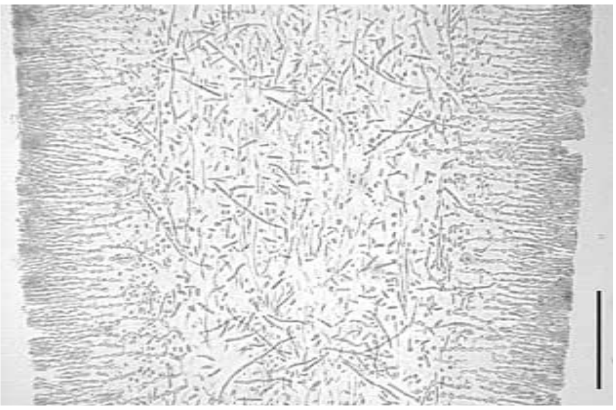

FIG. 48. – *Pachymenia carnosa*. Cross section of the blade. Scale bar = 160 µm.

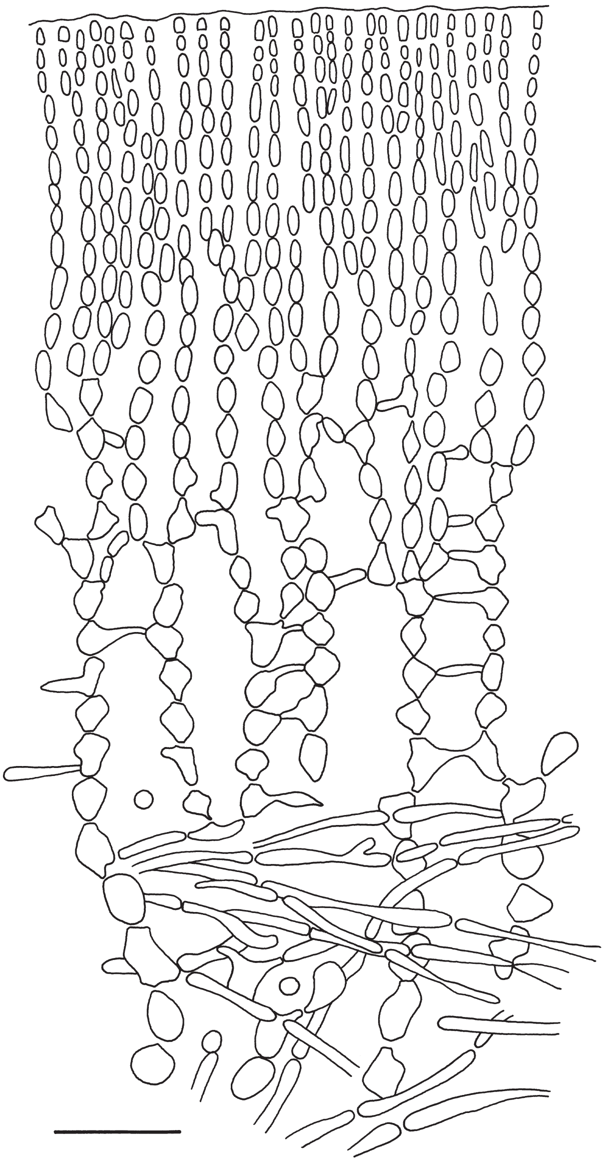

FIG. 49. – *Pachymenia carnosa*. Portion of a blade cross section. Scale bar = 30 µm.

blade. Outer cortical cells isodiametric in surface view, 2-5 µm in diameter. In cross section, blade 560-1200 µm thick, differentiated into cortex and medulla. Cortex 120-280 µm thick, consisting of more or less dichotomously branched filaments, (10-)15-30 cells long, anticlinally arranged; outer cortex (9-15 cells thick) with cells cylindrical or more or less fusiform, 4-22 x 2-5 µm, compactly arranged; inner cortex (6-13 cells thick) with cells fusiform or lemon-shaped, 10-18 x 3-12 µm, more loosely arranged and often with lateral protuberances connecting the cortical filaments with each other and with the medullary filaments; some inner cortical cells can be considered like stellate cells. Medulla 275-800 µm thick, consisting of two kinds of branched, irregularly arranged filaments not always easy to distinguish; some medullary filaments with cells cylindrical, 8-11 µm in diameter (the lumen 2-6 µm), and others, less abundant, with thinner and longer cells, 5-10 µm in diameter (the lumen 1-3 µm).

Reproduction: Tetrasporangia cruciate or decussate, elliptic, 24-46 x 8-12 µm, immersed in the outer cortex. Cystocarps pear-shaped, 140-240 x 100-200 µm, immersed in the inner cortex, opening to the exterior by a pore; carposporangia elliptic or almost isodiametric, 8-16 x 8-12 µm. Spermatangia not seen.

Habitat: Epilithic in the lower eulittoral zone; between the *Laminaria pallida* haptera in the upper sublittoral; also present in drift material.

Namibian distribution: Elizabeth Bay, Lüderitz, Swakopmund, Terrace Bay, Möwe Bay, Cape Frio, Angra Fria, Kunene River (Lawson *et al.*, 1990); Rocky Point (Map 20).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia, Angola (Lawson *et al.*, 1995). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Pachymenia carnosa* was described by J. Agardh (1848), as *Platymenia carnosa*, from South African material, and at present it occurs in South Africa (Atlantic and Indian coasts), Namibia and in southern Angola.

Chiang (1970) and Simons and Hewitt (1976) carried out a detailed study of the two species of *Pachymenia* occurring in South Africa (*P. carnosa* and *P. cornea* (Kützing) Chiang), emphasizing the presence of elongate cells arising from the stalk of gonimoblast, the latter, composed of the fusion cell and the gonimoblast initial. These cells, named *rays* by Simons and Hewitt (1976), are typical of the genus *Pachymenia* according to these authors. In contrast, Womersley and Lewis (1994) remarked that they have not seen *rays* in *P. orbicularis* (Zanardini) Setchell and Gardner, a species from southern Australia and Tasmania. In agreement with Womersley and Lewis (1994), in the cystocarps of our specimens the gonimoblast stalk, usually difficult to observe, is very short and neither has *rays*. This lack of *rays* could be explained if the cystocarps did not completely developed (Simons and Hewitt, 1976). According to these authors the carpospore production in *Pachymenia* would be a continuous process, and with time, the fusion cell increases in length and the gonimoblast filaments, after carpospore liberation, move downwards forming the *rays*. Otherwise, our material is compatible with the descriptions of Chiang (1970) and Simons and Hewitt (1976).

According to Simons and Hewitt (1976) and Lawson *et al.* (1995) both *Pachymenia carnosa* and *P. cornea* occur in Namibia. However, in the paper on the marine algal flora of Namibia, Lawson *et al.* (1990) record only *P. carnosa*. Both species mainly differ in the habit and in some morphological and anatomical features. Thus, according to Chiang (1970) and Simons and Hewitt (1976), *P. carnosa* consists of more elongated and narrow blades than *P. cornea*, which has an orbicular appearance. Moreover, the last species commonly shows thick, more or less dentate and often two-lipped blade margins, whereas in the former these features are less frequent. Anatomicaly, Chiang (1970) states that in *P. carnosa* the cortical cells are ellipsoid or spindle shaped, while they are more spherical in *P. cornea*. According to this, the two species seem quite similar and only the study of a significant number of specimens would provide sufficient criteria to differentiate them. Our specimens are more consistent with *P. carnosa* than with *P. cornea.*

According to Womersley and Lewis (1994), *Pachymenia orbicularis* is similar to *P. carnosa*, from which it differs by the size and shape of the cortical cells and by the absence of *rays* in the cystocarps.

Concerning the inner structure, *P. carnosa* is also quite similar to *Aeodes orbitosa*. In this way, both species differ in cortex thickness, which is broader and composed of more cells in the former than in the latter. Moreover, according to Simons and Hewitt (1976), *Pachymenia* differs from *Aeodes* because the former has *rays* in the cystocarps and the latter has not. However, it is important to point out that these structures are only visible in well developed cystocarps, and thus this feature must be considered with a certain caution (Simons and Hewitt, 1976).

Genus *Phyllymenia* J. Agardh (1848)

Phyllymenia belangeri (Bory de Saint Vincent) Setchell and Gardner

(Figs. 50-52)

Iridaea belangeri Bory de Saint Vincent (1834), p. 160.
Phyllymenia belangeri (Bory de Saint Vincent) Setchell and Gardner (1936), p. 473.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11594, with tetrasporangia and spermatangia; Rocky Point, 24-02-1986, BCF-A 11593, with tetrasporangia and carposporangia; Cape Frio, 23-02-1986, BCF-A 11595, with tetrasporangia and carposporangia.

References: Chiang (1970), Simons (1976), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant consisting of one to several elongated, stipitate, more or less divided, often truncate and proliferous, a few lanceolate blades up to 16 cm high and (1-)2-6 cm broad,

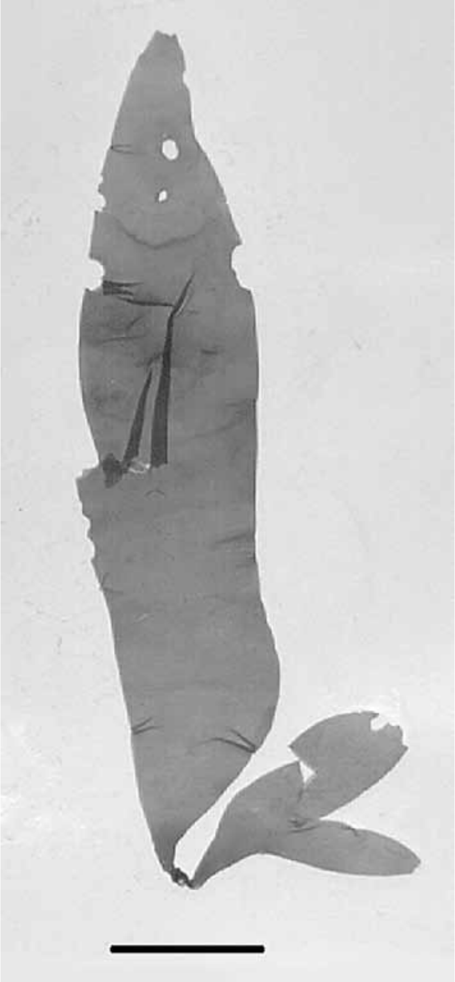

FIG. 50. – *Phyllymenia belangeri*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11594. Scale bar = 2 cm.

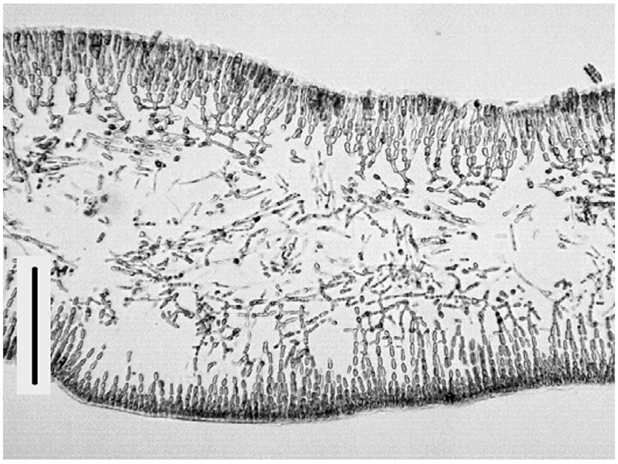

FIG. 51. – *Phyllymenia belangeri*. Cross section of the blade. Scale bar = 160 µm.

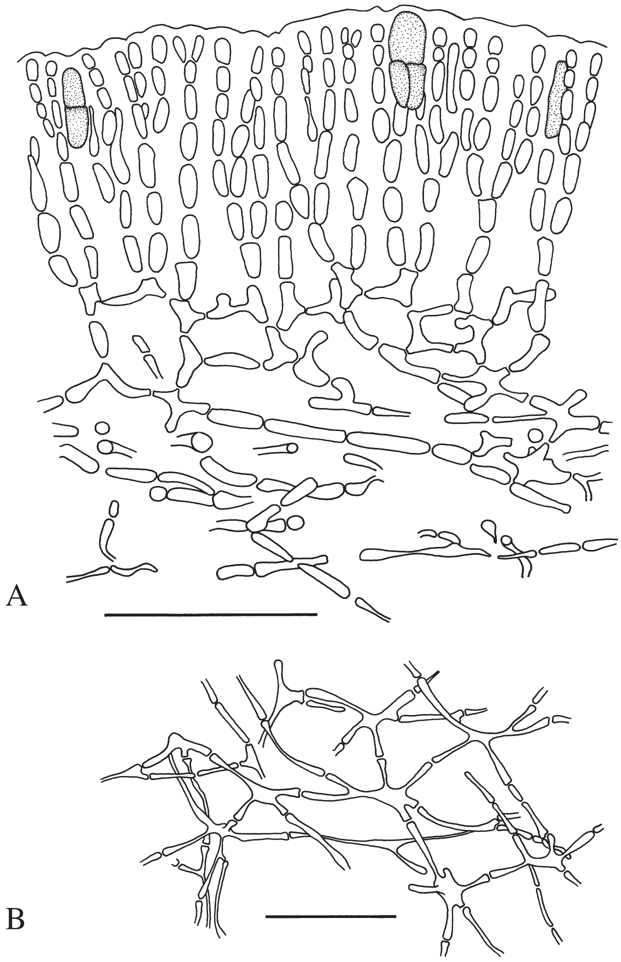

FIG. 52. – *Phyllymenia belangeri*. A. Portion of a blade cross section. B. Stellate cells in a section parallel to the blade surface. Scale bar = 75 µm.

attached to the substratum by a basal disc. Stipe terete at base, compressed upwards, cuneate, sometimes channelled, up to 10 mm long. Blade surface usually rugose or corrugated, smooth in some specimens, with or without perforations; blade margin entire, in some places asymmetrically two-lipped; proliferations generally marginal, especially abundant in truncate zones, occasionally arising from the blade surface. Outer cortical cells elongated or isodiametric in surface view, 4-8 µm in diameter. In cross section, blade 440-740 µm thick, differentiated into cortex and medulla. Cortex 65-140 µm thick, consisting of anticlinally dichotomously divided filaments 6-11(-16) cells long; cortical cells 6-20 x 3-10 µm, those of the upper half of filaments cylindric or fusiform, and those of the lower half with numerous lateral protuberances, joining the cortical filaments with each other; cuticle 4-6 µm thick. Medulla 237-460 µm thick, consisting of irregularly arranged branched filaments 4-13 µm in diameter (the lumen 2-4 µm). Transitional zone between cortex and medulla with stellate cells, from which relatively short, periclinally or obliquely arranged filaments arise; cells of these filaments cylindric, 16-36 x 4-7 µm. In a section parallel to the blade surface, medullary filaments much branched, consisting of cylindrical cells bearing protuberances or more or less stellate cells.

Reproduction: Tetrasporangia placed in the depressed zones of corrugate blade surface; tetrasporangia cruciate or decussate, elliptic or fusiform in shape, 28-44 x 8-16 µm, immersed in the outer cortex. Plant dioecious. Cystocarps broadly pear-shape, 119-280 x 95-240 µm, internal, opening to the exterior by a pore and also placed in clusters in the depressed zones of corrugate blade surface; carposporangia 12-20 x 8-13 µm. Spermatangia arising from the outer cortical cells.

Habitat: Epilithic in the lower eulittoral zone.

Namibian distribution: Lüderitz, Swakopmund, Torra Bay, Terrace Bay, Cape Frio (Lawson *et al.*, 1990); Rocky Point (Map 21).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia (Lawson *et al.*, 1990).

Remarks: *Phyllymenia belangeri* was described by Bory de Saint-Vincent (1834), as *Iridaea belangeri*, from material of False Bay (south coast of South Africa). Later, Setchell and Gardner (1936) transferred this species to the genus *Phyllymenia* and remarked that *P. belangeri* is identical to *P. hieroglyphica* J. Agardh (at present, *Cyrtymenia hieroglyphica* (J. Agardh) Schmitz). Subsequently, Chiang (1970) and Seagrief (1984) held *P. hieroglyphica* and *C. hieroglyphica* as synonyms of *P. belangeri*.

Our specimens are consistent with Chiang's (1970) description of *P. belangeri*. However, according to this author, the reproductive structures are scattered over the whole of the blade, except in the distal and basal parts, whereas in our material, although they are also scattered over the blade, they are arranged in groups in the depressed areas of the wavy blades.

P. belangeri is very similar to *Grateloupia doryphora*. According to Chiang (1970) the main difference between the two genera is in the cortex structure (see the remark in *G. doryphora*).

Order HILDENBRANDIALES Pueschel and Cole (1982)
Family HILDENBRANDIACEAE Rabenhorst (1868)
Genus Hildenbrandia Nardo (1834) *nom. cons.*

Key to species of *Hildenbrandia*:

1. Tetrasporangia zonately divided, with parallel cross walls.. *H. crouanii*
1. Tetrasporangia irregularly divided; cross walls not parallel..*H. rubra*

Hildenbrandia crouanii J. Agardh
(Fig. 53)

Hildenbrandia crouanii J. Agardh (1852), p. 496.

Lectotype: LD (Herb. Alg. Agardh, 27613). Brest (France).

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11996, with tetrasporangia; Mile 108, 13-07-1989, BCF-A 11997, with tetrasporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11998, with tetrasporangia.

References: Rosenvinge (1917), Denizot (1968), Irvine and Pueschel (1994), Womersley (1994).

Habit and vegetative structure: Plant crustose, thin, completely attached to the substratum. Cells more or less isodiametric in surface view, 2-4 µm in diameter. Crust of compact structure, 140-260 µm thick in cross section, consisting of quadrangular or rectangular cells, 3-6 x 2-4 µm, placed in closely joined erect filaments.

Reproduction: Tetrasporangia oblong, 16-24(-26) x (4-)5-10 µm, zonately divided with transverse cross walls, formed in conceptacles; conceptacles subspherical or slightly elongated, 50-142 x 50-95 µm, opening to the exterior by a pore. Other reproductive structures not seen.

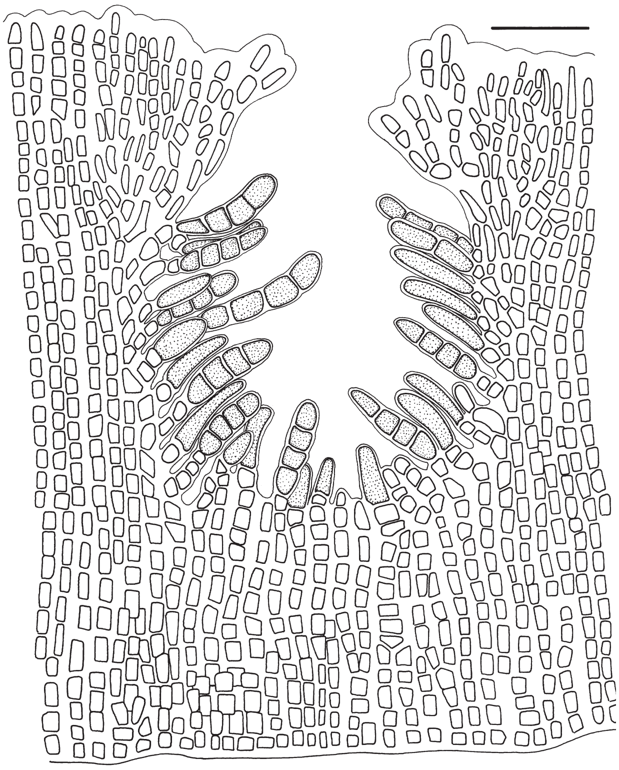

FIG. 53. – *Hildenbrandia crouanii*. Cross section of a conceptacle. Scale bar = 20 µm.

Habitat: Epilithic in shadow places of the lower eulittoral zone, sometimes together with *H. rubra*.

Namibian distribution: Swakopmund, Mile 108, South Kunene (Map 22).

World distribution: Widespread on temperate coasts (Womersley, 1994). According to Irvine and Pueschell (1994) the distribution of this species is difficult to specify because of uncertain species limits.

Remarks: *Hildenbrandia crouanii* is very similar to *H. canariensis* Børgesen, from which it differs in the cleavage of tetrasporangia (oblique in the former and transversal in the latter). However, Irvine and Pueschel (1994) remark that this feature is questionable and state the two taxa as synonyms.

Hildenbrandia crouanii is also quite similar to *H. lecanellieri* Hariot, a subantarctic species occurring in South Africa, but unlike *H. crouanii*, *H. lecanellieri* forms rugose and thicker crusts, often becoming detached in the centre (Stegenga *et al.*, 1997).

Our specimens form relatively thin crusts completely adherent to the substratum and present tetrasporangia transversally divided, in agreement with *H. canariensis*. However, following Irvine and Pueschel (1994), we have assigned them to *H. crouanii*.

Hildenbrandia rubra (Sommerfelt) Meneghini
(Fig. 54)

Verrucaria rubra Sommerfelt (1826), p. 140.
Hildenbrandia rubra (Sommerfelt) Meneghini (1841), p. 426.
Hildenbrandia rosea Kützing (1843), p. 384.

Lectotype: O. Saltdal. Norway.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11999, with tetrasporangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 12002, with tetrasporangia; Cape Cross, 7-07-1989, BCF-A 12000, with tetrasporangia; Mile 108, 13-07-1989, BCF-A 12001, with tetrasporangia.

References: Denizot (1968), Abbott and Hollenberg (1976), Lawson and John (1987), Irvine and Pueschel (1994), Womersley (1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant crustose, thin, completely adhered to the substratum, on which it forms reddish patches of variable size. Cells polygonal and more or less isodiametric in surface view, 2-4 µm in diameter. Crust of compact structure, 60-160 µm thick in cross section, consisting of quadrangular or rectangular cells 3-6 x 3-6 µm, arranged in simple or branched erect filaments closely joined to each other.

Reproduction: Tetrasporangia elliptic, 13-25 x 5-10 µm, irregularly divided, with the cross walls not parallel; conceptacles usually spherical, a few broader than long, 28-68 x 30-100 µm, opening to the exterior by a pore. Other reproductive structures not seen.

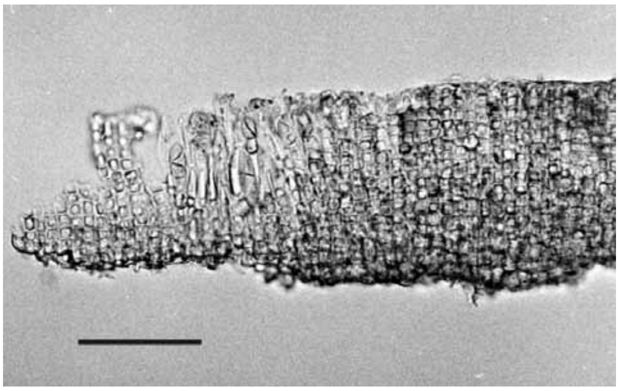

FIG. 54. – *Hildenbrandia rubra*. Cross section. Scale bar = 40 µm.

Habitat: Epilithic in the lower eulittoral zone, between the specimens of *Ahnfeltiopsis glomerata* and *Corallina* sp. Together *Chaetomorpha aerea* in tide pools.

Namibian distribution: Elizabeth Bay, Lüderitz, Swakopmund, Torra Bay, Rocky Point (Lawson *et al.*, 1990); Langstrand, Cape Cross, Mile 108 (Map 23).

World distribution: Widespread on temperate and tropical coasts (Womersley, 1994).

Order CORALLINALES P. Silva and Johansen (1986)
Family CORALLINACEAE Lamouroux (1812)
Genus *Corallina* Linnaeus (1758)

Corallina sp.
(Figs. 55-56; Plate IV)

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12112, with bisporangia; Swakopmund, beach, 8-07-1989, BCF-A 12113, with bisporangia; Möwe Bay, 4-02-1988, BCF-A 12114; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 12115.

Habit and vegetative structure: Plant calcified, articulated, 3-11 cm high, consisting of several branched erect axes of unlimited growth arising from a crustose base, and branches of limited growth pinnately arranged in the upper half of erect axes, usually 1-2 per segment in each side of axis. Axes of unlimited growth simple or pseudodichotomously, irregularly or more or less alternately branched in the lower half of the plant, and up to three times pinnately branched in the upper half, often whorled in some places, with up to six branches arising from the same segment, providing to the plant a more or less globose appearance; branches usually arising

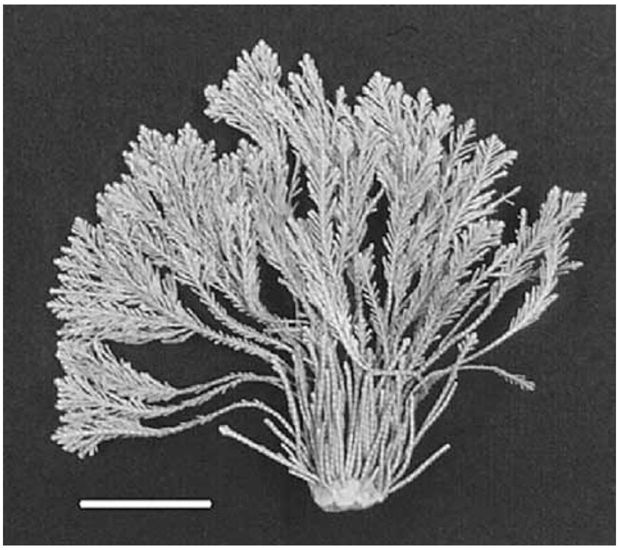

FIG. 55. – *Corallina sp.* Möwe Bay, 4-02-1988, BCF-A 12114. Scale bar = 2 cm.

from the upper zone of the segments, exceptionally from the centre; downwards rhizoids 1-6 segments long occurring often in the insertion point of some branches. Axes of unlimited growth with segments 0.4-2.5 times longer than broad, 700-1500 x 400-1300 µm, cylindrical in the lower part of axes and more or less trapezoidal upwards; branches of limited growth composed of one or more morphologically variable segments, some cylindrical and thin, up to 7 times longer than those of the main axes, 3.5-28.5 times longer than broad, 600-5700 x 150-300 µm; others irregular in shape, more or less spatulate, lanceolate, simple or palmately divided, 1.5-5.5 times longer than broad, 1200-3500 x 300-1300 µm, occasionally bearing up to 7 short branches distichously arranged; in some specimens, branches of limited growth composed almost exclusively of only one lanceolate or spatulate segment 1.4-7.7 times longer than broad, 1100-2500 x 300-1400 µm; in other specimens, branches of limited growth commonly thread-shaped and often curved, composed of cylindrical segments 1.3-14.5 times longer than broad, 200-2900 x 100-400 µm. Outer cortical cells of intergenicula ovate or more or less isodiametrical in surface view, 6-14 x 4-12 µm; intergenicular medullary cells placed in 9-12 tiers 60-80 µm width. In longitudinal cross section, intergenicula differentiated into medulla and cortex; medullary cells cylindrical, 32-80 x 6-10 µm, arranged in longitudinal filaments commonly simple and laterally joined by cell fusions, the outermost of them curved towards the exterior and more or less dichotomously divided, given rise to the cortex; cells of cortical filaments pigmented, 7-20 x 6-10 µm, the outermost (1-2 cells) small and broader than high, 2-4 x 6-8 µm; genicula consisting of a single tier of very long, cylindrical with acute apexes cells 200-320 x 6-10 µm.

Reproduction: Bisporangial conceptacles ovoid or pear-shaped, 500-700 µm in outside diameter, opening to the exterior by a central apical pore; conceptacles axial, usually placed in the apex of terminal segments, often bearing up to 5 simple, palmate or irregularly divided branches; some conceptacles lateral in intercalary segments; occasionally, conceptacles formed in the branches of other conceptacles; bisporangia elliptic or clavate, 116-212 x 32-92 µm; more commonly, sporangia undivided and smaller, 66-156 x 26-64 µm.

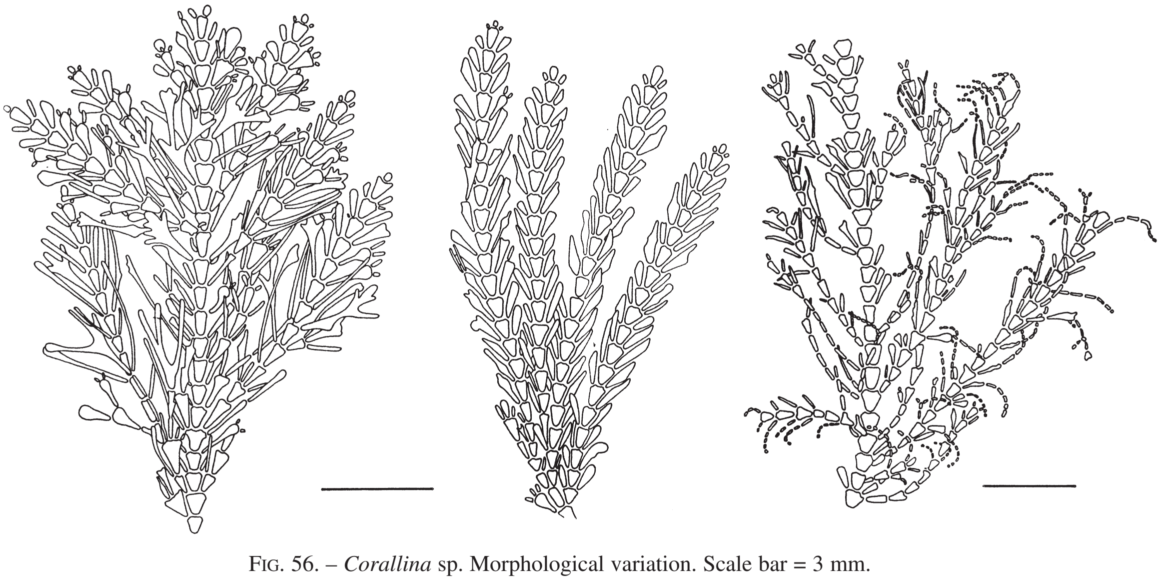

FIG. 56. – *Corallina* sp. Morphological variation. Scale bar = 3 mm.

Habitat: Epilithic in the lower eulittoral and the upper sublittoral zones; also in tide pools and in drift material.

Namibian distribution: Swakopmund, Möwe Bay (Map 24).

Remarks: Our material shows a great morphological variation: most specimens are more or less globose due to abundant ramification, often whorled; others show a more typically pinnate aspect, with branches of limited growth composed of only one more or less lanceolate segment; and others, more delicate, have branches of limited growth commonly curved and composed of several thin, cylindrical segments of different length. However, all the specimens are anatomically very homogeneous.

Because of the arrangement of the reproductive structures and the tier number of medullary cells, we have assigned our specimens to the genus *Corallina*. Most of our specimens are quite compatible with *Corallina officinalis* Linnaeus descriptions consulted, particularly with that of Womersley and Johansen (1996). However, in this species the number of tiers of medullary cells is slightly higher than in our specimens [(8-) 10-20(-25) tiers in comparison with 9-12 in our specimens] and the tetrasporangia are zonately divided (bisporangia in Namibian specimens). On the other hand, Irvine and Johansen (1994) state that *Corallina officinalis* can adapt to a wide range of habitats adopting different morphological aspects, a fact that could explain the morphological variety of our specimens. Regarding the tiers of medullary cells, a feature that seems to be taxonomically stable (Baba *et al.*, 1988; Johansen and Colthart, 1975), our material would be closer to *C. elongata* Ellis and Solander, since this species has 7-12 tiers of medullary cells in its segments (Irvine and Johansen, 1994). Moreover, as our specimens show a great morphological variation, some of them are also morphologically compatible with this species.

The distinction between *Corallina officinalis* and *C. elongata* is not easy, because it is mainly based on morphological features and these are very affected by the environment. In this way, Coppejans (1995) remarked that the genus *Corallina* has certain taxonomical problems on the Atlantic coasts of France and Belgium and, although he tentatively differentiated *C. officinalis* from *C. elongata*, he recognized the possibility that the two taxa are conspecific.

Corallina has been only recorded in Namibia at generic level. Wynne (1986) shows a photograph of an unidentified species of *Corallina* from Swakopmund pointing out that the specimens are similar to *Arthrocardia* Decaisne, but that the material has been examined by Dr. H.W. Johansen who identified it as a *Corallina* sp. Lawson *et al.* (1990) include this *Corallina* sp. in their species list of Namibia, as well as other material of this genus under the name *Corallina* spp.

Besides *Corallina*, the other geniculate Corallinaceae recorded from Namibia belong to the genus *Arthrocardia* (*A. carinata* (Kützing) Johansen, *A. filicula* (Lamarck) Johansen, *A. palmata* (Ellis and Solander) Areschoug and *Arthrocardia* sp.). Both genera basically differ in the arrangement of conceptacles (Johansen, 1969; Afonso-Carrillo, 1982) and in the number of tiers of medullary cells in the genicula, the latter being higher in *Arthrocardia* (Womersley and Johansen, 1996). Any of these mentioned species of *Arthrocardia* have been identified among our material.

Although our specimens do not seem much different of either *C. officinalis* or *C. elongata* (Afonso-Carrillo, pers. com.), we prefer not to assign them to any species, waiting for future studies to clarify the taxonomy of *Corallina* in this geographical area.

Genus *Lithophyllum* Philippi (1837)

Lithophyllum neoatalayense Masaki (Fig. 57)

Lithophyllum neoatalayense Masaki (1968), p. 34.

Holotype: HAK. Masaki, 3.vi.1961, Kominato Town, Chiba Pref.

Selected specimens: Cape Frio, 23-02-1986, BCF-A 12026, with tetrasporangia.

References: Chamberlain (1996).

Habit and vegetative structure: Plant crustose, calcified, flat, with the surface smooth, completely adhered to the substratum. Outer epithallial cells 7-10 x 6-8 µm in surface view; basal cells rectangular or elliptic in a underside view, 14-22 x 7-12 µm, more or less flabellately arranged; secondary pit connections frequent. In cross section, crust of dimerous structure, 700-1500 µm thick; basal cells quadrangular or rectangular, 8-18 µm long and 8-15 µm broad; erect filaments 65-70 cells long, with cells quadrangular or elongated, 8-20 x 6-10 µm, more or less arranged in horizontal rows and often joined by secondary pit connections; epithallial cells dome-shaped, squarish or flattened, 3-6 x 4-8 µm, occurring in 3-4 layers deep and often fallen off; subepithallial cells elongated, 10-20 µm long and 5-6 µm in diameter.

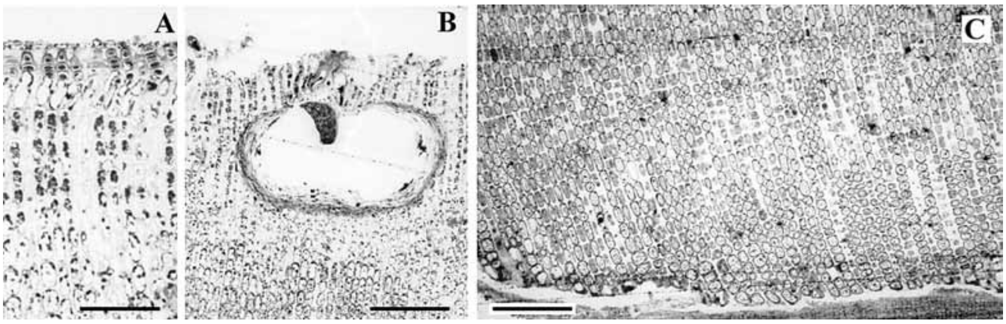

FIG. 57. – *Lithophyllum neoatalayense*. A-C. Cross sections. A. Upper part of erect filaments. B. Conceptacle with one tetrasporangium. C. Basal cells and erect filaments. A. Scale bar = 40 µm. B-C. Scale bar = 80 µm.

Reproduction: Tetrasporangia zonate, elliptic, curved and laterally compressed, 56-80 x 28-40 µm, placed in immersed, uniporate conceptacles 128-200 µm in outside diameter; pore diameter 16-32 µm; conceptacle chamber elliptic in cross section, 180-200 µm in diameter and 72-96 µm high; conceptacle roof 40-60 µm thick, composed of filaments 3-4 cells long plus 3 epithallial cells; cells of roof filaments elongate, 6-16 x 4-6 µm; pore canal 60-72 µm length, surrounded by vertically oriented clavate cells. Other reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral zone.

Namibian distribution: Torra Bay (Chamberlain, 1996); Cape Frio (Map 25).

World distribution: Atlantic Ocean: South Africa, Namibia (Chamberlain, 1996). Pacific Ocean: Japan (Chamberlain, 1996).

Remarks: Our material of this species consists of a fragment which anatomically agrees quite well with the Chamberlain (1996) description of *L. neoatalayense*. However, in agreement with the type material, our specimen has a flat surface and is completely adherent to the substratum, whereas the South African and Namibian material described by Chamberlain (1996) has overlapping lobes and protuberances.

Other specimens (Möwe Bay, Cala Poste, 7-02-1988, BCF-A 12025) that may be assigned to *Lithophyllum* by the presence of secondary pit connections, are morphologically more similar to those described by Chamberlain (1996). These plants are more or less globose, with a smooth surface and confluent, overlapping, lobulate margins forming numerous irregular protuberances or crests up to 5 mm high. In contrast, these specimens show certain anatomical differences with respect to those described by Chamberlain (1996), such as its apparently monomerous structure and its subepithallial cells not much elongated. Moreover, these specimens are not fertile and therefore it is not possible to identify them safely. Morphologically, these plants are also similar to *Leptophytum ferox* (Foslie) Chamberlain and Keats, another species recently reported from Namibia (Chamberlain and Keats, 1994), but this species has cell fusions instead of pit connections.

Lithophyllum neoatalayense is similar to *L. crouanii* Foslie, from which it differs by the shape of the tetrasporangial conceptacle chamber, elliptical in the former and globose in the latter (Chamberlain and Irvine, 1994; Chamberlain, 1996).

Genus *Melobesia* Lamouroux (1812)

Melobesia membranacea (Esper) Lamouroux (Fig. 58)

Corallina membranacea Esper (1796), pl. *Corallina* XII.
Melobesia membranacea (Esper) Lamouroux (1816), p. 315.

Neotype: CN. Lamouroux Herbarium (France). See Chamberlain (1985).

Selected specimens: Swakopmund, beach, 8-07-1989, BCF-A 12019, with tetrasporangia and carposporangia; Möwe Bay, 5-02-1988, BCF-A 12020, with carposporangia.

References: Taylor (1960), Woelkerling (1988, 1996a), Chamberlain and Irvine (1994), Coppejans (1995).

Habit and vegetative structure: Plant crustose, slightly calcified, thin, often translucent, more or less orbicular in shape and completely attached to the substratum. Subepithallial cells oblong in surface view, 5-8 x 3-4 µm, forming branched filaments flabellately arranged; epithallial cells more or less circular in outline, 1-2 µm in diameter. In cross section, structure dimerous, 20-32 µm thick in the vegetative part of the plant; basal cells rectangular, 6-8 µm high and 2-6 µm wide; erect filaments 2-5 cells long with cells 4-6 x 3-5 µm; epithallial cells dome-shaped, 2-4 x 2-3 µm; cell fusions present.

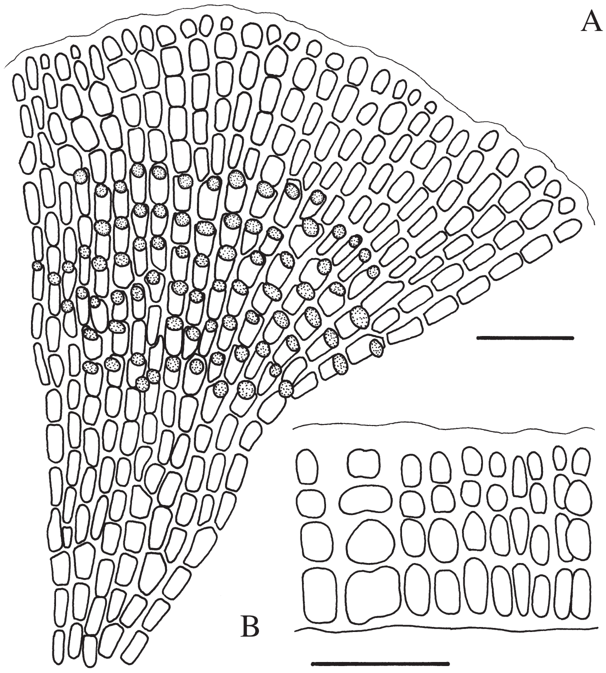

FIG. 58. – *Melobesia membranacea*. A. Surface view; epithallial cells only showed in the central zone. B. Cross section. Scale bar = 20 µm.

Reproduction: Tetrasporangia ovate or elliptic, 28-38 x 16-30 µm, zonately divided, formed in multiporate hemispherical conceptacles 68-96 µm in diameter. Carposporangia 24-34 x 14-22 µm, formed in uniporate hemispherical conceptacles. Spermatangia not seen.

Habitat: Epiphytic on *Plocamium rigidum* and *Rhodymenia obtusa*, together with *Ulvella lens*.

Namibian distribution: Swakopmund, Möwe Bay (Map 26).

World distribution: Probably cosmopolitan (Chamberlain and Irvine, 1994; Woelkerling, 1996a).

Remarks: *Melobesia membranacea* was described by Esper (1796) as *Corallina membranacea* and later Chamberlain (1985), in absence of type material, designated a specimen of the Lamouroux herbarium (CN) as neotype. According to Woelkerling (1996a) *Melobesia membranacea* is a widespread species, although many records require confirmation.

The thickness and cell size of our specimens are close to the minimum values pointed out by Chamberlain and Irvine (1994) and Woelkerling (1996a).

Genus *Synarthrophyton* Townsend (1979)

Synarthrophyton munimentum Keats et Maneveldt (Figs. 59-61)

Synarthrophyton munimentum Keats et Maneveldt (1997), p. 455.

Holotype: UWC 92/330, specimen deposited in L as 997.068 012. Grossebucht, Lüderitz, 14.vii.1992.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12023, with tetrasporangia.

References: Keats and Maneveldt (1997).

Habit and vegetative structure: Plant crustose, calcified, with the surface more or less corrugated or warty and the margins lobed, completely adhered to the substratum. Conceptacle numerous, orbicular or elongated in surface view, often confluent, multiporate, flat, with a raised peripheral rim. Epithalial cells polygonal, elongated or isodiametric in surface view, 5-7 x 4-6 µm, forming a continuous layer. Cells of the basal filaments elongated in a underside view, 9-26 x 4-7 µm; dark cells 20-36 x 4-10 µm, often in clusters, usually present. In cross section, crust structure monomerous, 340-600 µm thick; cells of medullary filaments elongated, 14-28 x 3-8 µm; cortical filaments composed of 35-45 elongated cells 5-12 x 3-5 µm; cell fusions frequent in both medullary and cortical filaments; epithallial cells dome-shaped or quadrangular, 2-4 µm high and 3-5 µm in diameter.

Reproduction: Tetrasporangia zonate, elliptic, 104-136 x 32-72 µm, formed in multiporate conceptacles 320-640 µm in outside diameter; conceptacle chamber 240-400 µm in diameter and 140-220 µm height; conceptacle roof 44-60 µm thick composed

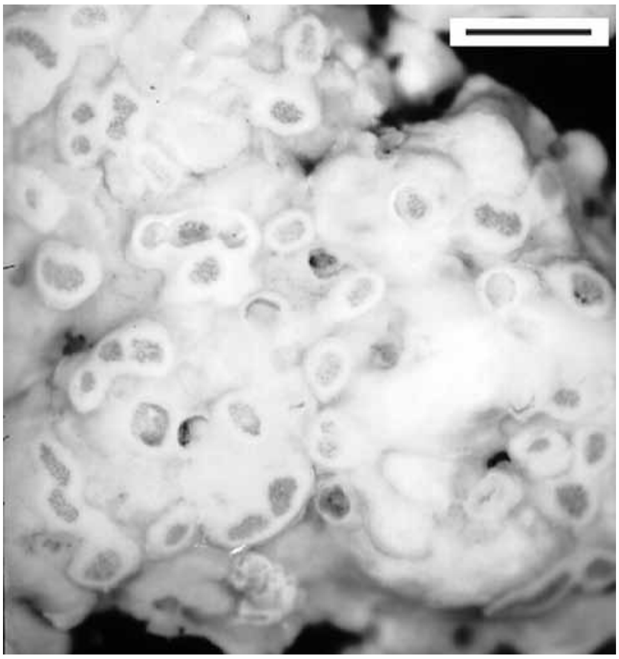

FIG. 59. – *Synarthrophyton munimentum*. 5 km south of Swakopmund, 6-07-1989, BCF-A 12023. Scale bar = 800 µm.

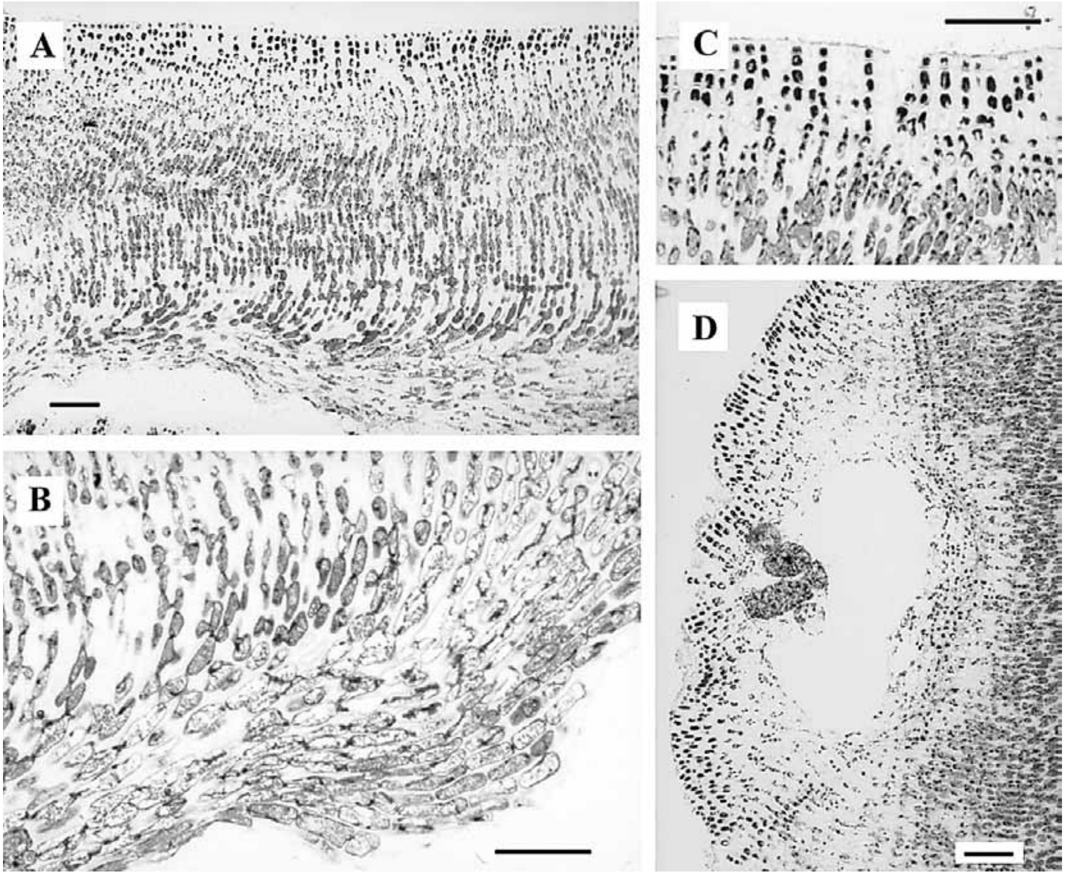

FIG. 60. – *Synarthrophyton munimentum*. A-D. Cross sections. A. Plant structure. B. Detail of medullary filaments. C. Cortical filaments and epithallial cells. D. Conceptacle. Scale bar = 40 µm.

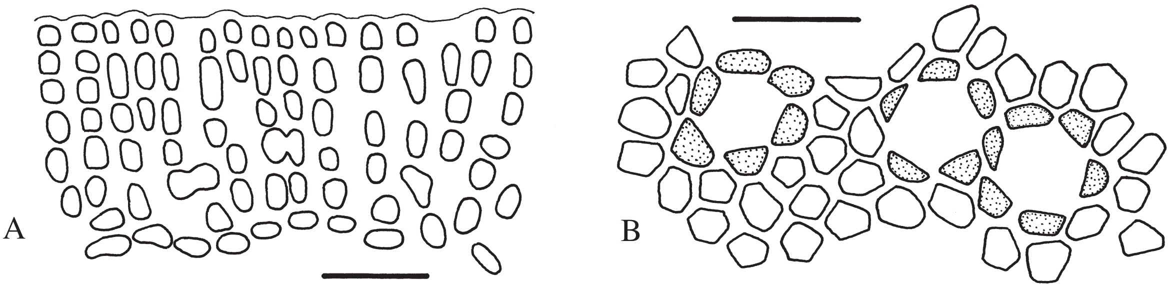

FIG. 61. – *Synarthrophyton munimentum*. A. Conceptacle roof in cross section. B. Conceptacle pores in surface view. Scale bar = 20 µm.

of anticlinal filaments 5-8 cells long; conceptacle pores polygonal, 10-14 µm in diameter, generally surrounded by six cells. Other reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral zone.

Namibian distribution: Grossebucht (Keats and Maneveldt, 1997); Swakopmund (Map 27).

World distribution: Atlantic Ocean: South Africa, Namibia (Keats and Maneveldt, 1997).

Remarks: This species has been recently described by Keats and Maneveldt (1997) from the Atlantic coast of southern Africa. According to these authors, the genus *Synarthrophyton* is very similar to *Mesophyllum*, from which it only differs by the presence of branched spermatangial systems instead of simple ones. Keats and Maneveldt (1997) also stated that the spermatangium arrangement shows a gradation from the simple spermatangial systems of the type species of *Mesophyllum* to the strongly branched ones of the type species of *Synarthrophyton*, with transitional species showing intermediate arrangements of these reproductive structures.

Although we have not observed gametophytic conceptacles in our material, in general the specimens agree quite well with the Keats and Maneveldt (1997) description of *Synarthrophyton munimentum*, the species to which we have assigned them. However, we must point out that in our specimens the epithallial cells are smaller (2-4 x 3-5 µm in cross section, opposite to 4.5-11 x 4.5-8 µm) and the diameter of pores of the tetrasporangial conceptacles is slightly bigger (10-14 µm, opposite to 7-10 µm). Moreover, according to Keats and Maneveldt (1997) the cells surrounding the tetrasporangial pore are narrower and more sunken than the epithallial cells of the pore plate, features which have not been possible to observe in our specimens.

Until now, this species had been recorded in Namibia only from Grossebucht, the type locality.

Corallinaceae ind.

(Figs. 62-63)

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12022, with tetrasporangia; Swakopmund, beach, 8-07-1989, BCF-A 12024, with tetrasporangia; Möwe Bay, 25-02-1986, BCF-A 12021, with tetrasporangia.

Habit and vegetative structure: Plant crustose, calcified, with the surface corrugated, more or less knobbly, completely adhered to the substratum. Conceptacle numerous, uniporate, not or only slightly raised. Epithallial cells polygonal in surface view, 7-10 x 5-8 µm, forming a continuous layer. Basal cells cylindrical in a underside view, 10-22 x 6-10 µm; cell fusions present. In radial cross section, crust structure generally monomerous, 260-280 µm thick, multistratose, even in the margins; basal and erect filaments with cell fusions; cells of basal filaments 7-22 x 5-10 µm; erect filaments composed of 20-25 elongated or almost isodiametric cells 5-7 x 3-6 µm; epithallial cells dome-shaped or more or less flattened, 4-6 x 4-6 µm, usually placed in single layer; trichocytes 8-12 x 4-8 µm, terminating erect filaments, occasionally in clusters.

Reproduction: Tetrasporangia zonately divided, ovate or elliptic, 36-66 x 18-34 µm, formed in uniporate conceptacles 160-200 µm in outside diameter; conceptacle pore 48 µm in diameter. In cross section, conceptacle chamber usually elliptic, (108-)160-200 µm in diameter and 56-84 µm height; conceptacle roof 28-36 µm thick, composed of filaments 4-5 cells long; pore canal 40-52 µm in length, surrounded by more or less horizontally arranged filaments, that often go out towards the exterior. Other reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral zone, together *Nothogenia erinacea*.

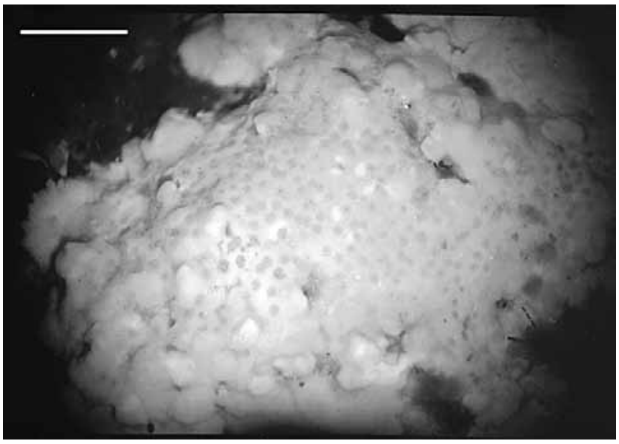

FIG. 62. – Corallinaceae ind. 5 km south of Swakopmund, 6-07-1989, BCF-A 12022. Scale bar = 2 mm.

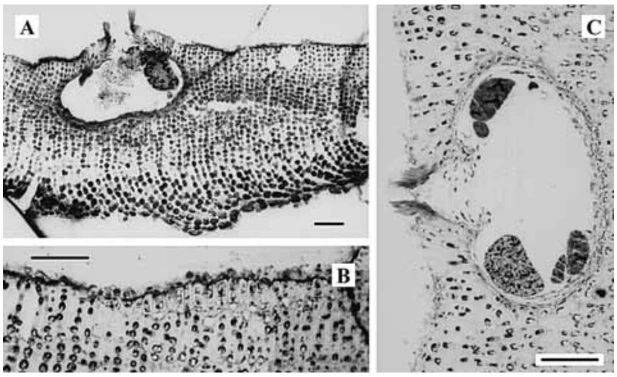

FIG. 63. – Corallinaceae ind. A-C. Cross sections. A. Plant structure. B. Upper part of erect filaments with terminal trichocytes. C. Conceptacle with tetrasporangia. Scale bar = 40 µm.

Namibian distribution: Swakopmund, Möwe Bay (Map 28).

Remarks: The vegetative structure of this plant, as well as the structure of its tetrasporangial conceptacles, suggest that it could belong to the genera *Hydrolithon*, *Pneophyllum*, *Spongites* or *Neogoniolithon*. According to Woelkerling (1996b) *Hydrolithon* differs from the other three genera by the presence of cells orientated more or less perpendicularly to the roof surface in the pore canals of the sporangial conceptacles. On the contrary, in our material, the filaments surrounding the pore canals of the tetrasporangial conceptacles are more or less orientated horizontally and pointed inwards in the pore canal. On the other hand, the distinction among *Pneophyllum*, *Spongites* and *Neogoniolithon* is more dificult, since it is based on the way the sporangial conceptacle roof is formed (Penrose and Woelkerling, 1991; Woelkerling, 1996b) and on the arrangement of both spermatangia in conceptacles and gonimoblast filaments in the fusion cells (Penrose, 1992; Woelkerling, 1996b), features which were not possible to observe in our specimens.

Chamberlain (1994) studied the South African species of *Spongites* and *Pneophyllum* and provided a key for its identification. One of these species (*S. discoideus* (Foslie) D. Penrose and Woelkerling) also occurs in Namibia. According to this work, and also to Chamberlain (1993) who provided a description of *Spongites yendoi* (Foslie) Y. Chamberlain from South Africa, we could assign our specimens to *S. yendoi*. However, unlike this species, in our specimens the structure seems dimerous in some places and the conceptacles lack columella. In this way, Chamberlain (1993) stated that the columella filaments can disappear in old conceptacles.

Chamberlain (1993) also provided a description of *Spongites decipiens* (Foslie) Y. Chamberlain, a species that was described from California by Foslie (1900) and that at present is known to occurs also in Argentina and the Falkland Islands. Chamberlain (1993) stated that *S. yendoi* and *S. decipiens* are very similar, but that they can be differentiated in the vegetative structure, which is monomerous in the former and dimerous in the latter. Moreover, the diameter of the cells of the basal filaments is bigger in *S. decipiens* than in *S. yendoi*. In this way, our specimens also show certain affinity with *S. decipiens* because in some places the structure seems dimerous. However, concerning the cell size of the basal filaments, they show an intermediate position between the two species.

Concerning *Spongites discoideus*, a species widespread in antarctic and subantarctic regions, Chamberlain (1994) remarks that the structure is mainly dimerous in young specimens and monomerous in the proliferations formed when the specimens develop to produce protuberant plants. Moreover, this author points out that in Namibia and South Africa this species only has been occasionally observed and usually in its young form. According to this, our specimens also agree in some way with *S. discoideus*, but the structure of the tetrasporangial conceptacles is different. In *S. discoideus* the conceptacle roof is thicker (35-100 µm thick opposite to 28-36 µm in our specimens) and consists of filaments with a higher number of cells (at least up to 10 cells long opposite to 4-5 cells long in our specimens). Likewise, the sporangial conceptacles of *S. discoideus* have a columella, whereas this structure is lacking in our specimens. Moreover, in surface view, the pore diameter of the sporangial conceptacles is larger in *S. discoideus* (at least up to 70 µm in diameter) than in our specimens (32-48 µm in diameter).

Penrose (1996) described *Spongites tunicatus* D. Penrose from southern Australia and remarked that it is closely related to *S. yendoi*, from which it differs by the presence of a corona of filaments surrounding the pore of the tetrasporangial conceptacles. In this way, our material also agrees quite well with the Penrose (1996) description of *S. tunicatus*, but differs from this species in the size and shape of the conceptacle chambers: elliptic, (108-)160-200 µm in diameter per 56-84 µm high in our specimens, in comparison with more or less globose, 136-142 µm in diameter per 109-158 µm high in *S. tunicatus*.

Order GIGARTINALES Schmitz in Engler (1892)
emend. Kraft and Robins (1985)
Family CAULACANTHACEAE Kützing (1843)
Genus *Caulacanthus* Kützing (1843)

Caulacanthus ustulatus (Turner) Kützing
(Figs. 64-65)

Fucus acicularis Wulfen var. *ustulatus* Turner (1809), p.143.
Caulacanthus ustulatus (Turner) Kützing (1843), p. 395.
Laurencia divaricata Suhr (1840), p. 265.
Caulacanthus divaricatus (Suhr) Papenfuss (1943), p. 86.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11626, with tetrasporangia and carposporangia; 5 km south of Swakopmund, 7-07-1989, BCF-A 11627, with tetrasporangia and carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11628, with tetrasporangia and carposporangia; Terrace Bay, February 1986, BCF-A 11629, with tetrasporangia; Möwe Bay, 25-02-1986, BCF-A 11630, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11818, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11631, with tetrasporangia.

References: Feldmann and Hamel (1936), Searles (1968), Chapman (1979), Cribb (1983), Lawson and John (1987), Adams (1994), Rueness (1997), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 4 cm high, consisting of much branched and often interwoven terete axes, 316-700 µm in diameter; branching irregular or more or less dichotomous, with branchlets of last order usually swollen and bearing small spine-like appendices; attachment by means of thinner and branched prostrate axes and several secondary attachment pads. Cortical cells elongated or more or less isodiametric in surface view, 4-11 x 3-8 µm; apical cell divided by a oblique septum. In cross section, central part of axes loose, containing one axial cell 44-88 µm in diameter, two pericentral cells placed at different heights and at right angle, and the basal part of cortical filaments; lower cells of cortical filaments 16-60 x 12-50 µm; outer cortex

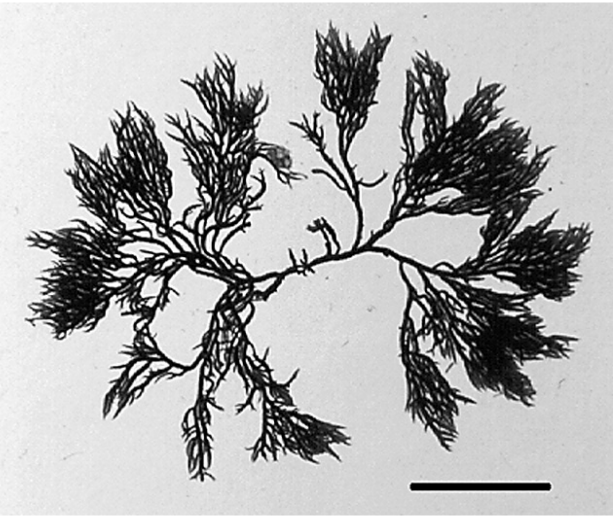

FIG. 64. – *Caulacanthus ustulatus*. Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11818. Scale bar = 1 cm.

more compact, with anticlinally elongated cells 9-18 x 4-10 µm. In longitudinal section, axial cells cylindric, 220-260 x 72-80 µm, bearing two pericentral cells inserted at right angle, from which pseudodichotomously branched cortical filament develops.

Reproduction: Tetrasporangia zonately divided, elliptic, 47-88 x 22-44 µm, radially arranged in the cortical zone of branches, forming more or less spread clusters; occasionally, tetrasporangia with tetraspores several times divided, forming a more or less compact cell cluster. Cystocarps ovoid or globose, acuminate, 900 µm long and 740-800 µm broad, ostiolate, occurring singly or in twos in the apex of last order branches; carposporangia clavate or ellipsoid, 48-120 x 24-32 µm, terminating in short filaments and radially arranged from fusion cell.

Habitat: In the eulittoral zone, epilithic, growing on mussel shells or epiphyte on other algae like *Rhodymenia natalensis*, *Ahnfeltiopsis glomerata*, *Corallina* sp., *Mazzaella capensis*, *Nothogenia erinacea* and *Gracilariopsis longissima*.

Namibian distribution: Elizabeth Bay, Lüderitz, Swakopmund, Torra Bay, Möwe Bay, Rocky Point (Lawson *et al.*, 1990); Langstrand, Terrace Bay (Map 29).

World distribution: Widespread in warm temperate and tropical seas (Lawson and John, 1987).

Remarks: We must highlight the presence of structures morphologically similar to tetrasporangia but containing a great number of spores in our specimens. In fact, these structures derive from the tetrasporangia since we have observed intermediate forms between the normal zonate tetrasporangia and this sort of polysporangia. In these intermediate

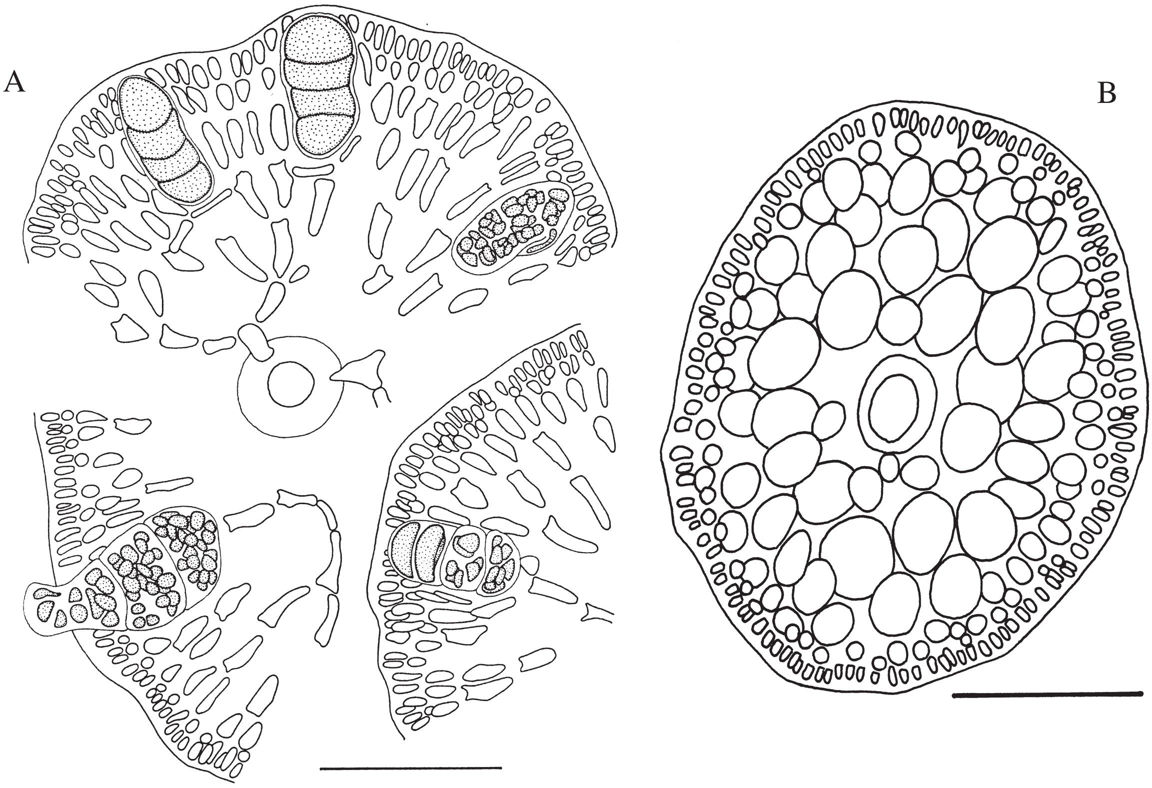

FIG. 65. – *Caulacanthus ustulatus*. A. Three portions of an axis cross section showing tetrasporangia and structures derived from the latter. B. Cross section of a sterile zone of an axis. Scale bar = 100 µm.

forms not all the spores of the tetrasporangium are divided (Fig. 65A). According to Sheath *et al.* (1987) it is still not clear if the polysporangia are more primitive than the tetrasporangia or, on the contrary, if they have evolved from the latter as accepted by several authors (Dixon, 1973; Guiry, 1978; Lee, 1989; Hoek *et al.*, 1995).

In addition to *Caulacanthus ustulatus*, material belonging to this genus has been recorded, as *Caulacanthus* sp., from Torra Bay (Lawson *et al.*, 1990).

Genus *Heringia* (Kützing) J. Agardh (1846)

Heringia mirabilis (C. Agardh) J. Agardh
(Figs. 66-67)

Sphaerococcus mirabilis C. Agardh (1820), pl. VII.
Heringia mirabilis (C. Agardh) J. Agardh (1846), pl. VII.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11842, with tetrasporangia and carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11845, with carposporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11844; Rocky Point, 24-02-1986, BCF-A 11843.

References: Harvey (1847), Kützing (1868), Kylin (1932), Searles (1968), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant consisting of a prostrate base from which several branched erect axes, up to 2 cm high, arise; erect axes cylindrical in the lower part, 160-280 µm in diameter, and compressed upwards, 240-540 µm in diameter in the middle part; branching dichotomous, pseudodichotomous or more or less palmate. Prostrate part flabellate in surface view, with two kinds of cells, some elongate, irregular in shape, 14-28 x 4-8 µm, forming a sort of ill-defined rib, and others rectangular or almost isodiametric, 6-18 x 4-10 µm; cortical cells of erect axes rounded or elongated in surface view, 5-10 x 4-8 µm; apex of erect axes rounded, obtuse, composed of several apical cells. In cross section, prostrate part mostly monostromatic, distromatic in some places, with cells 6-8 x 4-8 µm; erect axes differentiated into medulla and cortex; medullary cells ovate, elliptic or more or less isodiametric, 24-44 x 16-24 µm; cortical cells pigmented, smaller, 7-10 x 4-8 µm, arranged in two layers.

Reproduction: Tetrasporangia zonately divided, elliptic, 24-46 x 10-18 µm, placed in the upper part of cylindrical branches, forming a sort of stichidia 180-300 µm in diameter, slightly thicker than the branch in itself; in cross section, tetrasporangia radially arranged in the cortical zone, between elongate and more or less clavate cells. Cystocarps elliptic, 300-500 (-600) µm in external diameter, terminal or intercalary; carposporangia ovoid, 16-20 x 12-18 µm. Spermatangia not seen.

FIG. 66. – *Heringia mirabilis*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11842. Specimens epiphytic on *Cladophora hospita*. Scale bar = 1 cm.

Habitat: Epiphyte on *Cladophora hospita*, with the prostrate part placed below the cuticle of the support plant.

Namibian distribution: Swakopmund, Terrace Bay (Lawson *et al.*, 1990); Möwe Bay, Rocky Point (Map 30).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Heringia mirabilis* is a southern African endemic species initially described as *Sphaerococcus mirabilis* by C. Agardh (1820) from some specimens epiphytic on *Cladophora* occurring in the Cape of Good Hope. C. Agardh held the epiphyte and the support plant as different stages in the life cycle of a single species (although he assigned them to different genera) and he attributed the mor-

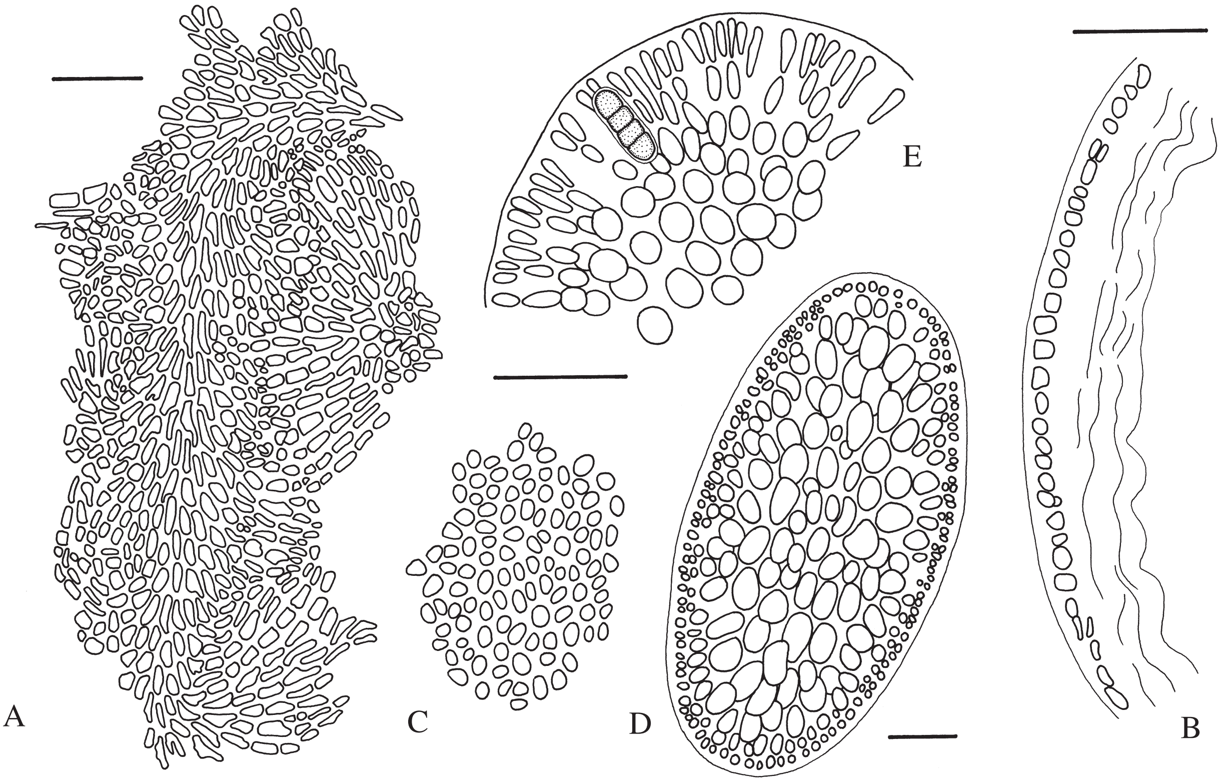

FIG. 67. – *Heringia mirabilis*. A-B. Prostrate part of the plant. A. Surface view. B. Cross section. C-E. Erect part of the plant. C. Cortical cells in surface view. D. Cross section of an axis in a sterile part. E. Portion of the cross section of an axis with one tetrasporangium. Scale bar = 50 µm.

phological differences to a miraculous metamorphosis process to which, probably, the name *mirabilis* makes reference (Searles, 1968).

Searles (1968) carried out a thorough morphologic and anatomic study of *Heringia mirabilis*, the only certain species of this genus according to Kyling (1956), and stated that the free living specimens are taller (up to 10-15 cm high) than those growing on other organisms (up to 2-3(-6) cm high). Likewise, this author remarked that free living and epiphytic specimens might belong to different species, but as he did not know if these differences corresponded to either genetic or ecological variations, he preferred to hold all the specimens as representative of a single species.

The whole of our material consists of specimens epiphytic on *Cladophora hospita* and it is compatible with the Searles (1968) description of *Heringia mirabilis*.

Family CYSTOCLONIACEAE Kützing (1843)
Genus *Rhodophyllis* Kützing (1847) *nom. cons.*

Rhodophyllis reptans (Suhr) Papenfuss
(Fig. 68)

Halymenia reptans Suhr (1834), p. 735.
Rhodophyllis reptans (Suhr) Papenfuss (1956), p. 71.
Rhodophyllis capensis Kützing (1849), p. 786.
Ectoclinum kowiense Holmes (1896), p. 349.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 11701, with carposporangia; Mile 30, 7-07-1989, BCF-A 11812; Möwe Bay, 5-02-1988, BCF-A 11994; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11813.

References: Kützing (1869), Papenfuss (1956), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant 1-2(-3) cm high, consisting of short erect blades, more or less lanceolate, often truncate, (0.5-)1-3 mm broad, simple or dichotomously divided, attenuate at base, stipitate, arising from prostrate axes bearing several attachment pads. Stipe up to 2 mm long and 200-240 µm in diameter. Blades with the surface smooth and the margin entire, occasionally with a few short marginal proliferations in the lower part; truncate blades often with shortly stipitate apical proliferations. Cortical cells polygonal, elongated or more or less isodiametric in surface view, 10-34 x 10-26 µm. Plastids numerous, discoidal. In cross section, blades 76-100 µm thick, consisting of a thin, ill-defined medulla and a cortex 1-2 cells thick; medulla with two kinds of cells, some ovate or elliptic, 12-36 x 10-20 µm, periclinally arranged, and others, smaller, 10-14 x 6-8 µm, scattered between the for-

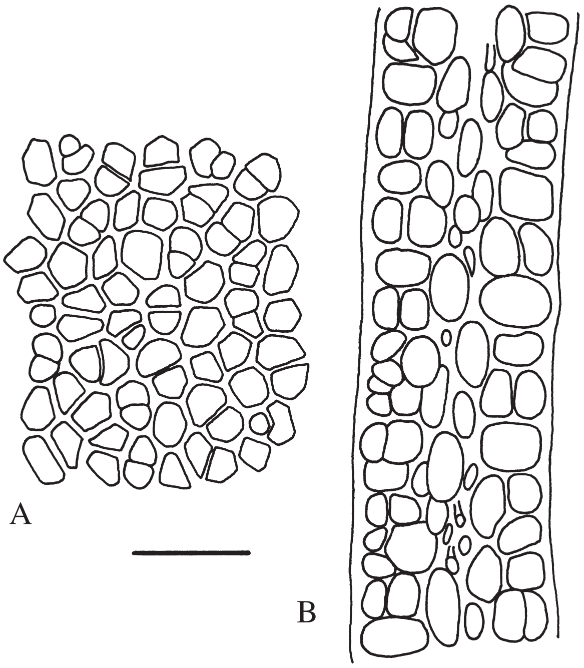

FIG. 68. – *Rhodophyllis reptans*. A. Cortical cells in surface view. B. Cross section of the blade. Scale bar = 50 µm.

mer; cortical cells anticlinally arranged, a few transversally divided, 12-32 x 12-24 µm, the outer ones more pigmented. In longitudinal section, blade structure quite similar, but with filaments or elongate and sinuous cells scattered in the medulla.

Reproduction: Cystocarps spherical, 560 µm in diameter, without pore, placed in the blade margins, protruding from both sides of the blade; in cross section, pericarp composed of five layers of pigmented and more or less elliptic cells periclinally arranged; carposporangia ovate or elliptic, 18-32 x 16-22 µm. Other reproductive structures not observed.

Habitat: Epiphyte on *Plocamium rigidum* and *P. glomeratum* in the upper sublittoral zone, between the *Laminaria pallida* haptera; on vertical walls of tide pools, together with *Ahnfeltiopsis glomerata* and *Plocamium rigidum*.

Namibian distribution: Swakopmund (Lawson *et al.*, 1990); Mile 30, Möwe Bay, South Kunene (Map 31).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa, St. Paul Island (Silva *et al.*, 1996).

Remarks: *Rhodophyllis reptans* was described by Suhr (1834), as *Halymenia reptans*, on the basis of material from Algoa Bay (east coast of South Africa). Some years later, Kützing (1849) described *Rhodophyllis capensis* from the Cape of Good Hope. Later, Schmitz (1894), and more recently Papenfuss (1956), concluded that *R. capensis* and *H. reptans* are conspecific.

Our material agree quite well with both the description and illustrations of this species showed by Stegenga *et al.* (1997). However, our specimens are relatively shorter, less branched and consist of thinner blades.

Family GIGARTINACEAE Bory de Saint Vincent (1828)

Genus *Gigartina* Stackhouse (1809)

Gigartina bracteata (S. G. Gmelin) Setchell and Gardner (Figs. 69-71)

Fucus bracteatus S. G. Gmelin (1768), p. 212.
Gigartina bracteata (S. G. Gmelin) Setchell and Gardner (1933), p. 258, 295.
Chondrodictyon capense Kützing (1843), p. 396.
Iridaea clathrata Decaisne (1844), p. 236.
Gigartina clathrata (Decaisne) Rabenhorst (1878), p. 71.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11634, with carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11636, with tetrasporangia; Mile 30, 7-07-1989, BCF-A 11637, with carposporangia.

References: Kützing (1867), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliaceous, of cartilaginous texture, consisting of lanceolate, cuneate, stipitate, simple or divided blades up to 42 cm high and 7-18 cm broad, attached to the substratum by means a basal disc. Stipe terete, 5 mm long and 3-4 mm in diameter. Blade surface smooth and homogeneously perforate to completely reticulate, exceptionally with some isolate proliferation in the margins of perforations (tetrasporophyte), or with many papilla-like proliferations homogeneously

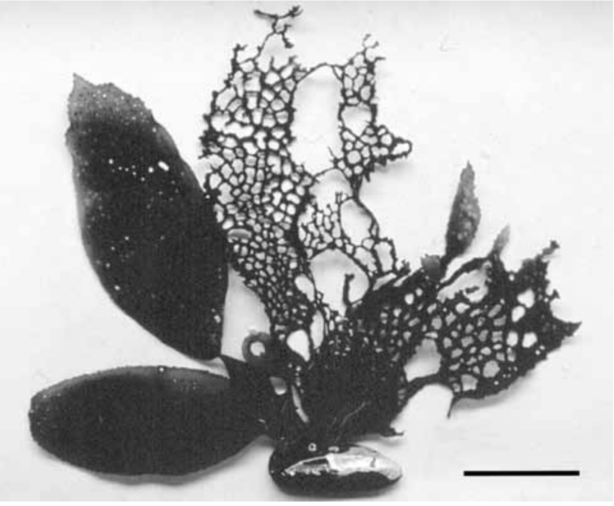

FIG. 69. – *Gigartina bracteata* (tetrasporophyte). Swakopmund, beach, 8-07-1989, BCF-A 11636. Scale bar = 7 cm.

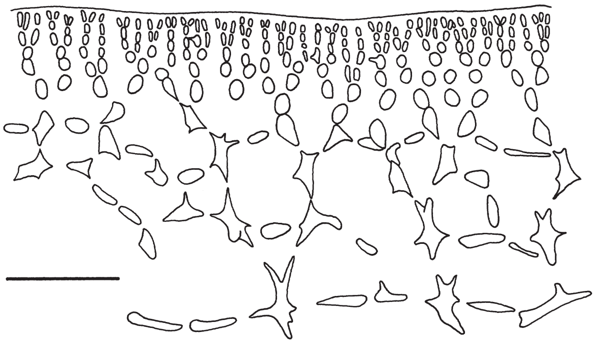

FIG. 70. – *Gigartina bracteata*. Portion of a blade cross section. Scale bar = 50 µm.

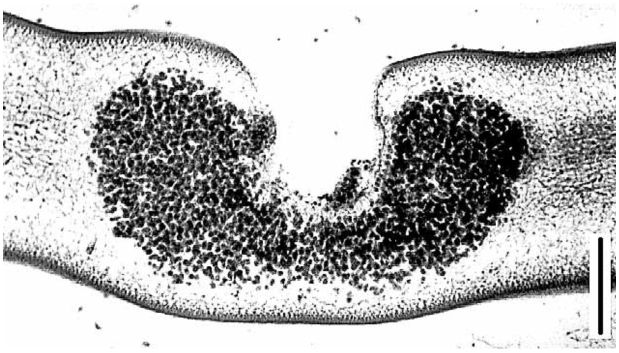

FIG. 71. – *Gigartina bracteata*. Cross section of the blade through a tetrasporangial sorus. Scale bar = 400 µm.

scattered over both sides, sometimes with some isolate perforation, and remaining a 5 mm wide marginal band free of papillae (female gametophytes); papillae simple, bifurcate or trifurcate, 2-7 x 1-2 µm; blade margin irregular, toothed (tetrasporophyte) or with papillae (female gametophyte). Outer cortical cells elongate or isodiametric in surface view, 2-4 µm in greater diameter. In cross section, blade 900 µm thick, differentiated into cortex and medulla. Cortex 60-80 µm thick, composed of anticlinally arranged, dichotomously divided filaments 6-8 cells long, with the inner cells elliptic or isodiametric, 6-16 x 4-8 µm, and the outer ones elongated, 3-8 x 2-4 µm; exceptionally, cortical cells with some lateral protuberance. Medulla 740 µm thick, composed of cells cylindrical or having more or less long protuberances; transitional zone between cortex and medulla with stellate cells of short arms forming a network; inner medulla more compact, with the cells arranged in periclinal branched filaments 2-5(-12) µm in lumen diameter. In a section parallel to the blade surface, medullary filaments branched, forming a network, composed of cells cylindrical or with more or less long protuberances.

Reproduction: Tetrasporangia cruciate or decussate, ovate or more or less elliptic, 28-38 x 20-26 µm, formed in internal, circular (in surface view) or ovate (in cross section) sori 1.4-2 mm in greater diameter; sori immersed in the medulla, later opening to the exterior through a depression and finally resulting in blade perforations; at first, perforations with a peripheral rim of remaining sporangia; sori more or less homogeneously scattered in the whole of the blade. Cystocarps spherical, 700-1500 µm in diameter, immersed in both marginal and superficial papillae, without pore; occasionally, a depression of the papilla surface reach the cystocarp; in cross section, gonimoblast delimited by a thin and compact layer of filaments; carposporangia spherical, ovoid or ellipsoid, 12-28 x 10-24 µm. Spermatangia not seen.

Habitat: On mussel shells in drift material.

Namibian distribution: Halifax Bay, Swakopmund (Lawson *et al.*, 1990); Mile 30 (Map 32).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997).

Remarks: Our specimens are consistent with the description and illustrations of *Gigartina bracteata* by Stegenga *et al.* (1997), as well as with the photographs of Wynne (1986) of this species. Likewise, our observations on the morphology of the tetrasporophyte completely agree with the remarks of Wynne (1986) on this subject.

In our opinion, and on the basis of the available bibliographical references, *Gigartina bracteata* is similar to *G. polycarpa* (Kützing) Setchell and Gardner, a species occurring from Lüderitz to a bit further than Cape Agulhas (Levitt *et al.*, 1995) and usually known by mistake under the name *G. radula* (Esper) J. Agardh (Hommersand *et al.*, 1994). In a work on the intertidal flora and fauna of South Africa, Stephenson (1948) recorded *G. radula* and *G. bracteata* (as *G. radula* var. *clathrata* (Decaisne) J. Agardh), pointing out that the former is perhaps identical to *G. polycarpa* and that the latter is a deep water species usually much eaten by snails. In fact, *G. radula* (at present *Sarcothalia radula* (Esper) Edyvane and Womersley) is a sublittoral species occurring in southern Australia, Tasmania and New Zealand (Edyvane and Womersley, 1994). This is a species morphologically similar to *G. polycarpa*, from which it can be differentiated by biochemical methods (Hommersand *et al.*, 1994).

Stegenga *et al.* (1997) recorded *G. radula* from the west coast of South Africa and remarked that *G. polycarpa* is a similar species occurring on the eastern Cape coast. According to these authors, *G. polycarpa* is more densely papillate than *G. radula*. Moreover, Stegenga *et al.* (1997) stated that the

South African specimens of *G. radula* differ from the Australian ones (as Bolton and Anderson (1990) has already pointed out) and that they must receive a different name since the type is Australian.

Gigartina bracteata differs from *G. polycarpa* in the morphology of the tetrasporophyte, which is completely perforate in the first species. Stephenson (1948) attributed this fact to the activity of the snails, whereas according to Wynne (1986) and to our own observations, the perforations are produced as a result of the spore release. In contrast, the gametophytes of both species are more difficult to distinguish and it is possible that some of our specimens can be assigned to *G. polycarpa*, a species that also has been recorded from Namibia. On the other hand, *G. bracteata* and *G. polycarpa* also can be differentiated by their ecology, since the former is a deep water species (Stephenson, 1948) whereas the latter grows in the eulittoral zone of rocky shores (Anderson *et al.*, 1989; Molloy, 1990; Levitt *et al.*, 1995).

In agreement with Wynne (1986), our material also consists of perforate sporophytes and papillate gametophytes. Moreover, in agreement with Stephenson (1948), it is possible that our specimens, as well as those of Wynne (1986), were of depth, since they were part of drift material and we did not find attached specimens in the eulittoral zone. For these reasons, we have assigned our material to *Gigartina bracteata*, although we think that a thorough study of both this species and *G. polycarpa* should be carried out since its gametophytes are very similar, as we have mentioned above.

According to Hommersand *et al.* (1993) and Hommersand *et al.* (1994) the genus *Sarcothalia* is characterized, among other aspects, by the dimorphism between gametophytes and sporophytes, so that the former usually are thorny or proliferous, with the cystocarps placed in the proliferations, and the latter smooth, with inner and non protruding sori of tetrasporangia. This feature agrees with those of *G. bracteata* and thus, we hold that this species should be transferred to the genus *Sarcothalia*. However, we believe that a taxonomic study of this species, especially concerning the development and morphology of the reproductive structures, should be carried out.

Finally, and as far as the gametophyte morphology is concerned, our specimens are similar to *Sarcothalia circumcincta* (J. Agardh) Hommersand (= *Gigartina circumcincta* J. Agardh), a New Zealand species that is very similar to *Sarcothalia radula* (Setchell and Gardner, 1933; Edyvane and Womersley, 1994). On the other hand, with reference to *G. circumcincta*, Adams (1994) remarked that *G. radula* is considered to be the correct name for this plant. Chapman (1979) pointed out that *G. circumcincta* is a very polymorphic species and that possibly a group of related species would be in either speciation or hybridisation process.

Genus *Mazzaella* De Toni (1936)

Hommersand *et al.* (1993) distinguished *Iridaea* from *Mazzaella*, and transferred *I. capensis* to the genus *Mazzaella*. In addition to this species, *I. elongata* also occurs in Namibia. This last taxon, that has not been taken into account in the work of Hommersand *et al.* (1993), is probably synonymous of *M. capensis* (see the remark in this taxon).

Mazzaella capensis (J. Agardh) Fredericq in Hommersand *et al.*

(Figs. 72-74; Plate II)

Iridaea capensis J. Agardh (1848), p. 47.
Iridophycus capensis (J. Agardh) Setchell and Gardner (1936), p. 470.
Mazzaella capensis (J. Agardh) Fredericq in Hommersand *et al.* (1993), p. 112.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11582, with tetrasporangia and carposporangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11583, with tetrasporangia and carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11584, with tetrasporangia; Cape Cross, 7-07-1989, BCF-A 11585, with carposporangia; Mile 108, 13-07-1989, BCF-A 11586, with carposporangia; Terrace Bay, February 1986, BCF-A 11587, with carposporangia; Möwe Bay, 25-02-1986, BCF-A 11763, with carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11588, with tetrasporangia and carposporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11762; Rocky Point, 24-02-1986, BCF-A 11765, with tetrasporangia and carposporangia; Cape Frio, 23-02-1986, BCF-A 11589, with carposporangia; Angra Fria, 20-02-1986, BCF-A 11591; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11590, with carposporangia.

References: Simons (1969, 1976), Simons and Hewitt (1976), Branch and Branch (1981), Anderson *et al.* (1989), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliose, consisting of one or more stipitate blades up to 58 cm high and 2-25 cm broad, attached to the substratum by a basal disc. Stipe 1-3 cm long, cylindric in the lower part, compressed, cuneate and often channelled upwards, with the margin entire, finely granulate or bearing more or less abundant lateral proliferations. Blade generally lanceolate and simple, sometimes more or less orbicular or broader than high, suddenly expanded from the stipe, simple or divided; blade surface smooth, more or less granulate in fertile specimens, sometimes with a few perforation; blade margin entire or irregularly sinuous, exceptionally two-

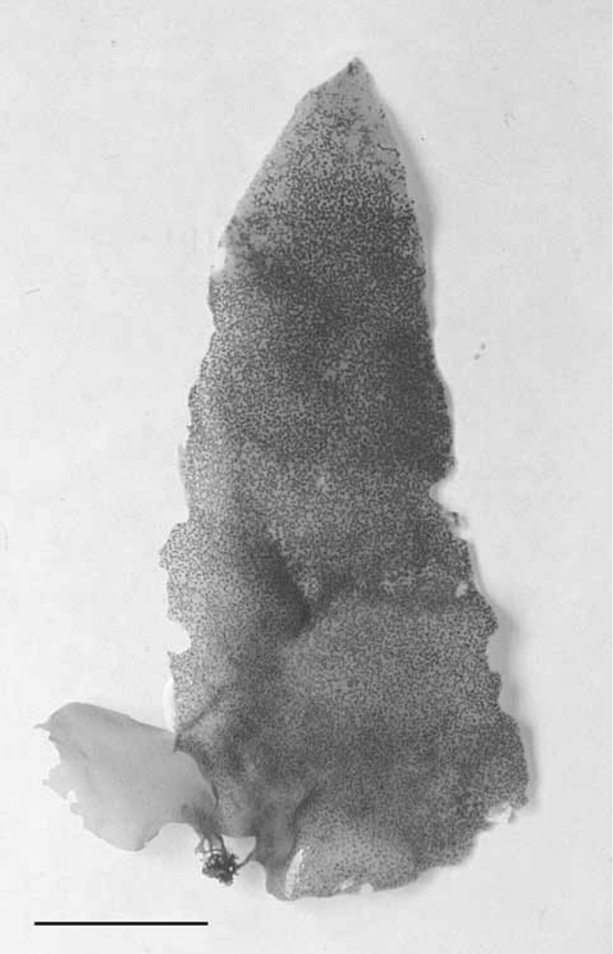

FIG. 72. – *Mazzaella capensis*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11583. Scale bar = 5 cm.

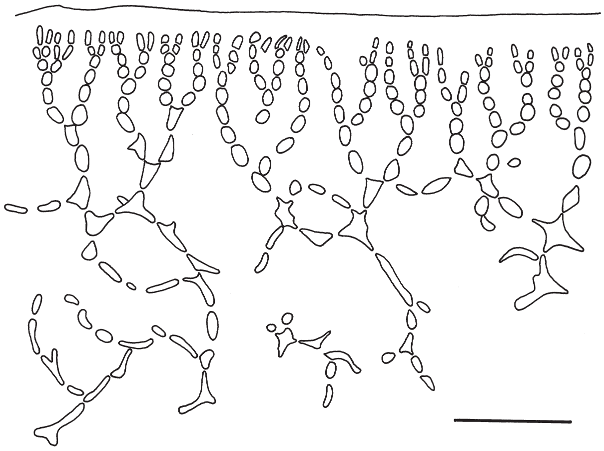

FIG. 73. – *Mazzaella capensis*. Portion of a blade cross section. Scale bar = 50 µm.

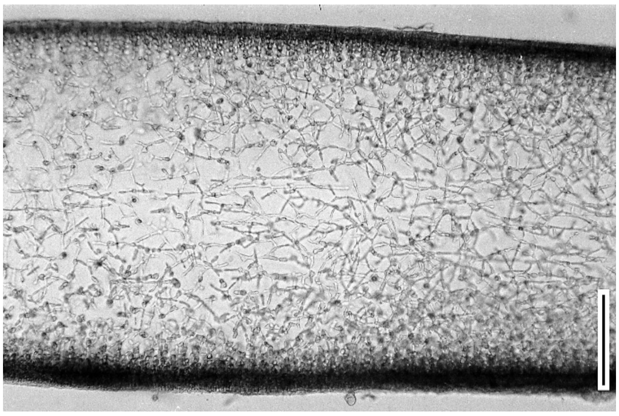

FIG. 74. – *Mazzaella capensis*. Cross section of the blade. Scale bar = 160 µm.

lipped in some places. Outer cortical cells elongated or more or less isodiametric in surface view, 3-6 µm in greater diameter. In cross section, blade 420-1100 µm thick, differentiated into cortex and medulla; cortex 55-100 µm thick, composed of anticlinal, dichotomously divided filaments (5-)7-10(-11) cells long, with cells elliptic or more or less isodiametric, 4-12 x (2-)3-8 µm, the inner ones elongated and bigger, 9-22(-26) x 4-12 µm; medulla (260-)360-780 µm thick, composed of filaments 4-14 µm in diameter (the lumen 2-4(-6) µm), with cells cylindrical or bearing irregular protuberances, a few more or less stellate, forming a loose network; in some specimens, inner medullary filaments more or lees periclinally arranged; transitional zone between medulla and cortex composed of short filaments and cells bearing protuberances, forming a network.

Reproduction: Tetrasporangia cruciate or decussate, usually elliptic, 22-42 x 16-30(-32) µm, arising from medullary filaments and placed in internal sori; sori circular or elliptic in surface view, 400-800 µm in greater diameter, scattered in the whole of the blade; in cross section, sori elliptic, 400-960 x 260-540 µm, placed in the outer medulla, below the cortex, in both sides of the blade. Cystocarps internal, more or less circular in surface view, 400-2000 µm in diameter, often consisting of two or more lobes, scattered in the whole of the blade; in cross section, cystocarps elliptic, 258-1900 x 215-800 µm, immersed in the medulla and protruding from both sides of the blade; carposporangia elliptic, more or less isodiametric or pear-shaped, 13-30(-34) x 12-22 µm. Spermatangia not seen.

Habitat: Epilithic or growing on mussel shells in the lower eulittoral zone, together with *Centroceras clavulatum*, *Gastroclonium reflexum* and *Caulacanthus ustulatus* among other species.

Namibian distribution: Elizabeth Bay, Grossebucht, Diaz Point, Lüderitz, Swakopmund, Terrace Bay, Möwe Bay, Cape Frio, Honolulu (Lawson *et al.*, 1990); Langstrand, Cape Cross, Mile 108, Rocky Point, Angra Fria, South Kunene (Map 33).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Mazzaella capensis*, previously known as *Iridaea capensis*, shows a distribution basically restricted to the Atlantic coast of southern Africa. This is a fairly common species growing on rocky substrate of sand-affected areas and thus, it can remain buried in the sand for some months, surviving as a crustose form and give rise to new blades when the sand moves away (Bolton and Levitt, 1992; Bolton and Joska, 1993).

In addition to *Iridaea capensis*, Lawson *et al.* (1990) recorded *I. elongata* Suhr from Walvis Bay on the basis of the work of Delf and Michell (1921). In the paper on the seaweeds of the western coast of tropical Africa, Price *et al.* (1992) remarked on the possibility that *I. elongata* may be a synonym of *Mazzaella capensis*. Likewise, on the basis of the rbcL sequence analysis, Hommersand *et al.* (1994) suggest the possibility that *Mazzaella capensis* may be a synonym of *M. laminarioides*, a south American species occurring also in Gough Island, Falkland Islands, Kerguelen, Crozet Islands and Auckland Island (Chamberlain, 1965).

Family HYPNEACEAE J. Agardh (1851)
Genus *Hypnea* Lamouroux (1813)

Key to species of *Hypnea*:

1. In cross section, medulla composed of cells more or less similar in size..2
1. In cross section, inner medulla composed of a cluster of cells smaller than those of the outer medulla..4

2. Plant consisting of axes 1 mm in diameter approximately ....*H. musciformis**
2. Plant consisting of narrower axes, up to 0.5 mm in diameter..3

3. Branching fastigiate; hooked apices usually absent...*H. ecklonii*
3. Branching irregular; hooked apices present......... ....*H. tenuis**

4. Plant consisting of free axes 1-2 mm in diameter ....*H. spicifera*
4. Plant consisting of axes 0.5 mm in diameter approximately, united by means secondary attachment pads................................*Hypnea.* sp.

* *H. musciformis* was not observed. You can find more information about this taxon in Lawson and John (1987) and Stegenga *et al.* (1997). On the other hand, Engledow (1998) recorded *H. tenuis* from several localities in Namibia. Some of our specimens of *H. ecklonii* are very similar to this species, but many intermediate forms between both taxa occur in our material. According to our own data, both species are very difficult to delimitate and we have preferred to consider all of our material as *H. ecklonii* (see the remark on this species).

Hypnea ecklonii Suhr
(Figs. 75-76)

Hypnea ecklonii Suhr (1836), p. 342.
Hypnea ceramioides Kützing (1849), p. 759.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11679; Swakopmund,beach, 8-07-1989, BCF-A 11680, with tetrasporangia; Mile 30, 7-07-1989, BCF-A 11681, with tetrasporangia; Mile 32, 7-07-1989, BCF-A 11682, with tetrasporangia and carposporangia; Möwe Bay, 4-02-1988, BCF-A 11814, with tetrasporangia and carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11683, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11815, with tetrasporangia and carposporangia; Rocky Point, 24-02-1986, BCF-A 12117, with tetrasporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11676.

References: Kützing (1849, 1868), Kylin (1938), Bodard (1968), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 7 (-10) cm high, consisting of much branched, terete axes 240-460 µm in diameter; branches often fastigiate, occasionally united by twisting some round others; attachment by means of branched haptera bearing small attachment pads; sometimes, specimens entangled with other algae, to which they attach via numerous hooked axis apices. Branching irregular, occasionally unilateral; branches usually tapering towards the apex and constricted at insertion point, some spine-like, others with slightly swollen hooked apices, sometimes completely twisted; spine-like branches and branches terminating in hooked apices more or less abundant depending on the specimens. Outer cortical cells elongated, triangular or more or less isodiametric in surface view, 8-22 x (6-)8-17 µm; apical cell single, dome-shaped. Plastids numerous. In cross section, medulla composed of an axial cell (40-)56-108 x (32-)44-84 µm surrounded with colourless and more or less polygonal cells (32-)52-104 x 24-76 µm, but some of smaller size; cortical cells pigmented, more or less rectangular in shape, 10-24 x 5-14 µm, anticlinally arranged forming a continuous layer; subcortical cells 14-48 x 9-40 µm. In longitudinal section, axial filament clearly visible, composed of cylindric

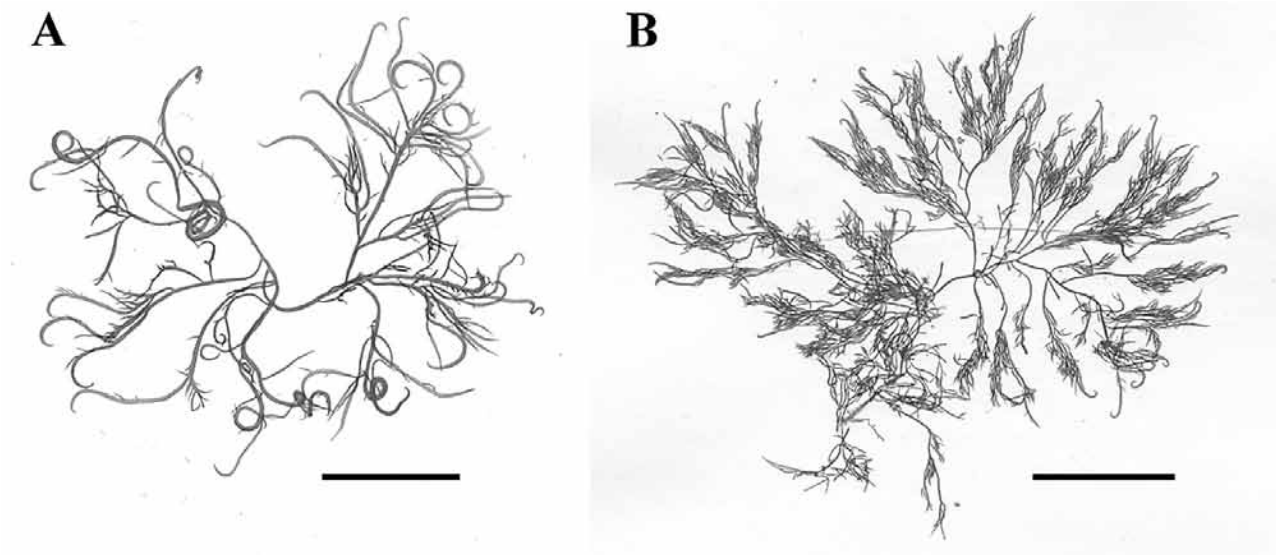

FIG. 75. – *Hypnea ecklonii*. A. Rocky Point, 24-02-1986, BCF-A 11675. B. 5 km south of Swakopmund, 6-07-1989, BCF-A 11679. A. Scale bar = 1 cm. B. Scale bar = 2 cm.

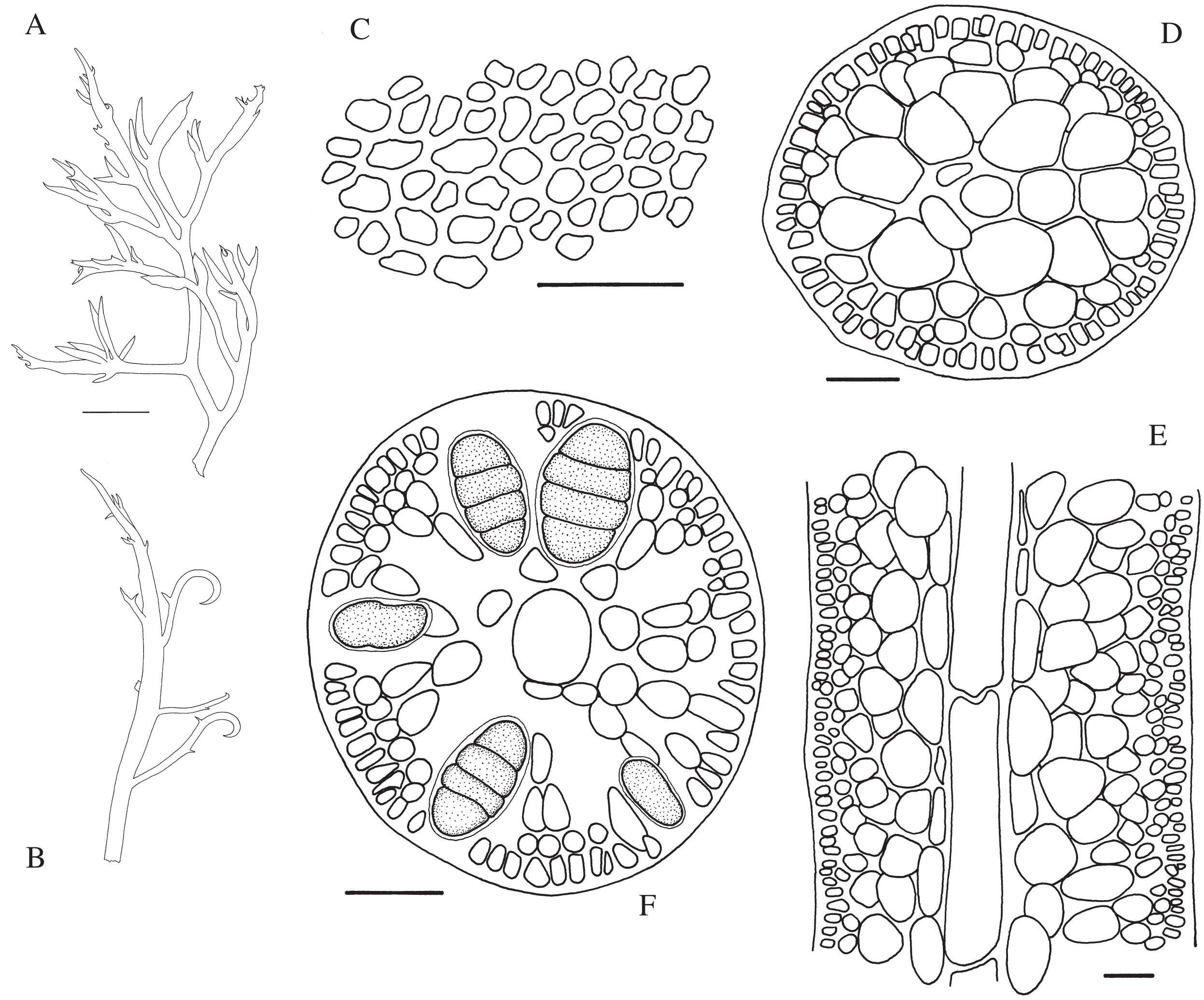

FIG. 76. – *Hypnea ecklonii*. A-B. Detail of two portions of the plant. C. Cortical cells in surface view. D. Cross section of an axis. E. Longitudinal section of an axis. F. Cross section of a branch with tetrasporangia. A-B. Scale bar = 1 mm. C-F. Scale bar = 50 µm.

or a little barrel-shaped cells (152-)300-514 x (32-) 48-134 µm.

Reproduction: Tetrasporangia zonately divided, elliptic, (48-)64-100 x 32-60 µm, formed in slightly swollen, simple or ramified branchlets constricted at base forming a short stalk; in cross section, tetrasporangia radially arranged, placed among dichotomously divided filaments arising from the axial cell. Cystocarps globose, 300-700 µm in external diameter, provided with a slightly prominent pore and eccentrically placed in the middle part of the spine-like branchlets; carposporangia obovate or elliptic, 30-44 x 22-30 µm, terminal in elongate, club-shaped cells, one in each cell. Spermatangia not seen.

Habitat: In tide pools; also occurring in the lower eulittoral and upper sublittoral zones, among *Laminaria pallida* haptera or epiphyte on several algae, as *Chaetomorpha robusta*, *Cladophora flagelliformis*, *C. hospita*, *Ahnfeltiopsis vermicularis* and *Tayloriella tenebrosa*. In drift material, epiphyte on *Chondria capensis* and *Ahnfeltiopsis vermicularis*.

Namibian distribution: Rocky Point (Lawson *et al.*, 1990); Swakopmund, Mile 30, Mile 32, Möwe Bay, South Kunene (Map 34).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); Senegal, Mauritania (Price *et al.*, 1992). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Hypnea ecklonii* was described by Suhr (1836) on the basis of material from Algoa Bay (east coast of South Africa) and later recorded from other localities of this country (Delf and Michell, 1921; Kylin, 1938; Stephenson, 1948; Jackelman *et al.*, 1991). Delf and Michell (1921) included a record of this species from Walvis Bay, but Lawson *et al.* (1990) held that the specimens to which it referred belong to *H. musciformis* (Wulfen) Lamouroux. On the other hand, Kützing (1849) described *H. ceramioides* from Table Bay, in the South African Atlantic coast. This species also has been recorded from Namibia, Senegal and Mauritania (Price *et al.*, 1992). Recently, Stegenga *et al.* (1997) held *H. ceramioides* as a synonym of *H. ecklonii* but they do not take into account the records of Senegal and Mauritania in its distribution. In contrast, Silva *et al.* (1996) considered the species as different taxa.

The material that we have assigned to *Hypnea ecklonii* show a fairly variable morphology, from specimens with fastigiate branches and straight apices to more chaotic specimens with numerous branches ending in hooked apices. The former are perfectly compatible with the Stegenga *et al.* (1997) drawing of *H. ecklonii* and with the Kützing (1868) illustrations of *H. ceramioides*. The latter agree quite well with the figures of *H. rosea* Papenfuss by Simons (1976) and Branch and Branch (1981), as well as with the Stegenga *et al.* (1997) drawing of *H. tenuis* Kylin. In contrast, anatomically, all specimens have a very similar inner structure, which agrees quite well with those of both *H. ecklonii* and *H. ceramioides*. However, in our material, the size difference between the axial cell and the medullary cells is not as marked as is shown by Stegenga *et al.* (1997) in *H. ecklonii*.

Hypnea rosea and *H. tenuis* occur mainly on the west coasts of the Indian Ocean (Silva *et al.*, 1996) albeit they have also been recorded from the south west coast of South Africa, between Cape Agulhas and Cape of Good Hope (Stegenga *et al.*, 1997), and *H. tenuis* also from Namibia (Engledow, 1998). According to Papenfuss (1947) and Stegenga *et al.* (1997) *H. rosea* consists of axes 1-1.5 mm in diameter, whereas in our specimens they are 240-460 µm in diameter. On the other hand, *H. tenuis* is a small species reaching at most 3 cm in height and consisting of axes 250(-400) µm in diameter (Kylin, 1938; Stegenga *et al.*, 1997). In contrast, our specimens can reach up to 7 cm high, although they also consist of relatively thin axes.

Lawson and John (1987) remarked that the presence of thickened and hooked apices in *Hypnea musciformis* (Wulfen) Lamouroux depends on the degree of wave action, so that the specimens growing in places with very little wave action show hooked apices whereas in those growing in places with moderate to strong wave action the apex may be straight and unthickened. This fact could explain the highest frequency of hooked apices in some of our specimens of *Hypnea ecklonii*.

Therefore, albeit some of our specimens are morphologically similar to *Hypnea rosea* and *H. tenuis*, we have preferred to assign them to *Hypnea ecklonii*, holding that the frequency of hooked apices depends on environmental features and that *H. rosea* and *H. tenuis* are almost exclusively Indian species (Stegenga *et al.*, 1997). However, it is important to point out that Lawson *et al.* (1990) recorded *Hypnea (?) tenuis* from the Kunene River, and more recently, Engledow (1998) recorded this species from several localities in Namibia.

In agreement with Price *et al.* (1992), we hold that the genus *Hypnea* includes numerous nomenclaturally and taxonomically confused species and that it requires a monographic treatment on a world scale.

Hypnea spicifera (Suhr) Harvey in J. Agardh (Figs. 77-78)

Gracilaria spicifera Suhr (1834), p. 731.
Hypnophycus spicifer (Suhr) Kützing (1843), p. 405.
Hypnea spicifera (Suhr) Harvey in J. Agardh (1847), p. 14.
Sphaeococcus musciformis var. *armatus* C. Agardh (1822), p. 328.
Hypnea armata (C. Agardh) J. Agardh (1851), p. 444, *nom. illeg.*
Hypnea harveyi Kützing (1849), p. 760.

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11672, with carposporangia; *ibid.*, BCF-A 11673, with tetrasporangia.

References: Harvey (1847), Isaac and Hewitt (1953), Hewitt (1960), Simons (1969, 1976), Branch and Branch (1981), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant 6-12 cm high, consisting of branched, terete erect axes 1-2 mm in diameter, arising from branched, interwoven, thinner prostrate axes attached to the substratum by means of several haptera. Branching irregular, sometimes proliferous, with branches tapering towards the apex; fertile specimens with numerous simple or branched spine-like branchlets bearing reproductive structures. Outer cortical cells elongated in surface view, 5-12 x 2-8 µm. In cross section, medullary cells colourless, polygonal, the central ones more or less isodiametric, 36-71 x 27-64 µm, and the outer elongated, bigger, 95-174 x 63-111 µm; subcortical and cortical cells pigmented, the latter elongated, 10-14 x 4-8 µm, anticlinally arranged forming a continuous layer. In longitudinal section, medullary cells polygonal, the central ones very long, 695-830 x 63-79 µm, and the outer progressively shorter and broader towards the cortex, 134-553 x 79-134 µm; cortical and subcortical cells as in cross section.

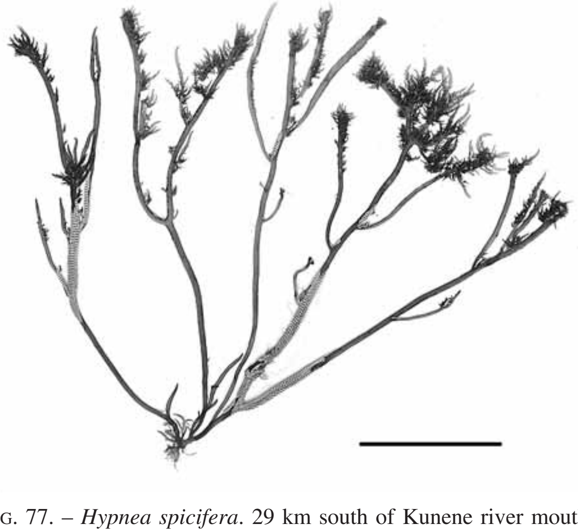

FIG. 77. – *Hypnea spicifera*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11672. Scale bar = 3 cm.

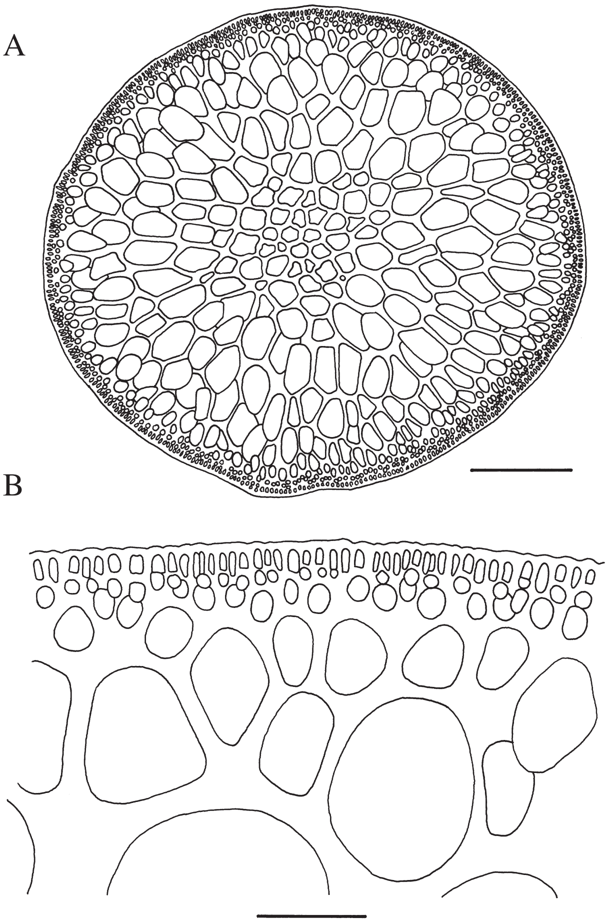

FIG. 78. – *Hypnea spicifera*. A. Cross section of an erect axis. Scale bar = 300 µm. B. Detail of the cortical zone in cross section. Scale bar = 50 µm.

Reproduction: Tetrasporangia zonately divided, 48-76 x 20-32 µm, placed in sori partially covering the simple or branched spine-like branches. Cystocarps globose, 728 µm in external diameter, opening to the exterior through a pore; carposporangia 27 x 18-27 µm. Spermatangia not seen.

Habitat: Epilithic in the lower eulittoral zone.

Namibian distribution: Lüderitz, Agate Beach, Rocky Point, Kunene River (Lawson *et al.*, 1990) (Map 35).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa, Madagascar, Réunion, Mauritius, Kenya, Pakistan, India (Silva *et al.*, 1996).

Remarks: *Hypnea spicifera* was described by Suhr (1834), as *Gracilaria spicifera*, on the basis of material from Algoa Bay (south east coast of South Africa). This species is widespread on the South African coasts, being more abundant in the east than in the west (Stephenson, 1948; Isaac and Hewitt, 1953). In Namibia, *H. spicifera* has been recorded from both north and south coasts, growing either in the lower eulittoral zone or among the *Laminaria pallida* specimens in the upper sublittoral (Penrith and Kensley, 1970a and 1970b; Lawson *et al.*, 1990).

Hypnea sp.
(Figs. 79-80)

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11677, with tetrasporangia.

Habit and vegetative structure: Plant up to 5 cm high, consisting of prostrate and erect, branched, interwoven axes forming dense turfs associated with sand cover. Erect axes terete, 480-640 µm in diameter, irregularly or more or less dichotomously branched, united by means secondary attachment pads and sometimes bearing some spine-like branchlets. Outer cortical cells elliptic, triangular or more or less isodiametric in surface view, 8-20 x 6-16 µm. Plastids discoidal. Apical cell single. In cross section, medulla composed of a central core of relatively small rounded cells 20-60 x 20-44 µm, surrounded by radially arranged, more or less elliptic cells 64-152 x 40-96 µm; one axial cell and 6-8 pericentral cells often visible in the central medulla, especially in the upper part of axes; cortex composed of a layer of pigmented, elongate or more or less isodiametric cells 10-16 x 8-16 µm; subcortical cells ovate, elliptic or rounded, 20-44 x 16-44 µm. In longitudinal section, central medullary cells elongated, 140-260 x 36-52 µm.

Reproduction: Tetrasporangia zonately divided, elliptic, 50-74 x 20-38 µm, radially arranged in small branches, among the cortical and subcortical cells of relatively swollen zones like nematecia. Other reproductive structures not observed.

Habitat: In the lower eulittoral zone, together with *Gelidium pusillum*, forming dense turfs truncate in the upper part, retaining sediment and small molluscs.

Namibian distribution: South Kunene (Map 36).

Remarks: On the basis of consulted literature, and by the presence of secondary attachment pads uniting the axes, our specimens are similar to *Hypnea cenomyce* J. Agardh, *H. spinella* (C. Agardh) Kützing and *H. pannosa* J. Agardh, species which are widespread in warm temperate and tropical seas (Lawson and John, 1987; Price and Scott, 1992). However, they differ from these species in habit and anatomy. Concerning inner structure, the three mentioned species show a single axial cell surrounded by several larger medullary cells (Yamagishi and Masuda, 1997; Chiang, 1997; Lewmanomont, 1997; Xia and Wang, 1997), whereas in our specimens the medulla consists of a central core of small cells surrounded by larger medullary cells. In this way, our material more or less agrees with *Hypnea rosea*, since this species has a medulla composed of small central medullary cells (an axial cell and 6-7 peri-

FIG. 79. – *Hypnea* sp. Habit. Scale bar = 1 cm.

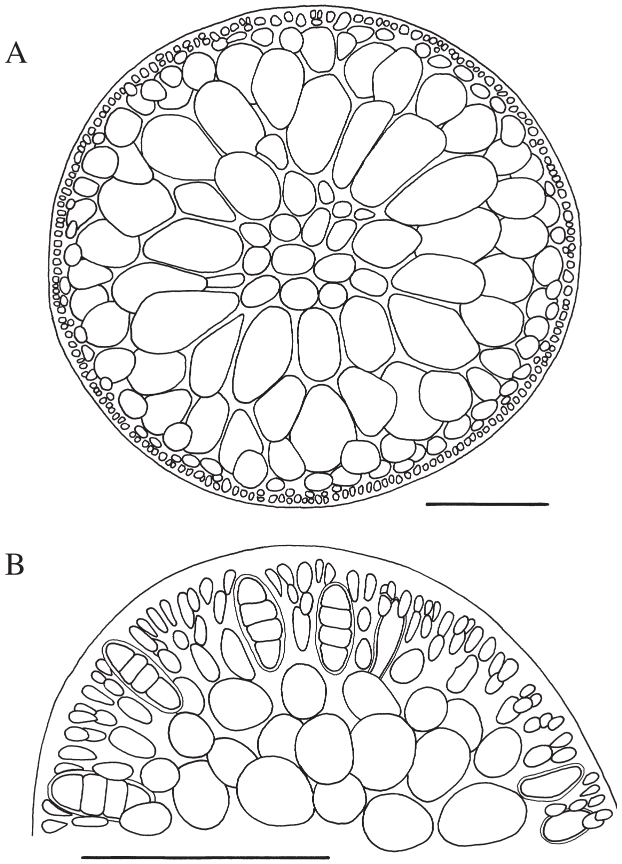

FIG. 80. – *Hypnea sp*. A. Cross section of an erect axis. B. Portion of a branch cross section with tetrasporangia. Scale bar = 150 µm.

central cells) surrounded by larger medullary cells (Papenfuss, 1947). Nevertheless, unlike our specimens, in *H. rosea* the axes are thicker, bear spine-like branchlets and often end in hooked apices. Likewise, by the presence of a central core of small cells, our specimens also agree with other species, like *H. spicifera* (Suhr) Harvey, *Hypnea chordacea* Kützing, *H. flagelliformis* J. Agardh, *H. japonica* Tanaka, *H. saidana* Holmes and *H. variabilis* Okamura. However, according to available descriptions, these species show a different habit, can reach a bigger size (up to 8-16 cm high in comparison with up to 5 cm in our specimens) and consist of relatively thicker axes (0.8-2.8 mm in diameter in comparison with 0.5-0.6 mm in our specimens).

Family KALLYMENIACEAE W.R. Taylor (1937)

During a meeting of the Phycological Society of America held at California in July 1996, the order Dumontiales, including the families Dumontiaceae, Polyideaceae, Rhizophyllidaceae and Kallymeniaceae, was proposed (Fredericq *et al.*, 1996). Since we do not know the work in which this new order is created, we prefer to follow Kraft and Robins (1985) and Saunders and Kraft (1996) and we place the family Kallimeniaceae in the order Gigartinales.

Genus *Kallymenia* J. Agardh (1842)

Key to species of *Kallymenia*:

1. Blade divided into cuneate lobes, with the distal margin entire or slightly granulate; stellate cells abundant in the medulla ....*K. schizophylla*
1. Blade divided into irregular lobes, with the distal margin usually toothed; stellate cells inconspicuous and scant in the medulla............*K. agardhii**

* *K. agardhii* was not observed. You can find more information about this taxon in Norris (1964) and Stegenga *et al.* (1997).

Kallymenia schizophylla J. Agardh (Fig. 81)

Kallymenia schizophylla J. Agardh (1848), p. 48.
Iridaea curvata Kützing (1849), p. 729.

Lectotype: Agardh Herbarium n. 24572. Table Bay, Cape Peninsula, South Africa.

Selected specimens: Möwe Bay, 5-02-1988, BCF-A 11995, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 1159, with carposporangia and spermatangia.

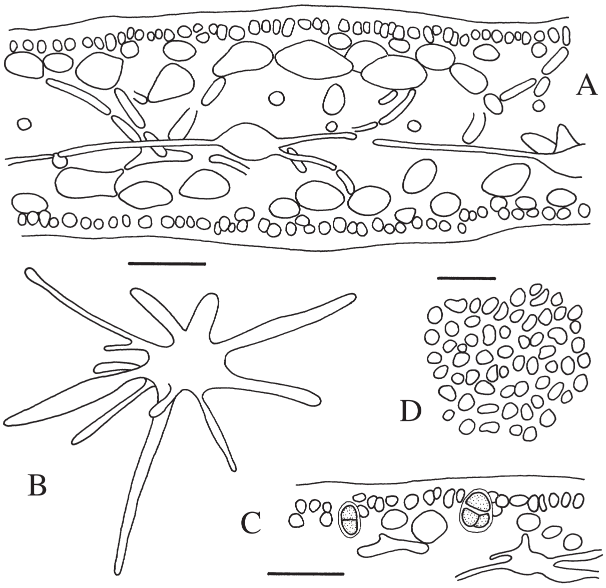

FIG. 81. – *Kallymenia schizophylla*. A. Cross section of the blade. B. Stellate medullary cell. C. Portion of a blade cross section with tetrasporangia. D. Cortical cells in surface view. A-C. Scale bar = 50 µm. D. Scale bar = 25 µm.

References: Norris (1964), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant consisting of a blade up to 12 cm high, divided into more or less cuneate lobes 1-3 cm broad, and attached to the substratum by a basal disc, without stipe; blade with the surface smooth and the margin slightly granulate. Outer cortical cells rounded or elongated in surface view, 4-10 x 4-8 µm. In cross section, blade 158-237 µm thick, differentiated into cortex and medulla; cortex 2-3 cell layers, the outer ones rounded or anticlinally elongated, 6-10 x 4-8 µm, and the inner ones elliptic or more or less isodiametric, bigger, 12-36 x 10-20; medulla filamentous, with stellate cells of long arms quite abundant; medullary filaments (2-)6-10(-16) µm in diameter, often with dense contents. In a section parallel to the blade surface, medullary filaments branched, and stellate cells with arms up to 200 µm long.

Reproduction: Tetrasporangia decussate, ovate or elliptic, 24-32 x 16-20 µm, placed among the cortical cells and occurring in sori in the blade lobes. Plant dioecious. Carpogonial branch apparatus composed of a supporting cell and several 3 celled carpogonial branches; the two lower cells of each carpogonial branch spheroid and of different size; carpogonia ending in a coiled trichogyne; cystocarps immersed, without pore, 360-500 x 300-460 µm in surface view, scattered over the whole of the blade, but more abundant in the marginal zones; carposporangia 11-14 x

8-11 µm. Spermatangia developed from the outer cortical cells, occurring in superficial sori.

Habitat: Epilithic in the upper sublittoral zone.

Namibian distribution: Lüderitz, Swakopmund, Terrace Bay (Lawson *et al.*, 1990); Möwe Bay, Rocky Point (Map 37).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); Cape Verde Islands, Senegal (Price *et al.*, 1992), Morocco (Dangeard, 1949).

Remarks: *Kallymenia schizophylla* was described by J. Agardh (1848) on the basis of material from Table Bay. Nowadays its distribution is limited to the Atlantic coasts of Africa and the Cape Verde Islands.

Our material agrees quite well with the Norris (1964) description of the species, albeit it has slightly larger tetrasporangia.

According to Norris (1964), *Kallymenia schizophylla* is very similar to the type species *K. reniformis* (Turner) J. Agardh, from which it differs in the life cycle. In this way, the former is an annual plant (at least the blade) whereas the latter is perennial.

In addition to *Kallymenia schizophylla*, the other species of this genus occurring on the south Atlantic coasts of Africa are *K. agardhii* Norris and *K. papenfussii* Norris. Both species were described by Norris (1964) on the basis of material from South Africa and at the present time its distributions are limited to the coasts of this country. According to this author, *K. agardhii* differs from *K. schizophylla* in having a thicker and more branched blade, which often has irregularly dentate margins and surface papillae. On the other hand, *K. papenfussii* differs from *K. schizophylla* by its perforate blade. However, Stegenga *et al.* (1997) held that the degree of blade perforation is very variable and they include *K. papenfussii* in *K. schizophylla*.

Family PHYLLOPHORACEAE Nägeli (1847)

Genus *Ahnfeltiopsis* P. Silva and DeCew (1992)

Silva and DeCew (1992) created the genus *Ahnfeltiopsis* in order to accommodate those species previously assigned to *Ahnfeltia* and *Gymnogongrus* that produce internal cystocarps and have a life history in which erect gametophytes alternate with a crustose tetrasporophyte (*Bonnemaisonia hamifera*-type life history). The genus *Ahnfeltia* also has this type of life history but, on the contrary, the carposporophytes are external (Maggs and Pueschel, 1989). In the genus *Gymnogongrus*, in contrast, the pustule-like tetrasporophytes (tetrasporoblast or nematecium) develop directly on gametophyte, lacking the carposporophyte (Masuda and Norris, 1994; Masuda *et al.*, 1996). On the other hand, on the basis of *rbc*L sequence analysis, Fredericq and Ramírez (1996) observed that some species with tetrasporoblasts are genetically more close to taxa bearing cystocarps than to other tetrasporoblastic species. Taking this into account, as well as the fact that the tetrasporoblasts, like cystocarps, develop from the auxiliary cells, Fredericq and Ramírez (1996) stated that the presence or absence of tetrasporoblasts cannot be used to distinguish genera. These authors also remarked that thorough morphological studies must be carried out before *Ahnfeltiopsis* and *Gymnogongrus* may be separated. At the same time, Masuda *et al.* (1996) observed that the development of the tetrasporoblasts in *Gymnogongrus griffithsiae* (Turner) Martius, the type species of the genus, is different from that of cystocarps in *Ahnfeltiopsis*, as already suggested by Masuda and Norris (1994). According to Masuda *et al.* (1996) the life history type occurring in the species of *Gymnogongrus* (*G. griffithsiae*-type) could derive from the life history type occurring in the species of *Ahnfeltiopsis* (*Bonnemaisonia hamifera*-type) through a reduction and loss of the carposporophytes or condensation of a tetrasporophyte and carposporophyte. Moreover, on the basis of morphological similarities between species of *Ahnfeltiopsis* and species of *Gymnogongrus*, Masuda *et al.* (1996) pointed out that the divergence from a life history type to other could have occurred independently several times along the evolution. If it is true, the genetic similarity between *Ahnfeltiopsis* and *Gymnogongrus* observed by Fredericq and Ramírez (1996) could be explained. However, in our opinion, this similarity should be ratified by the study of other base sequences.

In agreement with other authors (Silva and DeCew, 1992; Lewis and Womersley, 1994; Masuda and Norris, 1994; Silva *et al.*, 1996; Masuda *et al.*, 1996; Stegenga *et al.*, 1997), we treat *Ahnfeltiopsis* and *Gymnogongrus* as separate entities, since in our opinion, the life history type and the manner of development of both tetrasporoblasts and cystocarps are important enough features to distinguish them. Nevertheless, in agreement with Fredericq and Ramírez (1996) and Masuda *et al.* (1996), we hold that future studies on these taxa are required.

In this work, only the gametophyte description and distribution of both *Ahnfeltiopsis glomerata* and

A. vermicularis (the only two species found by us) are shown. However, there are some Swakopmund specimens of a crustose Rhodophyceae which could belong to the tetrasporophytic stadium of either of these two species or *A. polyclada* (Kützing) P. Silva and DeCew, the latter recorded from Namibia by Anderson and Bolton (1990). According to these authors, the tetrasporophytes of these species are morphologically and anatomically very similar and therefore difficult to distinguish. The specimens to which we refer to (5 km south of Swakopmund, 6-07-1989, BCF-A 12118, with tetrasporangia) have the following features: plant crustose, more or less soft in texture (the filaments separating under pressure); in cross section, cells of erect filaments rectangular or more or less spindle-shaped, 8-14 x 4-5 µm; tetrasporangia cruciate or decussate, spindle-shaped, 24-28 x 6-8 µm, seriate in erect filaments ending in one or more sterile cells, placed in sori.

Key to species of *Ahnfeltiopsis*:

1. Plant up to 6 cm high; axes flattened, 1-3 mm broad..*A. glomerata*
1. Plant up to 20 cm high; axes cylindrical or slightly compressed, 1-2 mm in diameter.......... ....*A. vermicularis*

In addition to the species referred to in the present study, *A. polyclada* (Kützing) P. Silva and DeCew and *A. complicata* (Kützing) P. Silva and DeCew were also recorded from Namibia. The former is similar to *A. vermicularis*, from which it differs by having secund series of short branchlets. *A. complicata* is very similar to some specimens that we have identified as *Gymnogongrus* sp. (see the remarks in this taxon).

Ahnfeltiopsis glomerata (J. Agardh) P. Silva and DeCew (Figs. 82-83)

Gymnogongrus glomeratus J. Agardh (1849), p. 88.
Ahnfeltiopsis glomerata (J. Agardh) P. Silva and DeCew (1992), p. 578.
Gymnogongrus corymbosus J. Agardh (1849), p. 88.
Chondrus coriaceus Kützing (1849), p. 736.
Gymnogongrus coriaceus (Kützing) Grunow (1867), p. 73.

Type: Agardh Herbarium n. 24204. Cape of Good Hope, South Africa.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11655, with carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11656; Mile 32, 7-07-1989, BCF-A 11657; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11816, with carposporangia; Rocky Point, 24-02-1986, BCF-A 11658, with carposporangia; Cape Frio, 23-02-1986, BCF-A 11660, with carposporangia; Angra Fria, 20-02-1986, BCF-A 11659, with carposporangia.

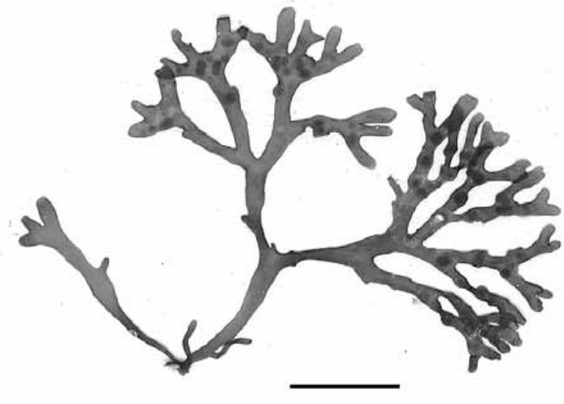

FIG. 82. – *Ahnfeltiopsis glomerata*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11655. Scale bar = 1 cm.

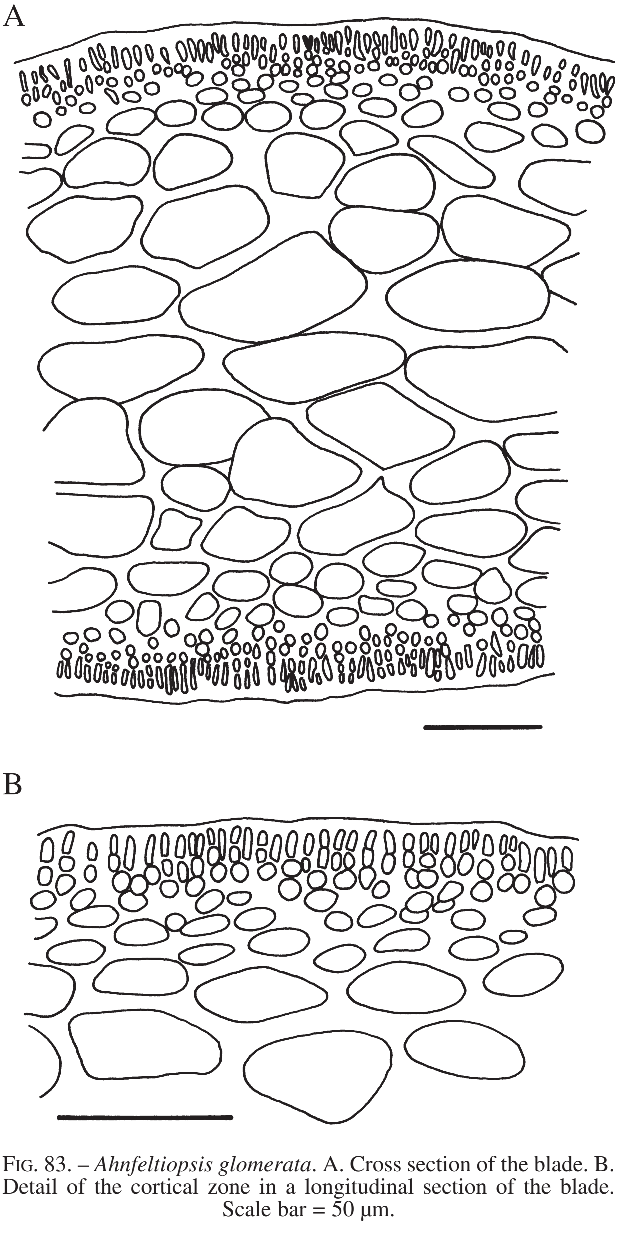

FIG. 83. – *Ahnfeltiopsis glomerata*. A. Cross section of the blade. B. Detail of the cortical zone in a longitudinal section of the blade. Scale bar = 50 µm.

References: Papenfuss (1943), Simons (1976), Branch and Branch (1981), Wynne (1986), Anderson and Bolton (1990), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, up to 6 cm high, consisting of flattened erect axes arising from a crustose base; erect axes branched, (1-)1.5-3 mm broad, tapering towards the base forming a cylindric or slightly compressed stipe about 1 mm in diameter and 1-10 mm in length; apical zone rounded, truncate or slightly emarginate, often curved; branching usually dichotomous, particularly abundant in the upper half of the plant, sometimes trichotomous, irregular or proliferous; upper interdichotomies short, showing occasionally a more or less palmate branching. Outer cortical cells rounded in surface view, 4-6 x 3-5 µm. In cross section, axes 280-400 µm thick, differentiated into medulla and cortex; medullary cells more or less polygonal, elongated, 20-108 x 12-68 µm, decreasing in size towards the cortical zone; cortex quite compact, composed of dichotomously divided anticlinal filaments (3-)4-7 cells long, the inner ones more or less isodiametric, 6-11 x 6-10 µm, and the outer elongate, 5-12 x 3-5 µm. In longitudinal section, medullary cells elongated, 40-168 x 28-72 µm, decreasing in size towards the cortex. Crustose basal zone 300-400 µm thick, consisting of basal periclinally arranged filaments given rise to closely joined, simple or slightly dichotomously branched at base erect filaments; cells of basal filaments elongated, 36-50 x 12-18 µm; cells of erect filaments more or less square, 6-12 x 8-12 µm.

Reproduction: Cystocarps immersed, protruding from the axes only for one side, without pore, 800-1100 µm in external diameter, occurring in both sides of axes; carposporangia in clusters, 8-12 x 6-10 µm. Other reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral and the upper sublittoral zones, forming more or less extensive turfs; also in tide pools.

Namibian distribution: Elizabeth Bay, Diaz Point, Lüderitz, Agate Beach, Swakopmund, Toscanini, Terrace Bay, Rocky Point, Angra Fria (Lawson *et al.*, 1990); Mile 32, Möwe Bay, Cape Frio (Map 38).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: St. Paul Island, South Africa, Mauritius, Sri Lanka (Silva *et al.*, 1996).

Remarks: *Ahnfeltiopsis glomerata* was described by J. Agardh (1849), as *Gymnogongrus glomeratus*, on the basis of material from the Cape of Good Hope and recently Silva and DeCew (1992) transferred it to the genus *Ahnfeltiopsis*. At present, the Atlantic distribution of this species is limited to the South Africa and Namibian coasts.

Papenfuss (1943) study the type specimens of both *Gymnogongrus glomeratus* and *G. corymbosus* J. Agardh and he concludes that the two taxa are conspecific, the latter only being a more divided form of the former. This opinion has been followed later by Seagrief (1984) and Silva *et al.* (1996) in their catalogues of marine algae of South Africa and the Indian Ocean respectively. On the contrary, in Namibia, Wynne (1986) and Lawson *et al.* (1990) treat *G. glomeratus* and *G. corymbosus* as two different species.

As a whole, our material is morphologically and anatomically quite homogeneous. However, the specimens from Cape Frio and Angra Fria show certain differences that must be mentioned. In these specimens the axes are slightly broader (up to 4 mm broad) and considerably thicker (600-700 µm thick opposite to 280-400 µm in the other specimens). Moreover, these specimens often bear marginal and sometimes also superficial proliferations. Lastly, lateral protuberances often occur in the inner cortical cells of these specimens in cross section. Despite these differences, we have tentatively assigned this material to *Ahnfeltiopsis glomerata*, although we think that subsequent studies could reveal that it represents a different entity. In this way, these specimens are perhaps compatible with some of those recorded by Lawson *et al.* (1990) as *Gymnogongrus* spp.

Ahnfeltiopsis vermicularis (C. Agardh) P. Silva and DeCew (Figs. 84-85)

Fucus vermicularis Turner (1811-1819), p. 61, *nom. illeg.*
Sphaerococcus vermicularis C. Agardh (1817), p. xvii.
Gymnogongrus vermicularis (C. Agardh) J. Agardh (1851), p. 323.
Ahnfeltiopsis vermicularis (C. Agardh) P. Silva and DeCew (1992), p. 578.

Selected specimens: Mile 30, 7-07-1989, BCF-A 11646, with carposporangia; Mile 32, 7-07-1989, BCF-A 11647; Cape Cross, 7-07-1989, BCF-A 11653; Mile 108, 13-07-1989, BCF-A 11648, with carposporangia; Terrace Bay, February 1986, BCF-A 11649; Möwe Bay, 25-02-1986, BCF-A 11654, with carposporangia; Rocky Point, 24-02-1986, BCF-A 11650, with carposporangia; Cape Frio, 23-02-1986, BCF-A 11651, with carposporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11652, with carposporangia.

References: Kützing (1867), Simons (1976), Anderson and Bolton (1990), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant consisting of branched, terete or slightly compressed erect axes, up to 20 cm high, attached to the substratum by means a caespitose disc; axes (0.5-)1-2 mm in diameter, thin-

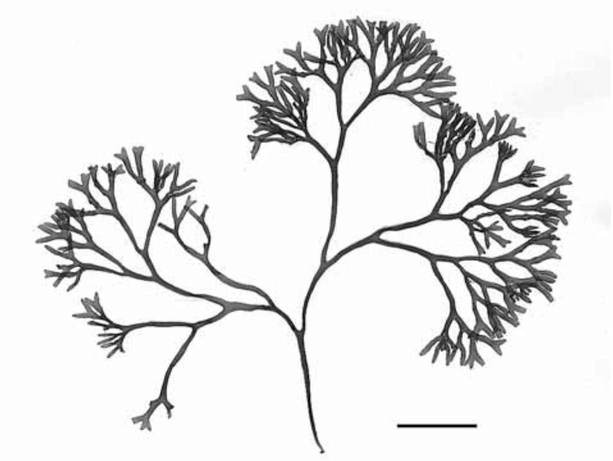

FIG. 84. – *Ahnfeltiopsis vermicularis*. Rocky Point, 24-02-1986, BCF-A 11650. Scale bar = 2 cm.

ner at base than in the middle part; branching usually dichotomous, sometimes trichotomous, irregular or proliferous from broken zones, more abundant in the upper half of the plant than in the lower one. Outer cortical cells rounded in surface view, 2-6 x 2-4 µm. In cross section, medullary cells rounded or elongated, thick-walled, 20-112 x 16-64 µm; smaller cells, 10-28 x 8-24 µm, occurring often among central medullary cells; cortex variable in thickness, composed of anticlinal rows 2-7(-14) cells long, especially developed near the cystocarps; cortical cells pigmented, 3-9 x 2-5 µm, the outer ones elongated and the inner ovate or more or less isodiametric. In longitudinal section, central medullary cells more or less fusiform, 60-240 x 20-80 µm, smaller and rounded towards the cortical zone.

Reproduction: Cystocarps immersed, protruding, 340-800 µm in diameter, without pore, usually placed in clusters in the upper half of the plant, deforming the axes; carposporangia in clusters, 8-19 x 8-15 µm. Other reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral zone, often carrying *Hypnea ecklonii* and little mussels that join the branches with each other; also in drift material.

Namibian distribution: Halifax Bay, Lüderitz, Swakopmund, Toscanini, Terrace Bay, Möwe Bay, Cape Frio, Kunene River (Lawson *et al.*, 1990); Mile 30, Mile 32, Cape Cross, Mile 108, Rocky Point, South Kunene (Map 39).

World distribution: Atlantic Ocean: South Africa, Namibia (Anderson and Bolton, 1990). Indian Ocean: St. Paul Island, South Africa, Mauritius, Sri Lanka (Silva *et al.*, 1996).

Remarks: *Ahnfeltiopsis vermicularis* is similar to *A. polyclada* (Kützing) P. Silva and DeCew, the latter described from the Cape of Good Hope by Kütz-

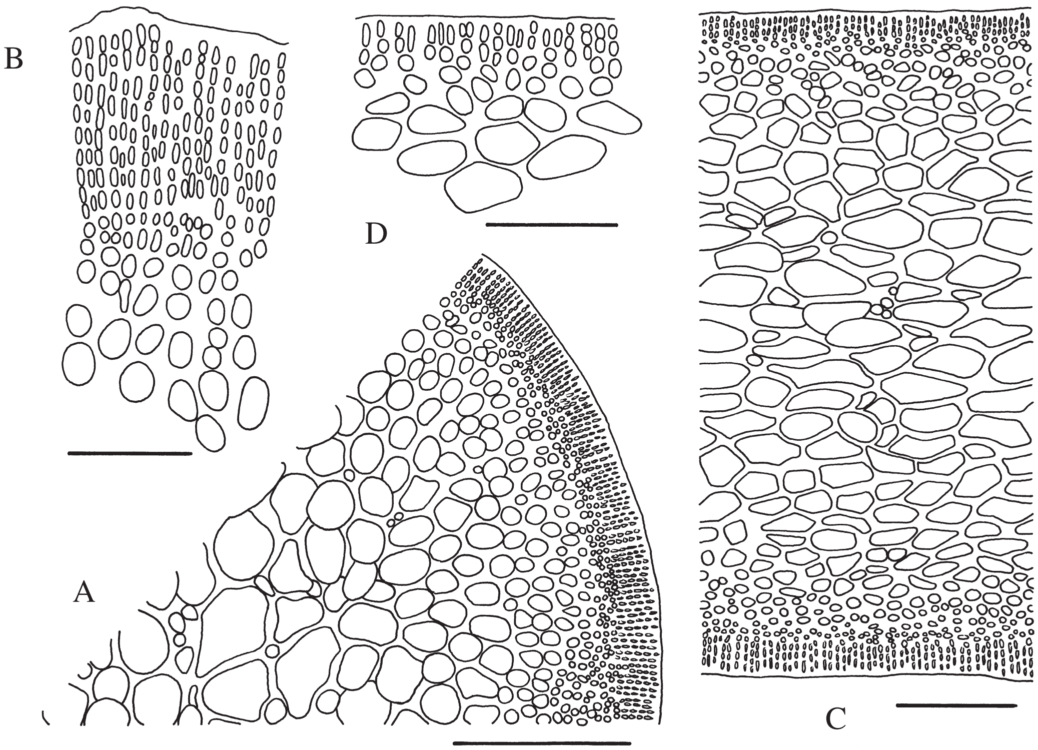

FIG. 85. – *Ahnfeltiopsis vermicularis*. A. Portion of the cross section of an axis. B. Detail of the cortical zone in cross section. C. Longitudinal section of an axis. D. Detail of the cortical zone in longitudinal section. A and C. Scale bar = 200 µm. B and D. Scale bar = 50 µm.

ing (1849) and occurring, at present, on the Atlantic coasts of Namibia and South Africa (Anderson and Bolton, 1990) as well as in Tristan da Cunha (Baardseth, 1941) and St. Paul Island (Silva *et al.*, 1996). According to Anderson and Bolton (1990), the presence of short branchlets (0.5-1 cm long) unilaterally arranged in the axes characterize this species. This feature, on the other hand, distinguishes *A. polyclada* from *A. vermicularis*.

Genus *Gymnogongrus* Martius (1833)

Key to species of *Gymnogongrus*:

1. Axes cylindric or slightly compressed, 1-2 mm in diameter ....*G.* sp.
1. Axes flattened, 5-12 mm in breadth ..*G. dilatatus*

Gymnogongrus dilatatus (Turner) J. Agardh (Figs. 86-87)

Fucus dilatatus Turner (1811-1819), p. 57.
Sphaerococcus dilatatus (Turner) C. Agardh (1817), p. xv.
Gymnogongrus dilatatus (Turner) J. Agardh (1851), p. 326.
Actinococcus latior Schmitz (1893), p. 387.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11661, with tetrasporangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11662, with tetrasporangia; Möwe Bay, 25-02-1986, BCF-A 11663, with tetrasporangia.

References: Simons (1969, 1976), Branch and Branch (1981), Wynne (1986), Anderson and Bolton (1990), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant cartilaginous, consisting of flattened erect axes 5-10 cm high and 5-12 mm broad, decreasing in breadth towards the base forming a short stipe; attachment by means a basal disc; axes dichotomously divided, sometimes bearing more or less abundant marginal proliferations, especially from broken zones; blade surface smooth; margin entire, often slightly thickened, sometimes warty at base; apical zone spatulate or slightly emarginate, occasionally curved; stipe cylindrical, up to 5 mm long and 1 mm in diameter. Outer cortical cells 4-8 x (2-)3-6(-8) µm in surface view. In cross section, blade 640-1000 µm thick, differentiated into cortex and medulla; cortex composed of dichotomously branched anticlinal filaments 5-6 cells long, the inner ones more or less iso-

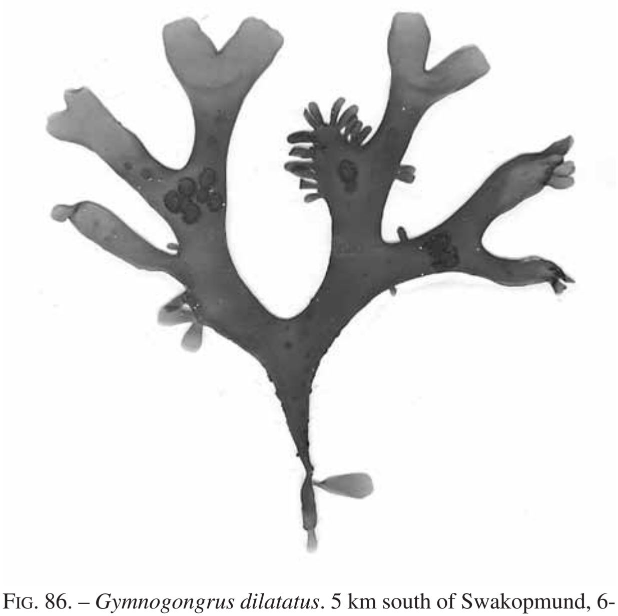

FIG. 86. – *Gymnogongrus dilatatus*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11662. Scale bar = 2 cm.

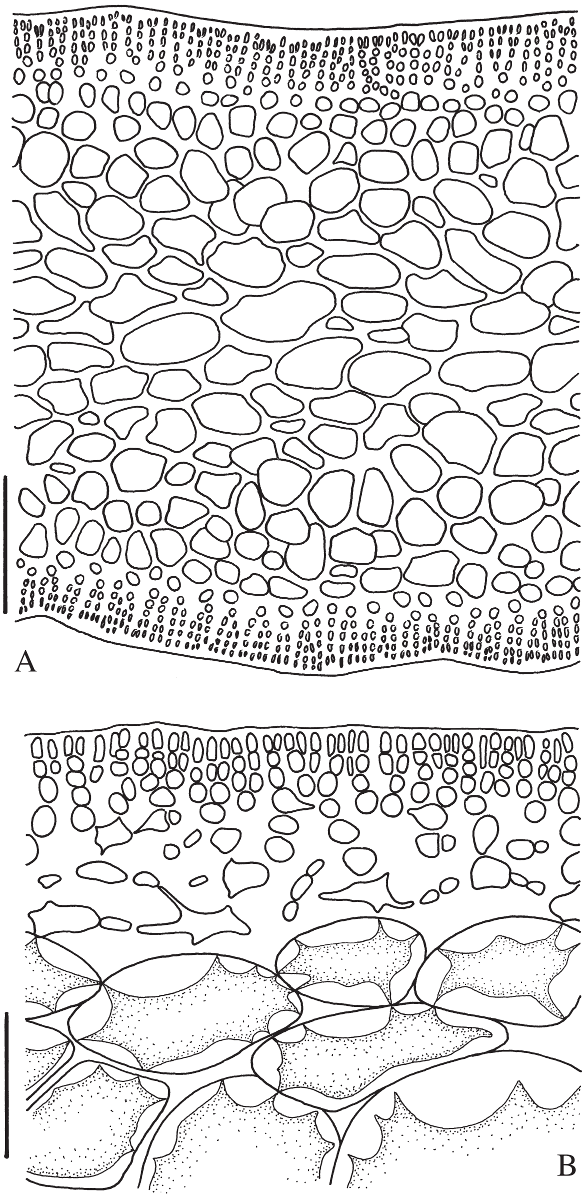

FIG. 87. – *Gymnogongrus dilatatus*. A. Cross section of the blade. B. Detail of the cortical zone in longitudinal section. A. Scale bar = 200 µm. B. Scale bar = 50 µm.

diametric, 6-11 x 6-10 µm, and the outer elongated, 4-10 x 3-4 µm; some lateral protuberances occurring in the inner cortical cells, joining the filaments with each other; medullary cells polygonal, elongated, thick-walled, 36-220 x 20-140 µm, the inner ones longer than the outer. In longitudinal section, medullary cells 60-269 x 44-119 µm.

Reproduction: Tetrasporangia cruciate or decussate, elliptic, 16-30 x 8-15 µm, formed in reddish nemathecia; nemathecia more or less hemispherical, up to 1 cm in diameter, sometimes confluent, occurring in one or both sides of the blade; in cross section, tetrasporangia placed in chain in the upper half of filaments arranged anticlinally and ending in 1-2 sterile cells; cells of nemathecium filaments cylindric, the inner ones bearing lateral protuberances. Other reproductive structures not seen.

Habitat: Epilithic in the upper sublittoral zone, between the specimens of *Laminaria pallida*; also epilithic in the lower eulittoral zone.

Namibian distribution: Lüderitz, Swakopmund, Terrace Bay (Lawson *et al.*, 1990); Langstrand, Möwe Bay (Map 40).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa, Indonesia (Java?), India (Silva *et al.*, 1996).

Remarks: *Gymnogongrus dilatatus* was described by Turner (1811-1819), as *Fucus dilatatus*, on the basis of material from the Cape of Good Hope. Weber van Bosse (1928) recorded this species from Java (with a query) and later Silva *et al.* (1996) included this citation in the catalogue of the benthic marine algae of the Indian Ocean.

On the other hand, Price *et al.* (1986) and Lawson *et al.* (1990) include former citations of *Actinococcus latior* Schmitz from Lüderitz and Walvis Bay in their catalogues. *Actinococcus latior* is the name with which the tetrasporophytic structures of *Gymnogongrus dilatatus* were formerly known (Anderson and Bolton, 1990; Silva *et al.*, 1996).

Gymnogongrus **sp.**

(Figs. 88-89)

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11642, with tetrasporangia; Mile 108, 13-07-1989, BCF-A 11643, with tetrasporangia; Möwe Bay, 25-02-1986, BCF-A 11644, with tetrasporangia; Cape Frio, 23-02-1986, BCF-A 11645, with tetrasporangia.

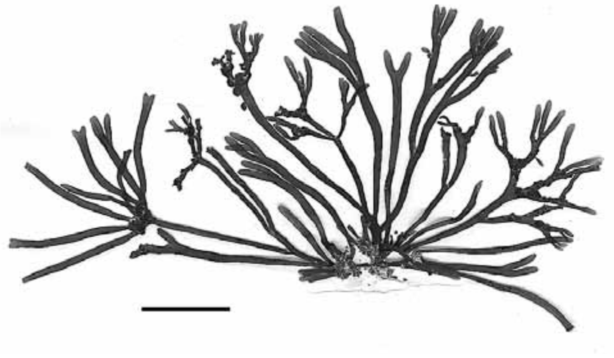

FIG. 88. – *Gymnogongrus* sp. 5 km south of Swakopmund, 6-07-1989, BCF-A 11642. Scale bar = 2 cm.

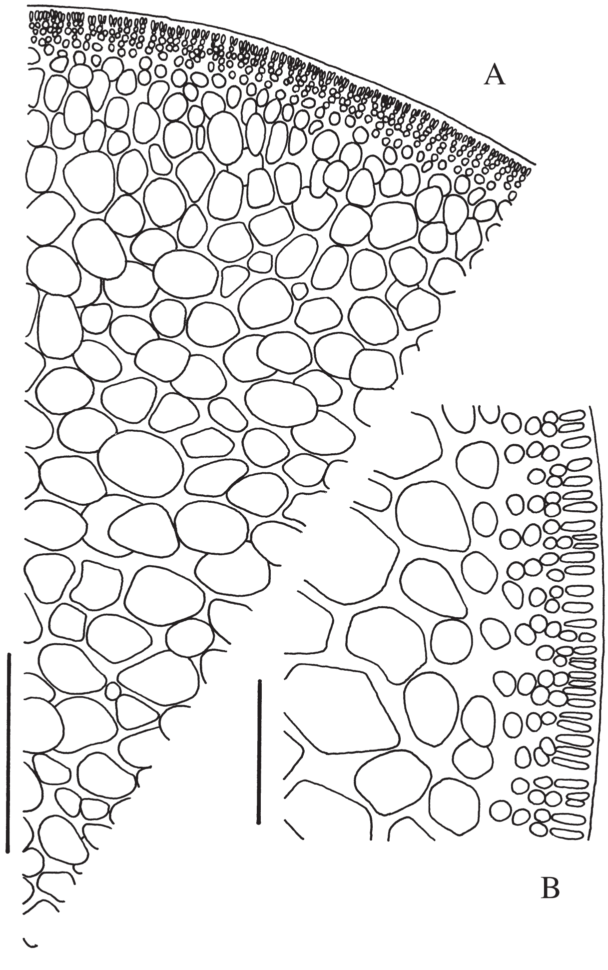

FIG. 89. – *Gymnogongrus* sp. A. Portion of the cross section of an axis. B. Detail of the cortical zone in cross section. A. Scale bar = 200 µm. B. Scale bar = 50 µm.

Habit and vegetative structure: Plant up to 12 cm high, consisting of cylindric or slightly compressed, branched erect axes 1-2 mm in diameter, attached to the substratum by means a caespitose basal disc; branching usually dichotomous, sometimes irregular, more or less lateral or proliferous from broken zones, more abundant in the upper than the lower half of the plant; axes often flattened at dichotomies;

last order branches with obtuse apex and usually slightly canaliculate. Outer cortical cells rounded in surface view, (2-) 4-6 x 3-4(-6) µm, forming a compact and homogeneous layer. In cross section, medullary cells polygonal, elliptic or more or less isodiametric, thick-walled, 36-104 x 30-88 µm; cortex composed of ill-defined, dichotomously branched, anticlinal filaments 3-6 cells long; outer cortical cells elongated, 4-14 x 2-5 µm; inner cortical cells isodiametric, 6-10 x 4-8 µm, a few bearing lateral protuberances. In longitudinal section, inner medullary cells elongated, 103-232 x 47-96 µm.

Reproduction: Tetrasporangia cruciate or decussate, elliptic, (13-)20-30 x (7-)10-12 µm, occurring in nemathecia; in cross section, tetrasporangia placed in series in the upper half of filaments anticlinally arranged and often ending in 1-2 sterile cells. Other reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral zone, together with *Ahnfeltiopsis glomerata*.

Namibian distribution: Swakopmund, Mile 108, Möwe Bay, Cape Frio (Map 41).

Remarks: Our specimens agree quite well with the illustrations and morphological remarks concerning *Ahnfeltiopsis complicata* (Kützing) P. Silva and DeCew (previously known as *Gymnogongrus complicatus* (Kützing) Papenfuss) found in the literature consulted. However, in agreement with the Namibian specimens assigned to this species by Wynne (1986), as well as with some of the South African ones studied by Stegenga *et al.* (1997), our specimens have nematecia with tetrasporangia, instead of cystocarps as was to be expected.

Among the nematecia producing species, only *Gymnogongrus dilatatus* (Turner) J. Agardh and *G. tetrasporiferus* Papenfuss ined. have been recorded from the African coasts of the southern hemisphere. The former consists of flattened axes 6-10 cm broad, in which it differs from our specimens. *G. tetrasporiferus* is an unpublished taxon from which Anderson and Bolton (1990) present both some morphological data and a photograph of the tetrasporangia. According to these authors, *G. tetrasporiferus* consists of dichotomously divided axes, 40-60 mm high and less than 1 mm thick, and has tetrasporangia 18-23 µm long. Our specimens, which basically show the same branching pattern, differ from *G. tetrasporiferus* in being more robust (with axes 1-2 mm in diameter) and in having slightly longer tetrasporangia (up to 30 µm in length).

Although our material is morphologically very similar to *Ahnfeltiopsis complicata*, we have preferred to assign it to the genus *Gymnogongrus* since, as we have already commented (page. 83), we hold that the presence of either cystocarps or nematecia is a taxonomically important feature. In the genus *Gymnogongrus*, Schotter (1968) points out the existence of morphologically similar pairs of species in which a species of the pair has internal cystocarops (now included in the genus *Ahnfeltiopsis*) and the other has nematecia. On the basis of these similarities, Masuda *et al.* (1996) hold the possibility that the species of *Gymnogongrus* had been derived from those of *Ahnfeltiopsis* several times during the evolution. In this way, it is possible that our specimens, as well as those of Wynne (1986) and some of those studied by Stegenga *et al.* (1997), had evolved from *Ahnfeltiopsis complicata* and now represent a new taxon. However, we think that a thorough comparative study of all this material, including the life history, is required in order to confirm this possibility.

Family SCHIZYMENIACEAE (Schmitz and Hauptfleisch) Masuda and Guiry (1995)
Genus *Schizymenia* J. Agardh (1851) *nom. cons.*

Schizymenia apoda (J. Agardh) J. Agardh
(Figs. 90-92)

Platymenia apoda J. Agardh (1848), p. 47.
Schizymenia apoda (J. Agardh) J. Agardh (1851), p. 175.
Platymenia undulata J. Agardh var. *obovata* J. Agardh (1848), p. 47.
Schizymenia obovata (J. Agardh) J. Agardh (1851), p. 175.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11592, with carposporangia.

References: Kylin (1932), Baardseth (1941), Simons (1976), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliose, consisting of an orbicular, irregularly sinuous blade, 5 cm high and 6.5 cm broad, shortly stipitate, attached to the substratum by a basal disc; blade surface finely granulate and somewhat perforate. Outer cortical cells elongated or isodiametric in surface view, (3-)4-5 µm in greater diameter; dark gland cells occurring in the cortex; gland cells isodiametric in surface view, 12-14 µm in diameter, scattered among the cortical cells. In cross section, blade corrugated, 500-580 µm thick, differentiated into medulla and cortex; medulla 260-320 µm thick, composed of irregularly arranged, generally unbranched filaments 8-12 µm in diameter (the lumen 2-4 µm); cortex 80-100 µm thick, composed of dichotomously branched, anticlinal filaments 8-10 cells long; inner cortical cells elongated, 12-20

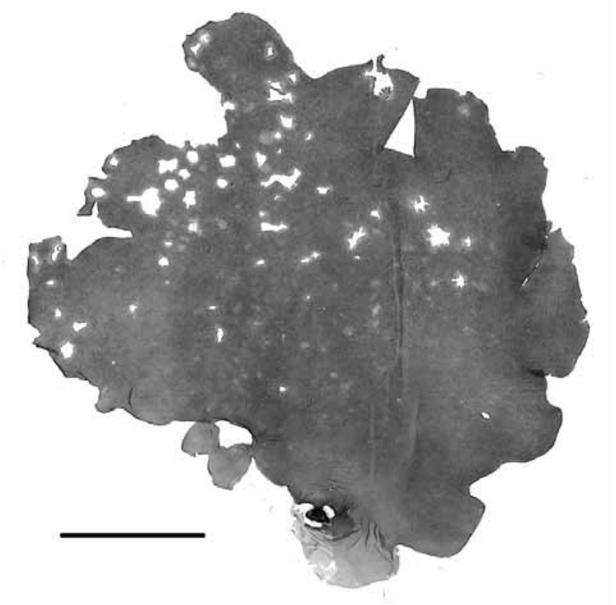

FIG. 90. *Schizymenia apoda*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11592. Scale bar = 2 cm.

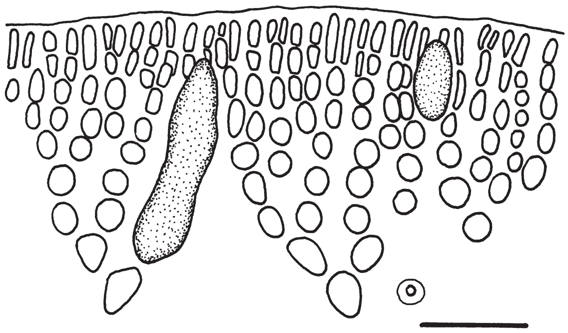

FIG. 91. *Schizymenia apoda*. Detail of the cortical zone of the blade with two gland cells, in cross section. Scale bar = 30 µm.

(-30) x 7-10 µm, a few with short protuberances; middle and outer cortical cells 5-10 x 2-10 µm, the former more or less isodiametric and the second elongated and thinner; gland cells very variable in size, elliptic or more or less clavate, 28-80 x 12-16 µm, placed among the cortical filaments, from which they arise.

Reproduction: Gonimoblasts two-lobed, globose, 79-134 µm in diameter, immersed in the outer medulla, below the cortex, and opening to the exterior through a pore 32-55 µm in diameter; carposporangia 16-38 x 16-30 µm. Other reproductive structures not seen.

Habitat: In the upper sublittoral zone.

Namibian distribution: Lüderitz, Swakopmund (Lawson *et al.*, 1990) (Map 42).

World distribution: Atlantic Ocean: Tristan da Cunha, South Africa (Stegenga *et al.*, 1997); Namibia (Lawson *et al.*, 1990). Indian Ocean: St. Paul Island, Somalia (Silva *et al.*, 1996).

Remarks: *Schizymenia apoda* (usually cited as *S. obovata* (J. Agardh) J. Agardh) was described by J. Agardh (1848), as *Platymenia apoda*, on the basis of material from Table Bay (South Africa). This is the only species of the genus occurring in the African coasts of southern hemisphere.

Our material agrees quite well with the description by Stegenga *et al.* (1997) of *Schizymenia obovata*. Likewise, the inner structure of our specimen is compatible with Wynne's (1986) illustrations of this species, albeit the lack of gland cells in the latter.

Baardseth (1941) remarks that the Tristan da Cunha plants agree well with the South African material of *Schizymenia obovata*, although in the former no glandular cells can be found. According to this author, the presence of this sort of cells in *Schizymenia obovata* is not constant, and under certain conditions they may even be absent. Likewise, gland cells may be absent in most specimens of *S. dubyi* (Chauvin ex Duby) J. Agardh from the British Isles (Dixon and Irvine, 1977), whereas in the Australian material of this species they occur in a variable frequency (Womersley and Kraft, 1994).

On the other hand, our specimens also agree quite well with the descriptions of both Dixon and Irvine (1977) and Womersley and Kraft (1994) of *Schizymenia dubyi*, with the exception of the blade shape. However, because of geographical reasons,

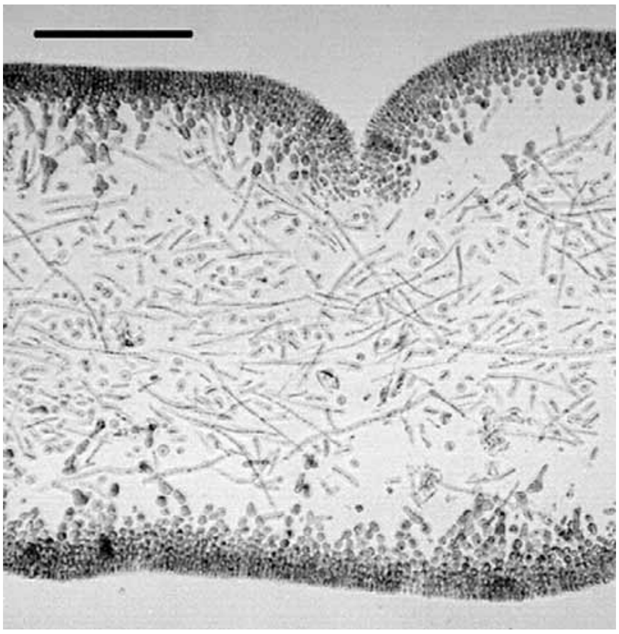

FIG. 92. *Schizymenia apoda*. Cross section of the blade. Scale bar = 160 µm.

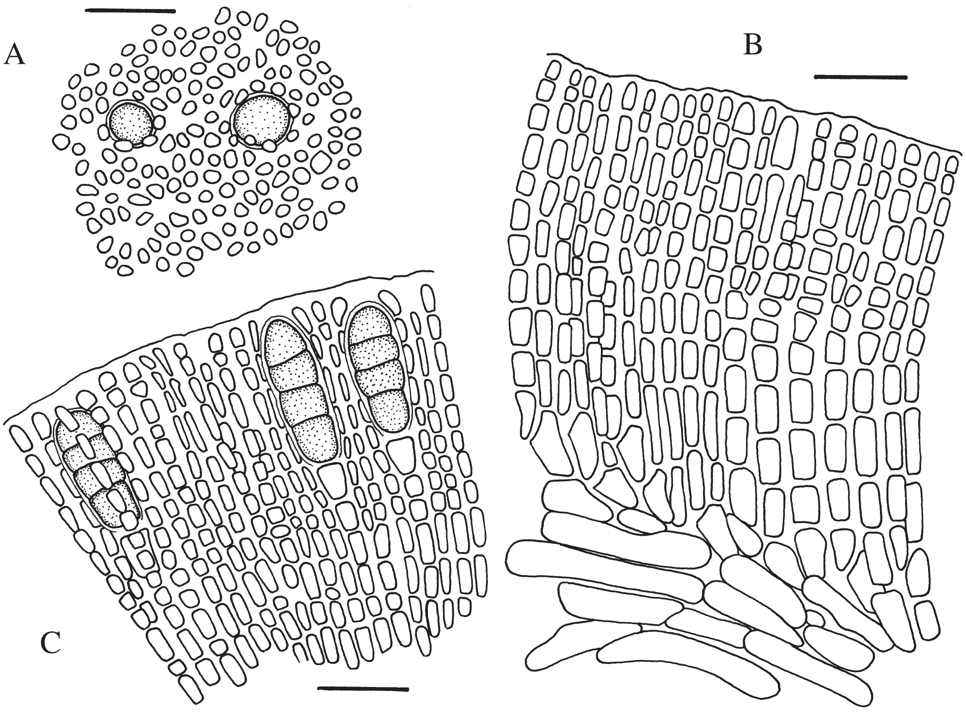

FIG. 93. – *Haematocelis epiphytica*. A. Apical cells of erect filaments and two tetrasporangia, in surface view. B. Structure of the plant, in cross section. C. Upper part of erect filaments with three tetrasporangia, in cross section. Scale bar = 30 µm.

we have preferred to assign it to *Schizymenia apoda*, waiting new studies which clarify the taxonomy of these species.

Schizymenia dubyi, the type species of the genus, shows an heteromorphic life history in which a crustose tetrasporophyte, formerly known as *Haematocelis rubens* J. Agardh, alternates with a laminar gametophyte (Sciuto *et al.*, 1979; Ardré, 1980). Moreover, Ardré (1980) remarked that *S. pacifica* (Kylin) Kylin and *S. obovata* (species with unknown tetrasporophytes) probably are the gametophytes of some of the *Haematocelis* species with which they coexist. In this way, DeCew *et al.* (1992) relate *H. rubens* from the Pacific coast of Mexico with *S. pacifica*, pointing out that both gametophytes and tetrasporophytes from the Pacific coast are anatomically very similar to the Atlantic gametophytes (*S. dubyi*) and tetrasporophytes (*H. rubens*). For this reason, DeCew *et al.* (1992) suggested the possibility that *S. dubyi* and *S. pacifica* can be conspecific.

Among our material there are some crustose plants (Möwe Bay, 5-02-1988, BCF-A 11992, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11993) which agree quite well with Baardseth's (1941) description of *Haematocelis epiphytica* and that could correspond to the *Schizymenia apoda* tetrasporophyte. These crustose plants growth on both bivalve mollusca shells and *Balanus* sp. and show the following features:

Plant crustose, forming patches up to approximately 3 cm^2 in surface that adjust to the substratum morphology of which they can be easily separated; crust surface more or less corrugated, sometimes with any wart-shaped proliferation; rhizoids absent. Cells elliptic, ovate or isodiametric in surface view, 4-12 µm in greater diameter. In cross section, crust of compact structure, 240-500 µm thick, differentiated into a multistratose basal layer of horizontally arranged filaments and a upper zone of densely packed erect filaments in which can be distinguished several horizontal bands; basal filaments branched, 8-10(-12) µm in diameter, with cells elongate, sinuous in outline, 37-74 x 8-10 µm, thick-walled and often with some refringent inclusion of great size; erect filaments arising from the basal ones, curved at base, branched; cells of erect filaments cylindrical, 4-30 x 3-10 µm, rich in storage substances; occasionally (in substrate depressions) the basal filaments give rise to descending filaments that form a structure similar to those formed by the erect filaments. Tetrasporangia cylindrical or more or less clavate, 40-72 x 14-20 µm, zonately divided, terminal in erect filaments, forming an horizontal band together paraphyses-like filaments in the outermost part of the crust, but occasionally in a lower level (Fig. 93).

Haematocelis epiphytica was described by Baardseth (1941) on the basis of material from Tristan da Cunha epiphytic on *Laminaria* sp. stipes. Until now, this species only was known from those Atlantic islands, where it coexists with *Schizymenia apoda*. Baardseth's (1941) specimens show two distinct, inner, horizontal layers of tetrasporangia instead of nemathecia, a fact which made the author doubt and assigns the species to the genus *Haematocelis* with a query. Some years later, Denizot (1968) pointed out that Baardseth's specimens actually belong to the genus *Haematocelis*, but that they do not have any significant difference with the type species *H. rubens*, and therefore must be treated as a synonym. Moreover, according to Denizot (1968) *H. rubens* is the only valid species of the genus. If correct, and since *H. rubens* is the tetrasporophytic stadium of *Schizymenia dubyi*, this species and *S. apoda* also were conspecific.

Our material is consistent with the description by Baardseth (1941) of *Haematocelis epiphytica*, except for the arrangement of the tetrasporangia, which in our specimens form an outer horizontal layer (sometimes, however, any tetrasporangium can be found in an inner position). According to Baardseth (1941), it is probable that the tetrasporangia form superficial nemathecia, but that they became overgrown by underlying tissue before they had been liberated. Denizot (1968) also pointed out the existence of inner layers of tetrasporangia in *H. rubens* and, as we have already commented, stated that no significant differences exist between these species. In this way, our material also is compatible with the description by Denizot (1968) of *H. rubens*.

Stegenga *et al.* (1997) described an unidentified species of *Haematocelis* from the Atlantic coasts of South Africa and Namibia, pointing out that it is exceedingly rich in gland cells and that it should be compared with *H. epiphytica*. Unlike the species of Stegenga *et al.* (1997), our specimens do not have rhizoids although, occasionally, some downward filaments similar to the erect ones can arise from the basal filaments. Moreover, our specimens have larger and regularly zonate tetrasporangia.

Finally, we believe that the *Schizymenia apoda* life history should be studied to know its relation to *H. epiphytica*. Likewise, a taxonomical research on the genus *Schizymenia* should be carried out, since *S. apoda* and *S. dubyi* are morphologically similar and could be conspecific, as occurs with the latter and *S. pacifica* (DeCew *et al.*, 1992).

Order PLOCAMIALES Saunders and Kraft (1994)
Family PLOCAMIACEAE Kützing (1843)
Genus *Plocamium* Lamouroux (1813) *nom cons.*

Key to species of *Plocamium*:

1. Plant with alternating secund groups of 2 laterals along axes 2
1. Plant with alternating secund groups of more than 2 laterals, at least in the upper part of axes 4

2. Axes terete ....*P. cornutum**
2. Axes compressed..3

3. Axes less than 3 mm in breadth; simple branchlets with entire or only slightly denticulate outer margin ....*P. suhrii**
3. Axes more than 5 mm in breadth; simple branchlets with a clearly dentate outer margin ....*P. corallorhiza**

4. Axes 2-3 mm in breadth ....*P. maxillosum**
4. Axes less than 2 mm in breadth........................5

5. Plant with alternating secund groups of 3-5 laterals along axes 6
5. Plant with alternating secund groups of 2 laterals in the lower part of axes and alternating secund groups of 3 laterals in the upper part ..*P. rigidum*

6. Lower lateral of each alternating secund group branched......................................*P. glomeratum*
6. Lower lateral of each alternating secund group simple....................................*P. cartilagineum**

* *P. cornutum*, *P. suhrii*, *P. corallorhiza*, *P. maxillosum* and *P. cartilagineum* were not observed. More information about *P. cartilagineum* can be found in Dixon and Irvine (1977), Lawson and John (1987), Womersley (1994) and Coppejans (1995); concerning the remaining taxa see Simons (1964) and Stegenga *et al.* (1997).

Plocamium glomeratum J. Agardh
(Fig. 94)

Plocamium glomeratum J. Agardh (1851), p. 397.
Plocamium subfastigiatum Kützing (1866), p. 18.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 11821, with tetrasporangia; Mile 30, 7-07-1989, BCF-A 11693, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11820; Rocky Point, 24-02-1986, BCF-A 11694, with tetrasporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11695.

References: Kylin (1938), Simons (1964), Stegenga *et al.* (1997).

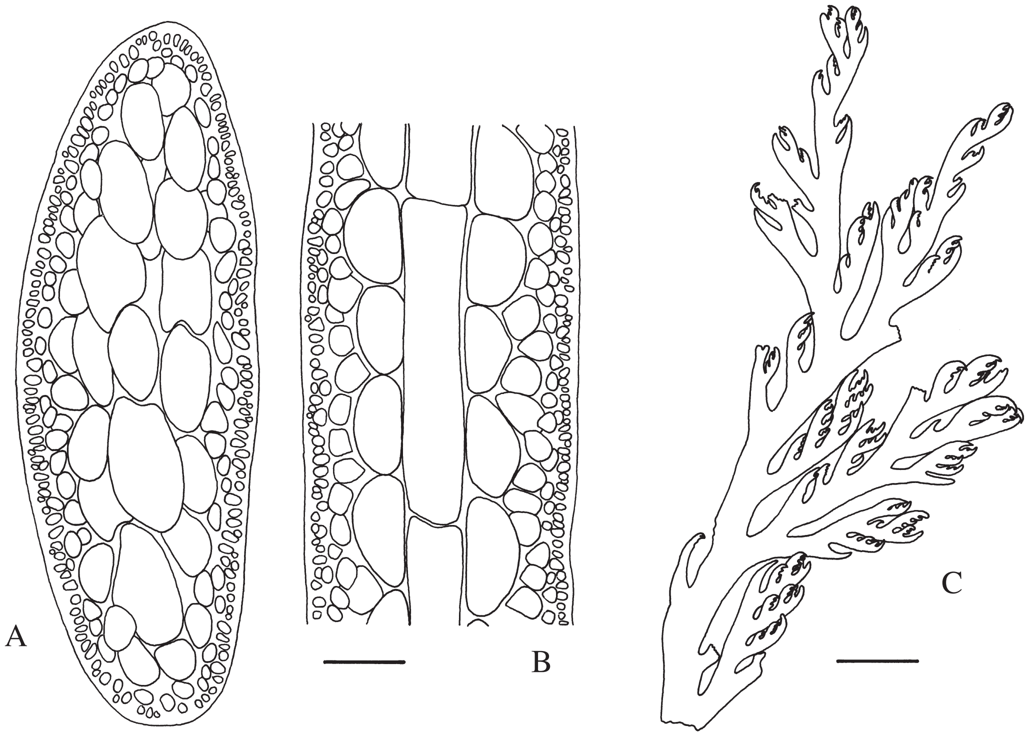

FIG. 94. – *Plocamium glomeratum*. A. Cross section of an axis. B. Longitudinal section of an axis. C. Upper part of the plant. A-B. Scale bar = 100 µm. C. Scale bar = 2 mm.

Habit and vegetative structure: Plant 3-7 cm high, consisting of branched, compressed erect axes, 0.5-1 mm broad, bearing alternating secund groups of 3-5 laterals, especially in the upper part; lower part of axes often devoid of laterals, but showing their scars; branching irregular or more or less dichotomous; laterals of each alternating secund group, including the lowest, bearing one-sided small branchlets adaxially arranged. Attachment by means of small discs. Cortical cells polygonal in surface view, 6-16 x 5-14 µm; dark cells 10-20 x 8-14 µm often scattered along axes, among the cortical cells; subcortical cells 12-32 x 10-22 µm. Plastids numerous. In cross section, axes 280-400 µm thick, differentiated into cortex and medulla; cortex composed of a single layer of pigmented, anticlinally elongated cells 8-28 x 6-18 µm; medulla composed of an elliptic axial cell 72-152 x 40-92 µm surrounded of several elliptic cells 36-160 x 28-120 µm; subcortical cells elliptic or more or less isodiametric, 16-60 x 12-44 µm. In longitudinal section, axial filament clearly visible, flanked by a layer of relatively big, more or less elliptic cells 87-159 x 47-79 µm; axial cells rectangular, 198-411(-537) x 55-95(-119) µm.

Reproduction: Tetrasporangia zonate, ellipsoid or more or less cylindrical, 56-100 x 32-72 µm, placed in two rows in the upper part of fertile branchlets occurring adaxially in the laterals; fertile branchlets cylindrical, up to 1600 µm long and 120-140 µm in diameter, fairly branched and more or less entangled; tetraspores often several times divided inside the tetrasporangia. Other reproductive structures not seen.

Habitat: In the lower eulittoral zone; in tide pools, between the specimens of *Ahnfeltiopsis glomerata*; also in drift material, epiphyte on *Ahnfeltiopsis vermicularis*.

Namibian distribution: Swakopmund (Lawson *et al.*, 1990); Mile 30, Möwe Bay, Rocky Point, South Kunene (Map 43).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa, Mozambique, Madagascar (Silva *et al.*, 1996).

Remarks: *Plocamium glomeratum* was described by J. Agardh (1851) on the basis of material from the Cape of Good Hope. At present, its distribution is limited to the coasts of southern Africa and Madagascar. In Namibia, until now, this species had been only recorded from Swakopmund (Lawson *et al.*, 1990).

P. glomeratum is similar to *P. cartilagineum* (Linnaeus) Dixon. This is a species widespread in temperate seas (Womersley, 1994) that also has been recorded from Namibia (as *P. vulgare* Lamouroux) by Lawson *et al.* (1990). *P. glomeratum* differs from *P. cartilagineum* mainly in the fertile branchlets morphology and in having the lower branchlet of each group of limited growth branches ramified. On the other hand, Baardseth (1941) described *P. fuscorubrum* from Tristan da Cunha and remarked that this species is similar to *P. glomeratum*, from which it differs in being essentially taller and in having broader and coarser fertile branchlets.

Plocamium rigidum Bory de Saint-Vincent (Figs. 95-96)

Plocamium rigidum Bory de Saint-Vincent (1834), p. 164.
Plocamium latiusculum Kützing (1866), p. 17.
Plocamium condensatum Kützing (1866), p. 17.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12120, with tetrasporangia; Swakopmund, beach, 8-07-1989, BCF-A 11697, with carposporangia; Mile 30, 7-07-1989, BCF-A 11698, with tetrasporangia and carposporangia; Möwe Bay, 5-02-1988, BCF-A 11825, with tetrasporangia and carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11823, with tetrasporangia and carposporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11822, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11699, with tetrasporangia.

References: Kylin (1938), Simons (1964, 1969, 1976), Branch and Branch (1981), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 11 cm high, consisting of branched, compressed erect axes 1-1.5(-2) mm broad, usually bearing alternating secund groups of 2 laterals in the lower part and alternating secund groups of 3 laterals in the upper part; occasionally, distribution of groups of laterals not so clear, with groups of 2 laterals along whole of the plant alternating with some group of 3 laterals in the upper part of axes; lower lateral of each alternating secund group simple and subulate, the remaining bearing one-sided small branchlets adaxially arranged; lower part of axes often devoid of branches but showing their scars; sometimes branching proliferous. Attachment by means of small discs developed in irregularly branched prostrate axes thinner than the erect ones. Cortical cells more or less isodiametric, elliptic or triangular in surface view, the outer loosely arranged, 5-15 x 4-10 µm, and the inner bigger and more compactly arranged, 8-24 x 6-20 µm. Plastids numerous. In cross section, axes 360-760 µm thick, differentiated into cortex and medulla; cortical cells pigmented, elongated or more or less isodiametric, 8-34(-46) x 4-16 µm, not horizontally aligned; medulla composed of an elliptic axial cell (64-)132-216 x 64-100 µm surrounded of several polygonal, elongate or more or less isodiametric cells (52-)88-192 x 48-140 µm, the outer smaller than the inner; axial cell sometimes difficult to distinguish; subcortical cells 16-60(-92) x 14-44 (-92) µm. In longitudinal section, axial filament more or less visible, composed of elongate cells 261-521 x 55-95 µm; medullary cells polygonal, those close to axial filament elongated and the remainder smaller and more or less isodiametric.

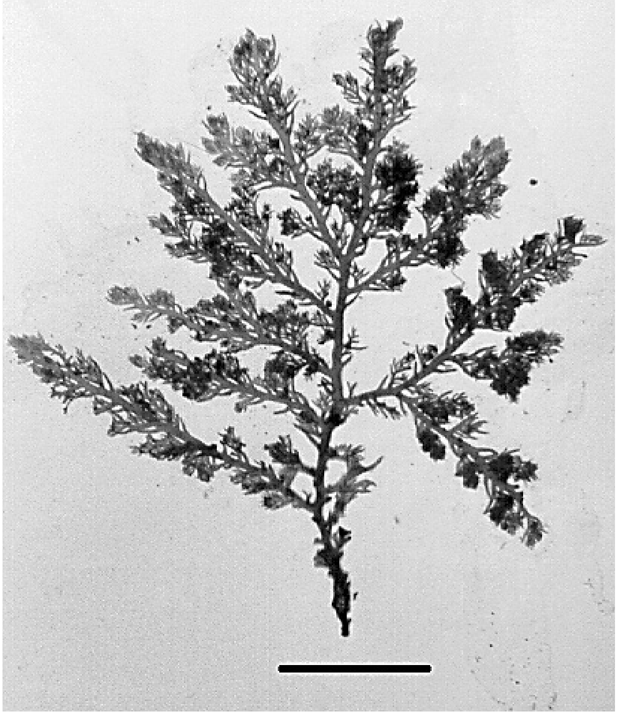

FIG. 95. – *Plocamium rigidum*. 5 km south of Swakopmund, 6-07-1989, BCF-A 12120. Scale bar = 2 cm.

Reproduction: Tetrasporangia zonate, more or less cylindrical, 48-92 x 30-68 µm, placed in two rows in short fertile branchlets adaxially arranged in last order branches; fertile branchlets cylindric or compressed, one or two times divided. Cystocarps globose, 700-1400 µm in external diameter, laterally arranged in both main axes and branches; carposporangia ovate, pear-shaped, clavate or more or less isodiametric, 32-68(-92) x 24-44(-64) µm, placed in branched chains; occasionally, carpospores several times divided inside the cystocarp. Spermatangia not seen.

Habitat: In the upper sublittoral zone, often epiphyte on *Rhodymenia obtusa* or growing on *Laminaria pallida* haptera. On vertical walls of tide pools, epiphyte on *Ahnfeltiopsis glomerata*. Also occurring in drift material.

Namibian distribution: Lüderitz, Swakopmund, Torra Bay, Terrace Bay, Möwe Bay, Rocky Point (Lawson *et al.*, 1990); Mile 30 (Map 44).

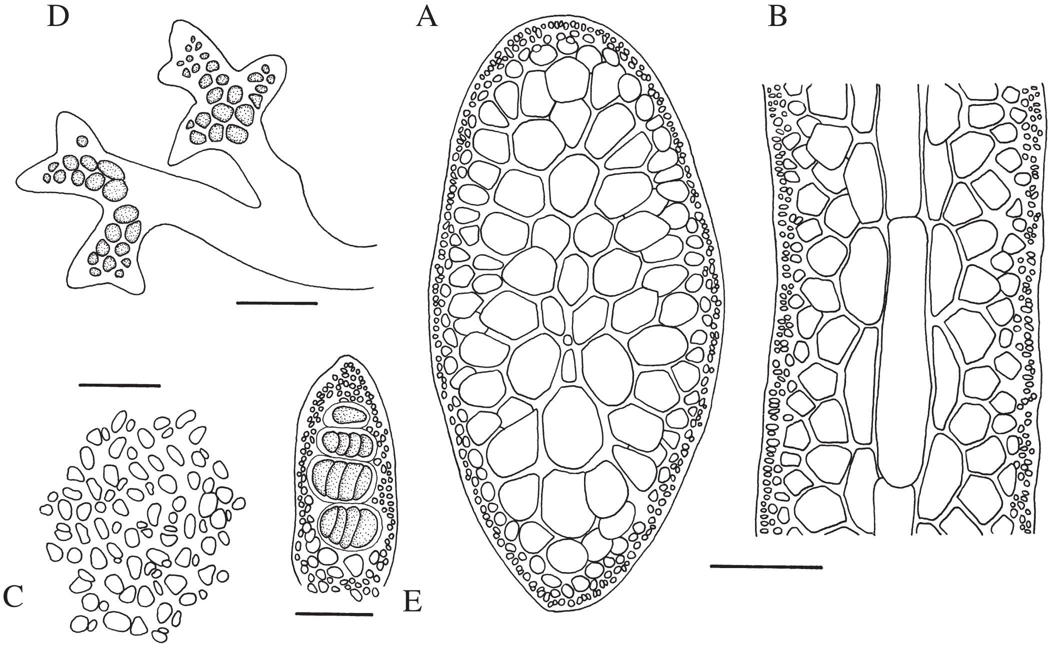

FIG. 96. – *Plocamium rigidum*. A. Cross section of an axis. B. Longitudinal section of an axis. C. Cortical cells in surface view. D. Branchlet with tetrasporangia. E. Longitudinal section of a branchlet with tetrasporangia. A, B, D. Scale bar = 200 µm. C. Scale bar = 50 µm. E. Scale bar = 100 µm.

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: Amsterdam Island, South Africa (Silva *et al.*, 1996).

Remarks: *Plocamium rigidum* was described by Bory de Saint-Vincent (1834) on the basis of material from the Cape of Good Hope and, at present, its distribution is limited to the coasts of Namibia and South Africa, as well as to the Amsterdam Island.

Our specimens are compatible with the descriptions of both Simons (1964) and Stegenga *et al.* (1997) of this species, as well as with the illustrations showed in the literature consulted. Simons (1964) remarked that *P. rigidum* is a very variable species and that its limits are difficult to establish. This author also stated that *P. rigidum* is similar to *P. cornutum* (Turner) Harvey, the latter occurring on the southwestern coasts of the Indian Ocean (Silva *et al.*, 1996) and on the Atlantic coasts of South Africa and Namibia (Stegenga *et al.*, 1997). According to Simons (1964), in *P. cornutum* the alternating groups of laterals consist mostly of two, whereas they consist of three in the upper part of the axes in *P. rigidum*. Moreover, Stegenga *et al.* (1997) pointed out that in *P. cornutum* the axes are cylindrical and not complanate, whereas they are compressed and largely complanate in *P. rigidum*. Among our material, there are specimens in which secund groups of two laterals alternate along the whole of the plant, with some scattered groups of three laterals in the upper part. However, as they consist of compressed axes and its habit is more similar to that of *P. rigidum* than that of *P. cornutum*, we have preferred to assign them to the former species.

On the other hand, and according to the literature consulted, *P. rigidum* does not seem very different from *P. telfairiae* (W. Hooker and Harvey) Harvey ex Kützing, the latter being widespread in many warm temperate and tropical seas (Lawson and John, 1987). The main difference between both species lies in the branching pattern. Like this, whereas in *P. telfairiae* groups of two laterals alternate along the whole of the plant, in the upper part of axes of *P. rigidum* the alternation is in groups of three laterals. In this way, those of our specimens in which the branchlets alternate basically in groups of two could belong to *P. telfairiae*. However, as this species has not been previously cited from Namibia, and as we hold that a more thorough study of the species of this genus in this geographical area should be carried out, we prefer to assign these specimens tentatively to *P. rigidum*.

Order RHODYMENIALES Schmitz in Engler (1892)
Family CHAMPIACEAE Kützing (1843)
Genus *Gastroclonium* Kützing (1843) *nom. cons.*

Gastroclonium reflexum (Chauvin) Kützing (Figs. 97-98)

Lomentaria reflexa Chauvin (1831), fasc. 6, no. 143.
Gastroclonium reflexum (Chauvin) Kützing (1849), p. 866.

Lectotype: CN (Herb. Lenormand). France.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 9610, with polysporangia; Swakopmund, beach, 8-07-1989, BCF-A 9607, with polysporangia and spermatangia; Mile 32, 7-07-1989, BCF-A 9612, with polysporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 12006, with polysporangia and carposporangia; Rocky Point, 24-02-1986, BCF-A 9609, with carposporangia and spermatangia; Angra Fria, 20-02-1986, BCF-A 9611, with polysporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 9606, with carposporangia.

References: Ercegovic (1956), Ardré (1970), Irvine and Guiry (1983).

Habit and vegetative structure: Plant up to 3.5 cm high, consisting of generally reflexed tubular branches arising from a solid stipe attached to the substratum by a disc or a more or less rhizoidal holdfast. Stipe simple or usually branched, terete, (0-)2-10(-22) mm long and 340-840 µm in diameter. Tubular branches terete, 540-1420 µm in diameter, simple or branched, constricted at regular intervals, arcuate, sometimes coalescent, often tapering towards the apex, and ending in secondary attachment pads that occasionally given rise to new stipes; tubular branches consisting of (3-)4-7(-15) more or less barrel-shaped segments, 0.7-4.6 times longer than broad; plant irregularly branched, with branches dichotomously divided or placed in groups, opposite or more or less verticillate, often isolate or paired on convex side of reflexed axes. Outer cortical cells polygonal in surface view, those of the stipe 16-44(-52) x (10-)12-28(-32) µm and those of the tubular branches (8-)12-56(-60) x (5-)8-28(-36) µm. In cross section, stipe medullary cells polygonal, elongate or more or less isodiametric, 28-116 x 24-92 µm, and the cortical ones, 14-44 x (10-)12-40 µm; cortical zone of tubular branches (2-)3 layered, the outer layer generally continuous, with cells elongated, (16-)18-48(-52) x (8-)12-36 µm, anticlinally arranged; inner cortical cells elliptic or subspherical, 28-72(-86) x (22-)24-72 µm. In longitudinal section, tubular branches with monostromatic septa at the constrictions; medullary filaments (10-)16-20(-32) µm in diameter, longitudinally arranged along the inner walls of the tubular branches, bearing gland cells 20-30 µm in diameter.

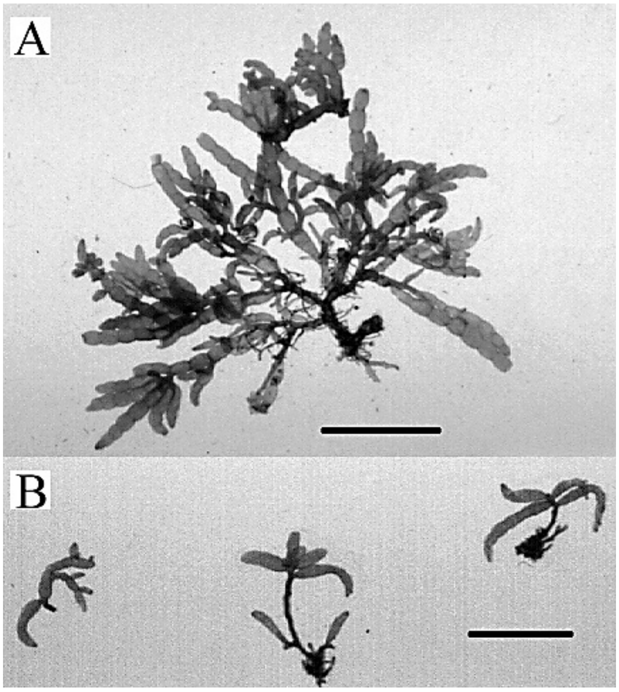

FIG. 97. – *Gastroclonium reflexum*. A. Mile 32, 7-07-1989, BCF-A 9612. B. Swakopmund, beach, 8-07-1989, BCF-A 9607. Scale bar = 1 cm.

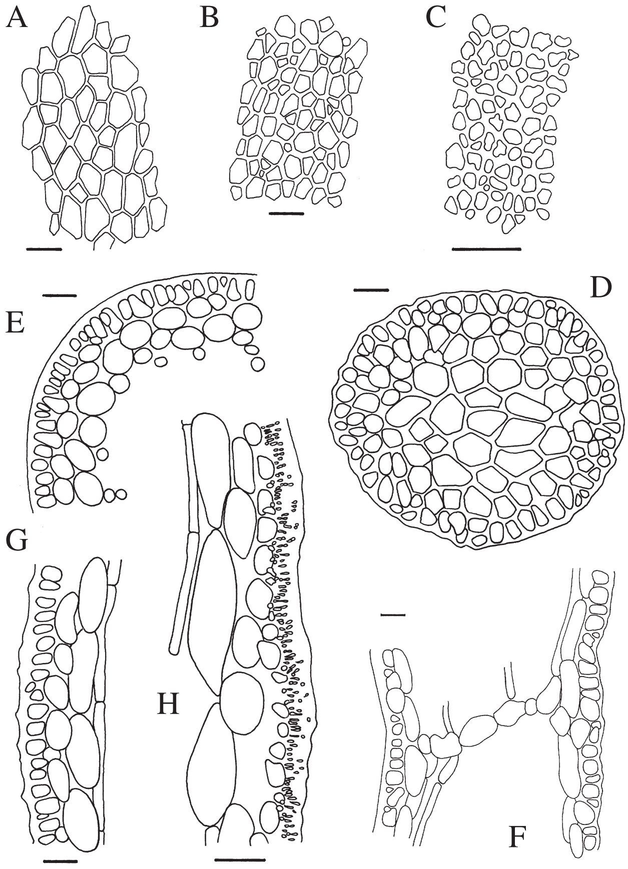

FIG. 98. – *Gastroclonium reflexum*. A-C. Outer cortical cells of a tubular branch, in surface view. A. Basal zone. B. Median zone. C. Upper zone. D. Cross section of the stipe. E. Portion of the cross section of a tubular branch. F. Longitudinal section of a tubular branch through a septum. G. Portion of the longitudinal section of a tubular branch. H. Portion of a longitudinal section of a tubular branch with spermatangia. Scale bar = 50 µm.

Reproduction: Polysporangia with 8-16 spores, spherical or ellipsoidal, (64-)80-158 x 60-126(-134) µm, immersed in the cortex of tubular branches. Plant dioecious. Cystocarps spherical, 540-660 µm in diameter, without ostiole; carposporangia trapeziform or more or less cuneiformis, 96-132 x 52-96 µm. Spermatangia elongate, arranged in superficial sori on the tubular branches.

Habitat: Epilithic or epiphytic on several algae in the lower eulittoral zone and in tide pools; also in drift material.

Namibian distribution: Swakopmund, Mile 32, Möwe Bay, Rocky Point, Angra Fria, South Kunene (Map 45).

World distribution: Atlantic Ocean: Namibia; Canary Islands (Pinedo *et al.*, 1992); Morocco? (Dangeard, 1949); north-western of Iberian Peninsula (Barbara, 1993); Portugal, France, Ireland, England, Norway? (South and Tittley, 1986). Mediterranean Sea (Giaccone *et al.*, 1985; Boudouresque and Perret-Boudouresque, 1987; Perret-Boudouresque and Seridi, 1989; Ballesteros, 1990). Adriatic Sea (Giaccone, 1978). Black Sea (Kalugina-Gutnik, 1975).

Remarks: *Gastroclonium reflexum* occurs basically along the eastern Atlantic coasts of the northern hemisphere and in the Mediterranean Sea. Anderson and Stegenga (1989) cited this species from the southern hemisphere (Indian coast of South Africa) for the first time. These authors remarked that the species is frequent in the studied area and that it had been possibly mistaken formerly for *Chylocladia capensis* Harvey. According to Anderson and Stegenga (1989), *G. reflexum* differs from *C. capensis* by its curved and secondarily attached axes, its smaller size, and the presence of polysporangia rather than tetrasporangia. These authors do not mention the existence of a solid stipe, a feature which defines the genus *Gastroclonium* (Kützing, 1843). Subsequently, Stegenga *et al.* (1997) cancel out the citation of Anderson and Stegenga (1989), pointing out that in the eastern Cape the habit of *C. capensis* is similar to that of *G. reflexum* (the species is shorter and caespitose, with branches usually recurved) and that in the west coast *C. capensis* also forms polysporangia.

G. reflexum had not been previously recorded from Namibia. However, according to our own data, it is a quite frequent species on the coasts north of Walvis Bay. It is possible that this species had been previously mistaken for either *C. capensis* or the material assigned to *Chylocladia* sp. by Lawson *et al.* (1990), the former recorded from Lüderitz and Swakopmund (Lawson *et al.*, 1990) but not found among our material.

Gastroclonium reflexum is morphologically and anatomically very similar to both *G. cylindricum* Santelices, Abbott and Ramírez and *G. trichodes* (Pujals) Santelices, Abbott and Ramírez. *G. cylindricum* occurs on the Pacific coasts of South America and it differs from *G. reflexum* by the habit, the branching type, the inner morphology and by the exclusive presence of polysporangia (Santelices *et al.*, 1989). According to Irvine and Guiry (1983), who typify *G. reflexum*, the cortex of the tubular branches in this species consists of two cell layers, the outer often incomplete. However, we had the opportunity to study some of Chauvin's specimens of this species (included the isotype BM 5029) and we have observed, in contrast, that the cortex of the tubular branches of these specimens consists of 2-3 cell layers and that the outer layer is continuous. On the other hand, we also had the opportunity to study the holotype of *G. cylindricum* (SGO 106271, march 1986, La Pampilla, Coquimbo; Chile) which showed us that its inner structure is very similar to that of Chauvin's specimens studied and that, contrary to the opinion of Santelices *et al.* (1989), both taxa are morphologically very similar and produce the same sort of reproductive structures. Concerning *G. trichodes*, a species described by Pujals (1967) as *Coeloseira trichodes* and occurring only on the coasts of Argentina, the study of the type material (BA 8685, 30-11-1951, General Alvarado, Miramar, Buenos Aires) showed that this species does not differ significantly from *G. reflexum*.

Finally, *G. reflexum* also shows a certain similarity with *G. pacificum* (Dawson) Chang and Xia. This is a Pacific species occurring in Mexico, Peru and Japan, and that it can develop both erect and reflex forms. In this way, *G. reflexum* is morphologically and anatomically very similar to the reflexed specimens of *G. pacificum*.

Family RHODYMENIACEAE Harvey (1849)

Genus *Rhodymenia* Greville (1830) *nom. cons.*

Key to species of *Rhodymenia*:

1. Plant with blades of more than 1 cm in breadth .. ..*R. obtusa*
1. Plant with blades of less than 1 cm in breadth ..2

2. Plant stoloniferous ....*R. natalensis*
2. Plant not stoloniferous 3

3. Blade regularly dichotomous divided, fan-shaped ....*R. pseudopalmata**
3. Blade irregularly dichotomous divided, not fan-shaped...*R. capensis*

* In addition to the species referred to in this key, *R. linearis* was also recorded from Namibia. This New Zealand species, which is very similar to *R. capensis*, has only been recorded in Namibia from Swakopmund by Wynne (1986). This author mainly used the arrangement of tetrasporangia to assign his specimens to *R. linearis* instead of to *R. capensis* (see remarks in *R. capensis*). *R. pseudopalmata* was not observed. More information about this taxon can be found in Irvine and Guiry (1983) and Stegenga *et al.* (1997).

Rhodymenia capensis J. Agardh
(Figs. 99-100)

Rhodymenia capensis J. Agardh (1894), p. 58.
Epymenia capensis (J. Agardh) Papenfuss (1940a), p. 222.
Epymenia stenoloba Schmitz ex Mazza (1907), p. 191.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12121, with tetrasporangia; Swakopmund, beach, 8-07-1989, BCF-A 12008, with spermatangia; Mile 30, 7-07-1989, BCF-A 12009, with tetrasporangia, carposporangia and spermatangia.

References: Kylin (1931), Papenfuss (1940a), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 16 (-24) cm high, consisting of several divided, stipitate erect blades, (1-)2-5(-6) mm broad, arising from a caespitose discoidal base. Blades usually up to six times dichotomously or pseudodichotomously divided; occasionally branching unilateral, alternate or more or less palmate, often proliferous; apical zone spathulate or slightly emarginate, sometimes ending in a more or less long linear prolongation. Stipe terete, up to 3 cm long and 0.5-1 mm in diameter, usually branched, progressively enlarged upwards to form the blade. Outer cortical cells elongated or more or less isodiametric, 4-14 x 3-8(-11) µm, loosely arranged. In cross section, structure differentiated into medulla and cortex; polygonal or rounded, elliptic or more or less isodiametric, those of the stipe 18-56 x 16-56 µm, and those of the blade 28-76(-108) x 20-64 µm; cortical cells elongated or isodiametric, without order, those of the stipe 4-10 x 3-6 µm, and those of the blade 4-9 x 3-8 µm; transitional zone between cortex and medulla with rounded or elongate cells 5-28 x 4-24 µm. In longitudinal section, blade 200-420 µm thick, with elliptic or more or less fusiform medullary cells 64-244 x 32-72 µm and elongate or isodiametric cortical cells 4-12 x 3-8 µm; cells of the transitional zone between cortex and medulla elongated, 10-68(-112) x 5-40 µm.

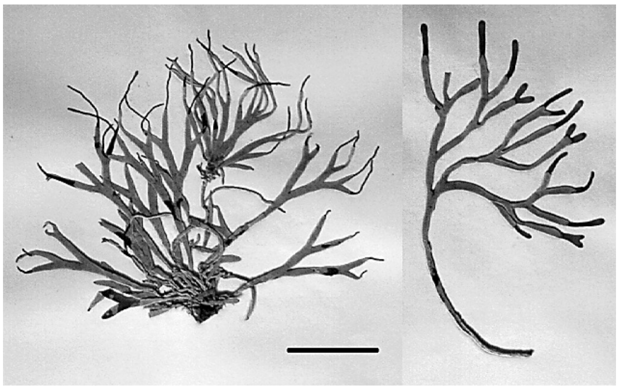

FIG. 99. – *Rhodymenia capensis*. 5 km south of Swakopmund, 6-07-1989, BCF-A 12121. Scale bar = 5 cm.

Reproduction: Tetrasporangia cruciate or decussate, elliptic, 24-46 x 14-20 µm, occurring in sori in the blade apices or in small blade proliferations; fertile proliferations marginal or apical, blade-like, more or less orbicular. Cystocarps globose or hemispherical, 600-800(-1020) µm in diameter, with ostiole, placed in small blade proliferations, in linear prolongations of the blade apex or directly over the blade; carposporangia 11-22 x 9-17 µm. Spermatangia elongated, placed in sori in small blade proliferations.

Habitat: In the upper sublittoral zone. Also in drift material, growing on mussel shells and almost completely covered by bryozoans.

Namibian distribution: Walvis Bay (Lawson *et al.*, 1990); Swakopmund, Mile 30 (Map 46).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia. Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Rhodymenia capensis* was described by J. Agardh (1894) on the basis of material from the Cape of Good Hope. Later, Papenfuss (1940a) examined J. Agardh's material and observed that the reproductive structures occur in proliferations arising from the blade surface. This feature defined the genus *Epymenia* and differred it from *Rhodymenia*. Therefore, Papenfuss (1940a) transferred the species to the genus *Epymenia* designating as the type the specimen No. 26950 of J. Agardh's Herbarium, which appear photographed in Kylin (1931). Sparling (1957) stated that in this species, as well as in *Epymenia obtusa*, cystocarps can also occur on the blade. This author remarked that *E. capensis* can represent a transitory stadium between *Epymenia* and *Rhodymenia*. More recently, Womersley (1996)

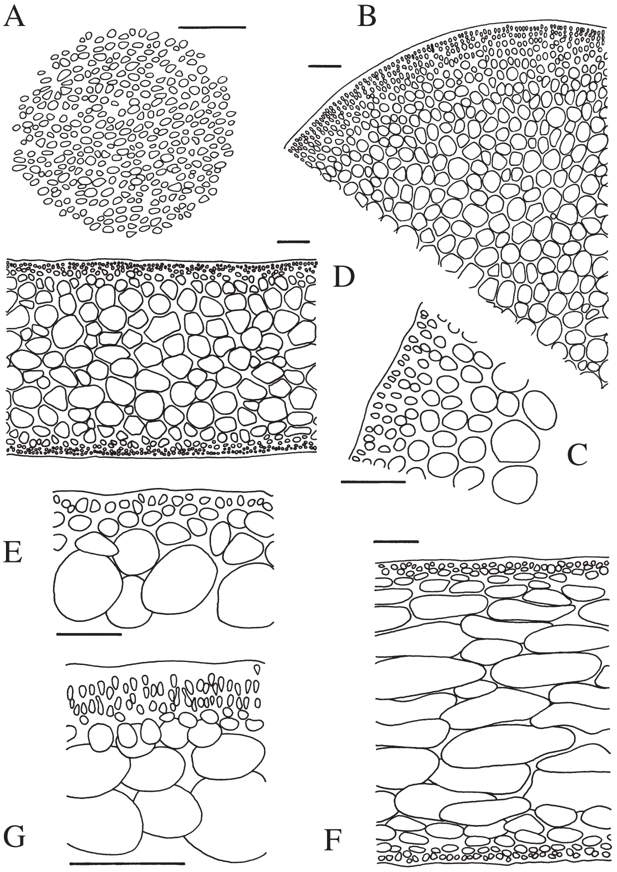

FIG. 100. – *Rhodymenia capensis*. A. Outer cortical cells in surface view. B. Portion of a cross section of the stipe. C. Detail of the stipe cortical zone, in cross section. D. Cross section of the blade. E. Detail of the blade cortical zone, in cross section. F. Longitudinal section of the blade. G. Portion of a cross section of a fertile proliferation with spermatangia. Scale bar = 50 µm.

pointed out that the arrangement of the reproductive structures in proliferations is not a good character to distinguish both genera since, as Sparling (1957) had already stated, there are species in which the reproductive structures may be formed either on the blade itself or in proliferations. For this reason, Womersley (1996) included *Epymenia* in *Rhodymenia*, a fact subsequently corroborated by Saunders *et al.* (1999) using molecular data.

Among our material there are specimens in which the reproductive structures occur in small marginal or superficial proliferations of the blade, whereas in others these structures develop directly on the blade. Since as a whole they do not show neither morphological nor anatomical appreciable differences, and as we have also observed specimens in which the reproductive structures occur either on the blade or in proliferations, we have preferred to follow Womersley (1996) and assign our material to *Rhodymenia*.

The distribution of *Rhodymenia capensis* is limited to the coasts of South Africa (probably mainly a south coast species) and Namibia. In the South African west coast it only occurs in the southern half of the Cape Peninsula (Stegenga *et al.*, 1997) and in Cape Hangklip (Jackelman *et al.*, 1991). In Namibia, this species had only been recorded until now from Walvis Bay (Delf and Michell, 1921).

On the other hand, Wynne (1986) cited *Rhodymenia linearis* J. Agardh from Swakopmund, pointing out that the specimens suggest *E. capensis* but that the arrangement of the reproductive structures and its long stipe agree with *R. linearis*. We had the opportunity to study Wynne's material and we have observed that the specimens are morphologically and anatomically similar to ours, although they have narrower blades (2-3 mm in comparison with 2-5 mm in our material). The only reproductive structures present in Wynne's material are tetrasporangia, which occur in sori at the ends of the blades. It is possible that this fact was the main feature used by Wynne (1986) to assign his specimens to *R. linearis* rather than *E. capensis*. However, as we have already commented, the arrangement of the reproductive structures does not seem to be a good character to distinguish both genera. Moreover, the distribution of *R. linearis* is possibly limited to New Zealand (Womersley, 1996), even though Jackelman *et al.* (1991) cite this species from the south west coast of South Africa.

All things considered, we have preferred to assign our specimens to *Rhodymenia capensis*, although we hold, in agreement with Womersley (1996), that a taxonomical research on the genus *Rhodymenia* (including *Epymenia*) should be carried out in this geographical area.

Rhodymenia natalensis Kylin
(Figs. 101-102)

Rhodymenia natalensis Kylin (1938), p. 13.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 12015; Swakopmund, beach, 8-07-1989, BCF-A 12016; Mile 30, 7-07-1989, BCF-A 12017, with tetrasporangia and carposporangia.

References: Kylin (1938), Simons (1969, 1976), Branch and Branch (1981), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant stoloniferous, 3-8 cm high, consisting of one or more stipitate blades, (1.5-)2-3(-4) mm broad, attached to the substratum by means of both a discoidal caespitose base and branched stolons arising from the stipe; blades up to four times dichotomously divided, with round-

FIG. 101. – *Rhodymenia natalensis*. Mile 30, 7-07-1989, BCF-A 12017. Scale bar = 3 cm.

ed or truncate apices and progressively attenuate at base. Stipe terete, branched, 440-840 µm in diameter; stolons cylindrical, about 0.5 mm in diameter, reflexed, up to 3.5 cm in length. Outer cortical cells rounded, elongated or more or less isodiametric in surface view, 4-12 x 2-8 µm. In cross section, structure differentiated into medulla and cortex. Blade 220-400 µm thick; medullary cells polygonal, more or less isodiametric, (20-)44-104 x 20-76 µm; cortical cells 4-9 x 3-8 µm, more or less arranged in two irregular layers; transitional zone between cortex and medulla with cells ovate or elliptic, 5-22 x 4-14 µm. Medullary cells of the stipe rounded or polygonal, ovate or approximately isodiametric, 20-60(-84) x 16-48(-72) µm; subcortical cells 5-20 x 4-16 µm; cortical cells 4-10 x 3-5(-8) µm. In longitudinal section, blade structure similar, but with elongate medullary cells, (80-)108-224 x 40-72 µm, and subcortical cells also elongated, 6-72 x (4-)6-16 µm.

Reproduction: Tetrasporangia cruciate or decussate, elliptic, 24-34 x 14-19 µm, placed in sori in the apical zone of the blades. Cystocarps globose, with ostiole, 500-600 µm in diameter, scattered over the blade or placed in blade margins; carposporangia 12-18 x 10-15 µm. Spermatangia not seen.

Habitat: Growing on vertical walls of tide pools. Also present in drift material, often associated with sponges.

Namibian distribution: Swakopmund (Wynne, 1986); Mile 30 (Map 47).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia. Indian Ocean: South Africa, Mozambique (Silva *et al.*, 1996).

Remarks: *Rhodymenia natalensis* was described from Durban (east coast of South Africa) by Kylin (1938). At present, its distribution virtually includes the whole of the Southern African coasts (Stegenga *et al.*, 1997). Wynne (1986) cited this species from Swakopmund, pointing out that he also had found specimens from the Cape of Good Hope area.

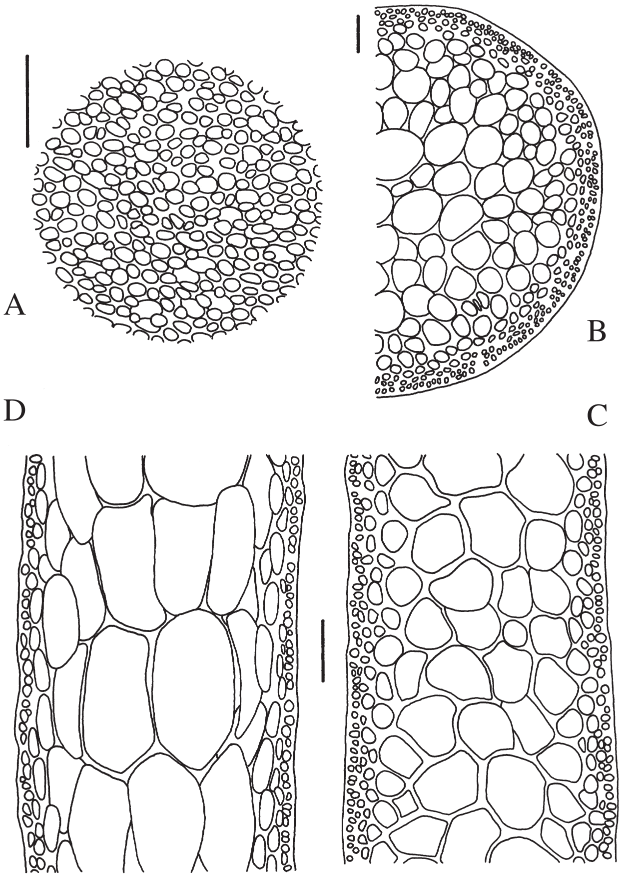

FIG. 102. – *Rhodymenia natalensis*. A. Outer cortical cells in surface view. B. Portion of a cross section of the stipe. C. Cross section of the blade. D. Longitudinal section of the blade. Scale bar = 50 µm.

Our specimens agree quite well with Wynne's (1986) observations on this species, although they are slightly taller and show broader blades [up to 8 cm high and 2-3 mm broad, opposite to 4-5 cm high and 1-2 mm broad according to Wynne (1986)]. Since we had the opportunity to study Wynne's material (MICH, without number) we have observed, moreover, that our specimens also have thicker blades (220-400 µm thick in comparison with 160 µm in Wynne's specimens). This difference in the blade thickness could be due to environmental differences (Sparling, 1957). However, concerning the plant habit our specimens are practically identical to those of Wynne (1986).

On the other hand, our material also agrees quite well with *R. leptophylla* J. Agardh. This species occurs mainly in New Zealand and Australia and, according to the illustrations and descriptions consulted, it seems not to differ significantly from *Rhodymenia natalensis*. Likewise, Namibian specimens are also similar to the European species *R. holmesi* Ardissone and *R. coespitosella* L'Hardy-Halos, but the former has broader and thinner blades (5 mm broad and 100-150 µm thick) and the latter smaller medullary cells (45-65 x 25-30 µm).

Rhodymenia obtusa (Greville) Womersley
(Figs. 103-104)

Phyllophora obtusa Greville (1831), p. 148.
Epymenia obtusa (Greville) Kützing (1849), p. 787.
Rhodymenia obtusa (Greville) Womersley (1996), p. 79.

Selected specimens: Langstrand, 6-07-1989, BCF-A 12010, with tetrasporangia; 5 km South of Swakopmund, 6-07-1989, BCF-A 12011, with tetrasporangia and carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 12012, with tetrasporangia and carposporangia; Mile 30, 7-07-1989, BCF-A 12013, with carposporangia; Möwe Bay, 5-02-1988, BCF-A 12014, with carposporangia.

References: Kylin (1931), Sparling (1957), Chapman and Dromgoole (1970), Simons (1969, 1976), Branch and Branch (1981), Wynne (1986), Adams (1994), Womersley (1996), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 37 cm high, consisting of one or more stipitate blades (0.7-) 1-3(-3.5) cm broad, attached to the substratum by a discoid holdfast; blades elongated, with the apex spathulate or emarginate and the base cuneate, usually dichotomously divided, sometimes more or less palmate, often proliferous; proliferations arising from the blade surface or from broken apical zones. Blade with smooth surface and entire margin; fertile specimens with clusters of small proliferations longitudinally arranged along the central axis of the blade, especially in the lower half of the plant. Stipe terete, 0.5-2.7 cm long and 1.5-2.5 mm in diameter, simple or branched, occasionally prolonged as an inconspicuous midrib in the lower part of some blades. Outer cortical cells of the blade ovate or elliptic in surface view, 4-10 x 3-6 µm. In cross section, structure differentiated into medulla and cortex. Blade 280-420 µm thick; medullary cells polygonal or rounded, ovate elliptic or isodiametric, 30-112(-136) x (20-)28-92(-100) µm; cortical cells

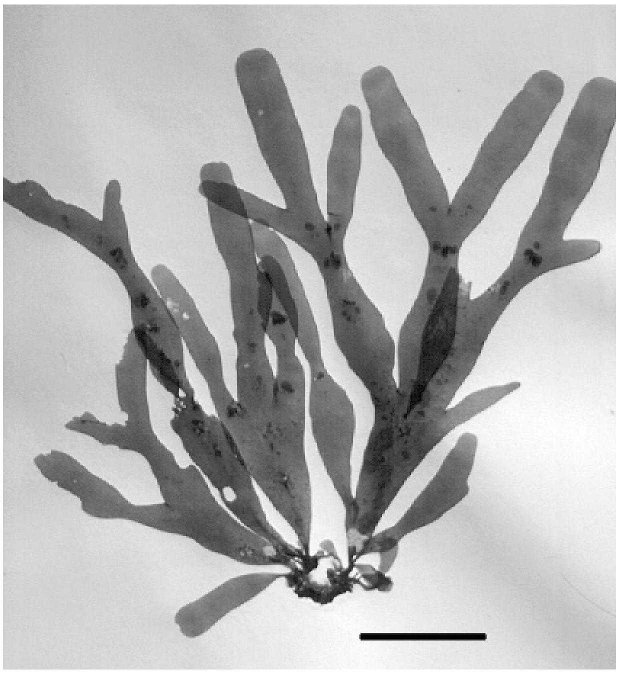

FIG. 103. – *Rhodymenia obtusa*. 5 km south of Swakopmund, 6-07-1989, BCF-A 12011. Scale bar = 5 cm.

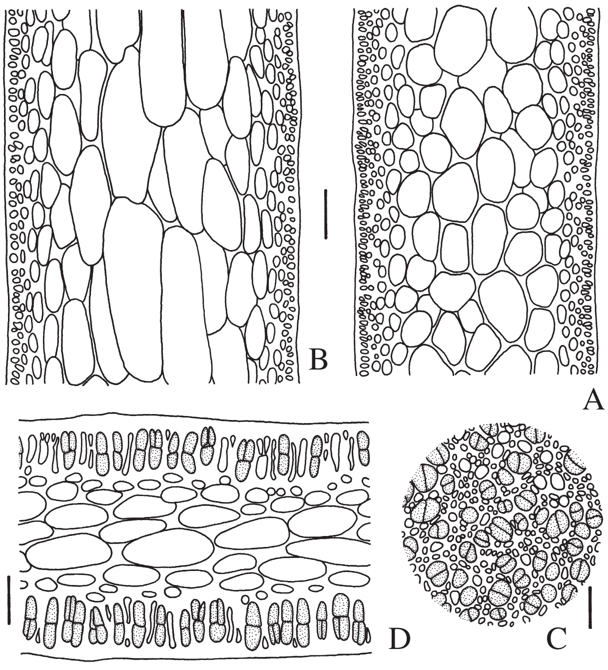

FIG. 104. – *Rhodymenia obtusa*. A. Cross section of the blade. B. Longitudinal section of the blade. C. Tetrasporangia in surface view. D. Cross section of a fertile proliferation with tetrasporangia. A, B, D. Scale bar = 50 µm. C. Scale bar = 25 µm.

elongated, 5-11 x 2-6 µm, anticlinally arranged in 1-2 irregular layers; transitional zone between cortex and medulla with more or less elliptic cells 8-32 x 6-24 µm. Stipe medullary cells rounded or polygonal, more or less isodiametric, 16-76 x 14-60 µm; cortical zone consisting of a more or less wide strip of radially arranged elongate cells, the inner ones bigger than the outer. In longitudinal section, blade medullary cells elongated, 72-288 x 32-92 µm.

Reproduction: Reproductive structures developed in small proliferations of the blade surface. Tetrasporangia cruciate, usually decussate, elliptic, 28-60 x 14-24 µm, formed in rounded or reniform, stipitate, laminar proliferations about 2 mm in diameter and 200-240 µm thick. Cystocarps globose, 740-1200 µm in diameter, formed in small laminar proliferations, deforming them; carposporangia 16-36 x 12-28 µm. Spermatangia not seen.

Habitat: Epilithic or growing on mussel shells in the upper sublittoral zone, among the *Laminaria pallida* specimens; frequent in drift material; often almost completely covered by bryozoans.

Namibian distribution: Elizabeth Bay, Lüderitz, Swakopmund, Terrace Bay (Lawson *et al.*, 1990); Langstrand, Mile 30, Möwe Bay (Map 48).

World distribution: Atlantic Ocean: South Argentina (Pujals, 1977); Uruguay (Coll and Oliveira, 1999); South Africa, Namibia (Stegenga *et al.*, 1997). Pacific Ocean: South Australia, Tasmania (Womersley, 1996); New Zealand (Adams, 1994).

Remarks: *Rhodymenia obtusa* was described by Greville (1831), as *Phyllophora obtusa*, on the basis of material from the Cape of Good Hope. Later, Kützing (1849) created the genus *Epymenia* and established the combination *Epymenia obtusa*, the name by which the species was known in South Africa and Namibia until a few years ago. Recently, Womersley (1996) included *Epymenia* in the genus *Rhodymenia* (see remark in *R. capensis*), to which he transferred the species with the name *R. obtusa* (Greville) Womersley.

Silva *et al.* (1996) remarked that the occurrence of *R. obtusa* in the Indian Ocean is only due to an erroneous citation from Natal (east coast of South Africa) and, accordingly, these authors excluded *R. obtusa* from that Ocean.

Rhodymenia obtusa is very similar to the Tristan da Cunha species *Epymenia elongata* Baardseth. Baardseth (1941), who described the species, remarked that *E. elongata* is similar to *E. membranacea* Harvey and *E. wilsonis* Sonder (at present both synonymous of *R. obtusa*) but that it differs from these species in lacking a midrib in the base of the blades and because the latter are narrower. According to Sparling (1957) these features are variable and their importance in the species distinction should be confirmed. In agreement with this author, we hold that these characteristics are few stable and that themselves do not distinguish species. Hence, it is probable that *E. elongata* also can be treated as a synonym of *R. obtusa*, although we think that a thorough study on these species should be carried out.

Rhodymeniaceae ind.
(Fig. 105)

Selected specimens: Möwe Bay, 4-02-1988, BCF-A 12119, with tetrasporangia.

References: Stegenga *et al.* (1997).

Habit and vegetative structure: Plant 1.2 cm high, consisting of a stipitate, simple or divided, cuneate blades 2-3 mm broad, with smooth surface and entire margin, attached to the substratum by a basal disc; branching more or less dichotomous, proliferous from broken zones; blades occasionally coalescent; stipe cylindric, simple or branched, 0.5-1 mm in length. Outer cortical cells elliptic or rounded in surface view, 4-7 x 4-6 µm, loosely arranged. In cross section, blade 140-160 µm thick,

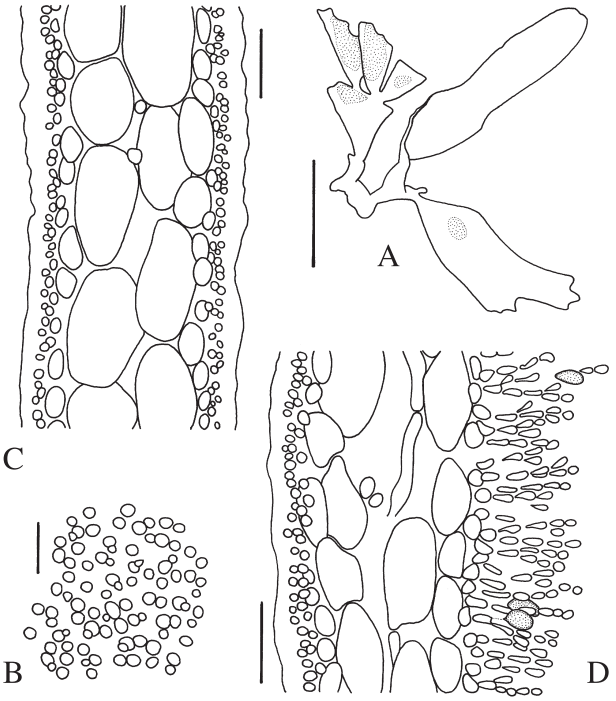

FIG. 105. – Rhodymeniaceae ind. A. Habit. B. Outer cortical cells in surface view. C. Cross section of the blade. D. Cross section of the blade through a tetrasporangial sorus. A. Scale bar = 5 mm. B. Scale bar = 25 µm. C-D. Scale bar = 50 µm.

up to 200 µm thick in fertile areas, differentiated into medulla and cortex; medulla composed of two layers of loosely arranged elliptic cells, 48-88 x 28-48 µm; sometimes, some small cells or some filament occurring among the big medullary cells; cortex composed of 1-2 ill-defined layers of pigmented and rounded cells, 4-6 µm in diameter; subcortical cells 12-34 x 8-20 µm. In a section parallel to the blade surface, medullary cells polygonal with rounded angles, elliptic or more or less isodiametric, 84-132 x 68-104 µm; some short branched filaments occurring among medullary cells; cells of filaments irregular in shape or more or less elongated, 6-10 µm in diameter.

Reproduction: Tetrasporangia cruciate or decussate, oblong, 30-38 x 20-26 µm, formed in elongate sori placed in the central part of the blade, leaving a sterile marginal band; sori occurring in one or both sides of the blade; in cross section, sori similar to nemathecia, with the tetrasporangia placed between dichotomously branched filaments. Other reproductive structures not seen.

Habitat: In the upper sublittoral zone.

Namibian distribution: Möwe Bay (Map 49).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997). Namibia.

Remarks: Our material, which is represented only by one specimen, agrees quite well with the Stegenga *et al.* (1997) description and illustrations of a undetermined Rhodymeniaceae from the west coast of South Africa. However, the Namibian specimen is smaller (1.2 cm high in comparison with up to 5 cm in the South African material), it consists of a relatively thinner blade (140-160 µm thick in comparison with 200-300 µm) and it has shorter tetrasporangia (30-38 x 20-26 µm in our specimen in comparison with 60 x 30 µm in the South African material). Moreover, according to Stegenga *et al.* (1997), some inconspicuous gland cells occur into the central cavity in the South African material, whereas they were not observed in our specimen.

Anatomically, the Namibian specimen also agrees quite well with the cross section photograph of *Leptofauchea anastomosans* (Weber-van-Bosse) Norris et Aken showed by Norris and Aken (1985). However, the habit of this plant is different from that of our specimen.

Like the South African material, our specimen does not have cystocarps, and therefore it is not possible to assign it definitely to any genus. Stegenga *et al.* (1997) remarked that anatomically their specimens are reminiscent of the genus *Chrysymenia*, but that concerning reproductive structures, they are similar to *Fauchea*.

Order CERAMIALES Oltmanns (1904)
Family CERAMIACEAE Dumortier (1822)
Genus *Aglaothamnion* Feldmann-Mazoyer (1941)

Aglaothamnion hookeri (Dillwyn) Maggs and Hommersand (Fig. 106)

Conferva hookeri Dillwyn (1809), pl. 106.
Callithamnion hookeri (Dillwyn) S. Gray (1821), p. 324.
Aglaothamnion hookeri (Dillwyn) Maggs and Hommersand (1993), p. 102.

Lectotype: TCD, Hooker and Borrer, Cawsie, undated.

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11774, with carposporangia.

References: Dixon and Price (1981), Stegenga (1986), Wynne (1986), Lawson and John (1987), Maggs and Hommersand (1993) Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, forming small tufts 3-7 mm high, attached to the substratum by rhizoids. Erect axes alternately branched, distichous, bearing a branch in every cell; basal cell (and often next 2-3 cells) of the first and second order branches usually devoid of laterals; last order branchlets sometimes secund, adaxial. Cells of the main axis 60-176 x 52-88 µm, 1.5-2.6 times longer than broad in the lower half of the plant, and more or less as long as broad in the upper half; branch cells 1.5-2.1 times longer than broad, 52-80 x 32-40 µm; main axis apical cell 12-32 16-20 µm, not overtopped by its young laterals, which often reach the apical cell level; branch apical cell 20-40 x 20-24 µm. Rhizoidal filaments multicellular, simple or branched,

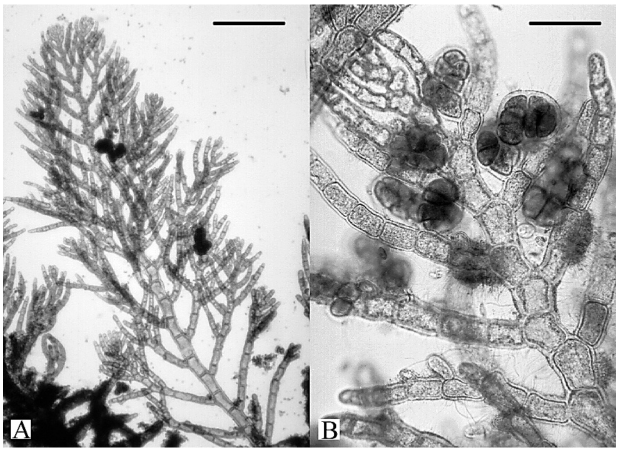

FIG. 106. – *Aglaothamnion hookeri*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11774. A. Main axis. Scale bar = 400 µm. B. Detail of a branch with gonimoblasts. Scale bar = 80 µm.

20-40 µm in diameter, arising from the cells of the main axis or from the basal cells of the branches, and growing downwards forming a loose adherent cortex in the lower part of the plant.

Reproduction: Gonimoblasts globose, adaxial, 119-166 µm in great diameter, composed of two rounded lobes; carposporangia 24-48 x 20-36 µm. Other reproductive structures not seen.

Habitat: Epiphyte on *Hypnea spicifera* in the lower eulittoral zone.

Namibian distribution: Swakopmund (Wynne, 1986); South Kunene (Map 50).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); Angola and areas of cold upwelling in Gulf of Guinea, from Canary Islands and Morocco to northern Norway, Iceland (Lawson and John, 1987; Maggs Hommersand, 1993). Mediterranean Sea (Gallardo *et al.*, 1985). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: Wynne (1986) cited *Aglaothamnion hookeri* from Swakopmund on the basis of sterile specimens. At the same time, Stegenga (1986) cited this species from the west coast of the Cape Province (South Africa) and few years later from the east coast (Stegenga, 1988). Our specimens agree quite well with the photographs of this species showed by Wynne (1986), but differs from the material described by Stegenga (1986) and Stegenga *et al.* (1997) mainly in the branching pattern. According to these authors, branching is not completely distichous, a fact which distinguishs this plant from *Aglaothamnion tripinnatum* (C. Agardh) Feldmann-Mazoyer (=*Callithamnion tripinnatum* C. Agardh), the latter also recorded from the South African coasts (Stegenga, 1988; Stegenga *et al.*, 1997). In this way, our specimens could correspond to *A. tripinnatum*. Maggs and Hommersand (1993) gave an extensive description of both species and pointed out that *A. hookeri* shows great morphological variation and that the branching in this species may be either alternate and distichous or sparse. According to these authors, *A. tripinnatum* and *A. hookeri* can be easily differentiated, since the former, unlike *A. hookeri*, presents an adaxial branch in the basal cell of the pinnae. Maggs and Hommersand (1993) also pointed out that these taxa require a critical biosystematic research, which would confirm its world distribution.

According to the work of Maggs and Hommersand (1993) our specimens agree better *A. hookeri* than with *A. tripinnatum* and for this reason we have preferred to assign them to the former species.

Genus *Antithamnion* Nägeli (1847)

Key to species and varieties of *Antithamnion*:

1. Pinnae opposite and distichously arranged, with adaxial secund branchlets.................................2
1. Pinnae decussate, with opposite or alternate branchlets 3

2. Indeterminate lateral branches opposite to a determinate lateral branch (pinna)...*A. secundum*
2. Indeterminate lateral branches not opposite to a determinate lateral branch ....*A. densum**

3. Pinnae 300-400 µm in length ....*A. diminuatum* var. *diminuatum*
3. Pinnae longer, up to 900 µm in length ....*A. diminuatum* var. *polyglandulum*

* In addition to the species referred to in this key, *Antithamnion eliseae* Norris has been also recorded from Namibia (Möwe Bay) by Engledow (1998). This taxon shows intermediate features between both varieties of *Antithamnion diminuatum* (see the remark in *A. diminuatum* var. *polygaldulum*). *A. densum* was not observed. More information about this taxon can be found in Maggs and Hommersand (1993) and Athanasiadis (1996).

***Antithamnion diminuatum* var. *diminuatum* Wollaston**

Antithamnion diminuatum var. *diminuatum* Wollaston (1968), p. 293.

Selected specimens: Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11780; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11859; Rocky Point, 24-02-1986, BCF-A 11779; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11393.

References: Wollaston (1968), Stegenga (1986), Norris (1987a), Sansón (1991, 1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, 2-10 mm high, consisting of partly prostrate, uniseriate, ecorticate, branched filaments 52-64 µm in diameter, bearing in every cell determinate branches (pinnae) decussately arranged; prostrate part of axes with the pinnae perpendicular to the substratum. Indeterminate branches usually arising from the cells of main axes, but sometimes from the basal cell of pinnae; main axes cells cylindric, 60-160 x 52-64 µm. Pinnae plumose, 300-400 µm long, arising from the upper third of the main axis cells; basal cell of the pinnae short, 18-20 x 24 µm, given rise to one or three multicellular rhizoidal filaments, 16-32 µm in diameter, ending or not in a attachment pad; axial cells of the pinnae 28-64 x 20-32 µm; pinnae with opposite branchlets in the proximal 1-2 axial cells and alternate branchlets in the distal part; opposite branchlets usually different, one simple and the other bearing an abaxial 3-5 celled ramuli with a gland cell; alternate branchlets simple or bearing a small abaxial ramuli with a gland cell; gland cells ovate, 16-20 x 10-16 µm, a few swollen and darker, 30-32 x 20-28 µm.

Reproduction: Reproductive structures not seen.

Habitat: Epiphyte on several algae, like *Centroceras clavulatum*, *Hypnea ecklonii*, *Plocamium rigidum*, *Tayloriella tenebrosa*, *Griffithsia confervoides*, *Corallina* sp. and *Caulacanthus ustulatus*, in the lower eulittoral zone.

Namibian distribution: Torra Bay, Möwe Bay (Stegenga *et al.*, 1997); Rocky Point, South Kunene (Map 51).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); Canary Islands (Sansón, 1994). Indian Ocean: South Africa, Australia (Silva *et al.*, 1996).

Remarks: Stegenga *et al.* (1997) gave a description of *Antithamnion diminuatum* pointing out that the specimens with larger dimensions in all parts and more abundant gland cells correspond to the variety *polyglandulum*. These authors also stated that the ranges of distribution of both varieties largely overlap. In this way, Stegenga *et al.* (1997) presented a global distribution of this species which did not distinguish the varieties.

On the other hand, we must point out that some large cells replacing the normal gland cells, usually occur in our specimens. More information about these cells can be found in the remark of var. *polyglandulum*.

Antithamnion diminuatum var. ***polyglandulum*** Stegenga (Fig. 107)

Antithamnion diminuatum var. *polyglandulum* Stegenga (1986), p. 30.

Holotype: Stegenga slide n. 700 (in BOL), 25-10-1984, Swartklip.

Selected specimens: Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11860; Möwe Bay, 25-02-1986, BCF-A 9603; Rocky Point, 24-02-1986, BCF-A 11861.

References: Stegenga (1986), Rull Luch and Gómez Garreta (1993), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous 3-13 mm high, having similar features to the var. *diminuatum*, from which it mainly differs in the main axes diameter, the pinnae length and the size and number of gland cells. Main axis 60-120 µm in diameter, with cells cylindric, 120-280 x 60-120 µm, attached to the substratum by multicellular rhizoidal filaments 24-44 µm in diameter; indeterminate branches usually arising from the basal cells of the pinnae. Pinnae (277-)395-909 µm long, with the axial cells 48-116 x 32-56 µm and the basal cell 28-60 x 36-60 µm; gland cells numerous, 26-39 x 17-30 µm, occurring on a usually 3-celled abaxial branchlet; some bigger and darker gland cells, 56-76 x 52-72 µm, apparently pedicellate, generally occurs; the pedicel 20 x 40 µm. Plastids numerous, discoidal or elongated.

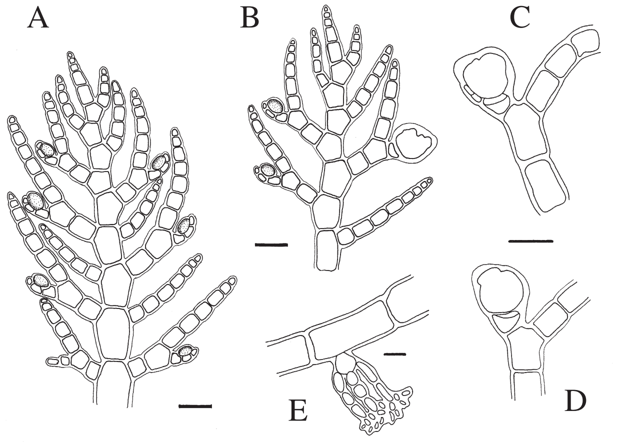

FIG. 107. – *Antithamnion diminuatum* var. *polyglandulum*. A. Detail of a pinna. B. Detail of a pinna with two normal gland cells and a swollen gland cell. C-D. Detail of two swollen gland cells; in C the three cells of the supporting branchlet are visible. E. Rhizoid. Scale bar = 50 µm.

Reproduction: Reproductive structures not seen.

Habitat: Epiphyte on *Tayloriella tenebrosa* and *Acrosorium cincinnatum* in the lower eulittoral zone; growing on *Plocamium rigidum* and *Centroceras clavulatum* in the upper sublittoral zone, among the specimens of *Laminaria pallida*.

Namibian distribution: Torra Bay, Möwe Bay (Stegenga *et al.*, 1997); Rocky Point (Rull Lluch and Gómez Garreta, 1993). See remarks on the distribution in var. *diminuatum* (Map 52).

World distribution: Atlantic Ocean: South Africa (Stegenga, 1986); Namibia (Rull Lluch and Gómez Garreta, 1993). Canary Islands (Sansón, 1994). Indian Ocean: South Africa (Stegenga and Bolton, 1992).

Remarks: Our specimens of this variety, as well as those of var. *diminuatum*, often present some swollen cells, apparently pedicellate, that are reminiscent of monosporangia, but whose arrangement suggests structures derived from gland cells. In fact, these swollen cells occur in branchlets similar to those bearing gland cells, but as a result of their big size often hide all the cells of the branchlet except the basal one, which seems to be a pedicel. However, occasionally, the branchlet cells can be observed beneath these swollen cells (Fig. 107C). Moreover, Sansón (1991 and 1994) observed the same sort of structures together with cruciate tetrasporangia in Canarian specimens of this species.

Norris (1987a) studied the species of *Antithamnion* occurring in Natal (east coast of South Africa) and remarked that there are specimens which agree with *A. diminuatum* var. *polyglandulum* but that due to several differences he preferred to describe them as a new species named *A. eliseae* Norris. This author pointed out the differences between *A. diminuatum* and *A. eliseae* but did not refer to var. *polyglandulum*. On the other hand, Stegenga *et al.* (1997) stated that the differences in size between var. *polyglandulum* and *A. eliseae* appear to be as big as those between *A. eliseae* and *A. diminuatum* var. *diminuatum*, and they suggested the possibility that the three taxa could be considered as different species.

Antithamnion secundum Itono (Fig. 108)

Antithamnion secundum Itono (1971), p. 212.

Selected specimens: Mile 30, 7-07-1989, BCF-A 11392.

References: Itono (1971, 1977), Norris (1987a).

Habit and vegetative structure: Plant 1 mm high, consisting of prostrate and erect axes. Prostrate axes 40-56 µm in diameter, attached to the substratum by multicellular rhizoids, 28-40 µm in diameter, with digitate haptera. Erect axes 52-64 µm in diameter, with distichously arranged determinate laterals, one opposite pair in every cell; cells of erect axes 60-84 x 48-56 µm; rhizoids and indeterminate branches arising from the basal cells of the determinate laterals, which they move on to rhizoid or indeterminate branch; indeterminate branches opposite to a determinate lateral or a rhizoid. Determinate laterals 20-24 µm in diameter, simple or bearing secund branchlets adaxially arranged, some of which, usually the shorter ones, bear a gland cell; cells of determinate laterals 18-38 µm long and 18-24 µm broad, the 1-2 basal ones shorter, 16-18 x 20 µm. Gland cells scarce, 16 x 12 µm.

Reproduction: Reproductive structures not seen.

Habitat: Epiphytic on *Rhodymenia natalensis*, in drift material.

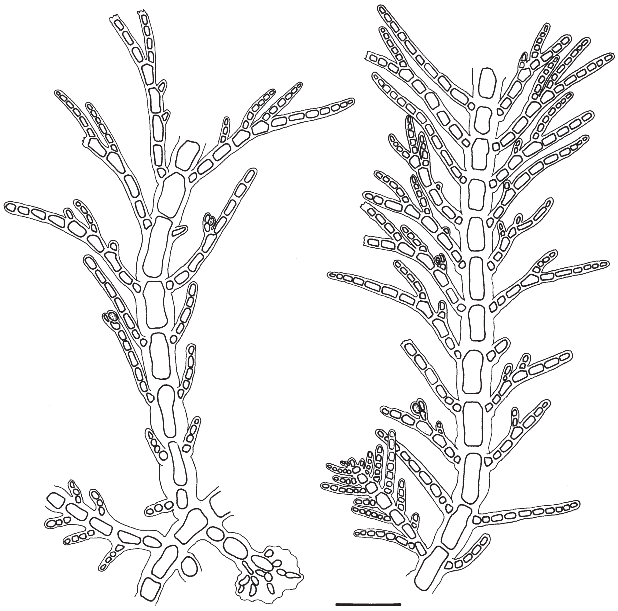

FIG. 108. – *Antithamnion secundum*. Two portions of the plant showing the main axis and determinate laterals. An indeterminate branch opposite to a determinate one is also visible in the drawing at right. Scale bar = 100 µm.

Namibian distribution: Mile 30 (Map 53).

World distribution: Atlantic Ocean: Namibia. Pacific Ocean: Japan (Itono, 1971). Indian Ocean: South Africa (Norris, 1987a).

Remarks: *Anthithamnion secundum* was described by Itono (1971) on the basis of Japanese material, and later, it was recorded from the east coast of South Africa by Norris (1987a). Until now, this species had not been recorded from the Atlantic Ocean.

Our material agrees quite well with the descriptions of Itono (1971) and Norris (1987a), although there are some differences. On the one hand, the Namibian specimens have relatively thicker axes (52-64 µm in diameter, in comparison with 40-45 µm) and broader cells (48-56 µm broad, in comparison with 18-40 µm) than the specimens from Japan and South Africa. On the other hand, our specimens have some gland cells, unlike the Japanese material in which these cells are lacking (Itono, 1971, 1977). Norris (1987a) remarked that the gland cells are usually absent in South African material, but that they occur in one of the specimens studied. This author also pointed out that the branching is not completely distichous in the apical zones of some specimens.

By the presence of a determinate branch opposite to the indeterminate branches, *A. secundum* is similar to *A. kylinii* Gardner, *A. nematocladellum* Norris and to some specimens from Sierra Leone described by Lawson and John (1987) as *Antithamnion* sp. *A. kylinii* occurs on the Pacific coast of North America (Scagel *et al.*, 1986) and is represented by erect specimens, lacking prostate axes, and taller (4-5 cm) than those of *A. secundum* (Abbott and Hollenberg, 1976). *A. nematocladellum* is an endemic species of the South African east coast (Cormaci and Furnari, 1989), which differs from *A. secundum* in having, at the basal zone of the indeterminate branches, a pair of determinate branchlets opposite and decussate in relation to the upper ones, which are distichously arranged. Finally, the Sierra Leone specimens differ from *A. secundum* in having a pyramidal appearance.

Wynne (1986) cited *Antithmnion leptocladum* (Montagne) Wynne [= *A. densum* (Suhr) Howe, according to Athanasiadis (1990)] from Swakopmund (Namibia). This species is similar to *A. secundum*, from which it differs in lacking a determinate branchlet opposite to the indeterminate branches.

Since the presence or absence of a determinate branchlet opposite to the indeterminate branches is an important feature to determine species in the genus *Antithamnion* (Norris, 1987a), we have tentatively assigned our specimens to *A. secundum*, waiting for a future study which will allow comparison of our material with Wynne's (1986) specimens.

Genus *Antithamnionella* Lyle (1922)

Key to species of *Antithamnionella*:

1. Axes with whorls of 2-4 determinate branchlets 150-400 µm long............................*A. australis**
1. Axes with whorls of 4-6 determinate branchlets 100-220 µm long...........................*A. verticillata*

* *A. australis* has been recently recorded from southern Namibia (Grossebucht) by Engledow (1998), but not observed among our material. More information about this taxon can be found in Baardseth (1941).

Antithamnionella verticillata (Suhr) Lyle (Fig. 109)

Callithamnion verticillatum Suhr (1840), p. 290.
Antithamnionella verticillata (Suhr) Lyle (1922), p. 349.

Selected specimens: Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11394; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11863; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11862, with spermatangia.

References: Stegenga (1986), Stegenga *et al.* (1997).

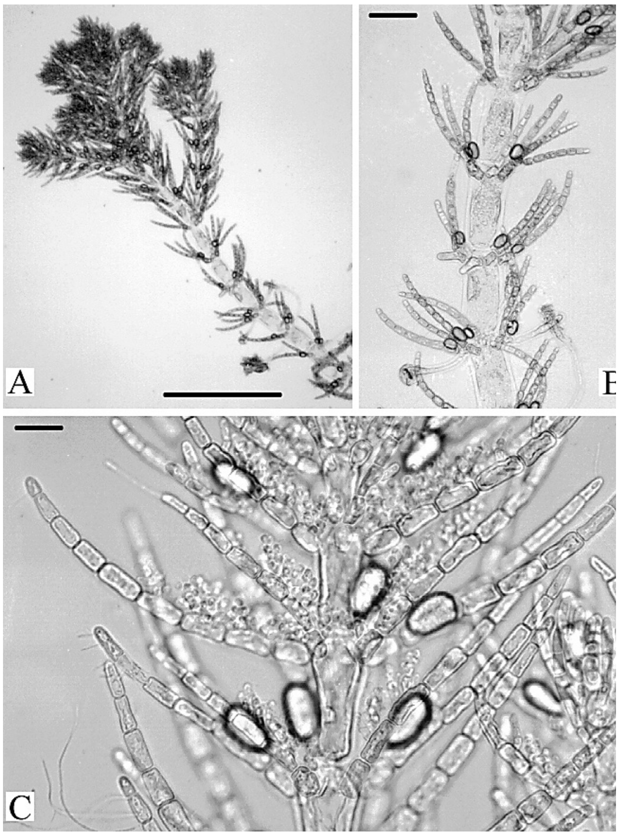

FIG. 109. – *Antithamnionella verticillata*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11862. A. Habit. B. Detail of main axis. C. Determinate branches with spermatangia and gland cells. A-B. Scale bar = 200 µm. C. Scale bar = 20 µm.

Habit and vegetative structure: Plant 2-3 mm high, consisting of an uniseriate main axis, ecorticate, partly prostrate and attached to the substratum by rhizoids, that bear whorled determinate branchlets in the upper part of the cells. Rhizoids uni- or multicellular, 16-20 µm in diameter, arising from the cells of main axis or from the basal cells of determinate branchlets, with or without attachment pads. Main axis (40-)60-148 µm in diameter, irregularly branched, with cells cylindrical, 100-240 µm long and 40-148 µm broad; indeterminate branches arising from cells of main axes, replacing a determinate branchlet. Determinate branchlets (4-)5-10(-11) cells long (108-220 µm) and 12-20 µm broad in the middle part, often with a gland cell near the base; each whorl with 4-6 determinate branchlets, simple or with one ramification just above the gland cell. Gland cells ovate, 24-36 x 16-26 µm, refringent, placed on the second or third basal cells of determinate branchlets.

Reproduction: Spermatangia in clusters adaxially arranged on lower cells of determinate branchlets. Other reproductive structures not seen.

Habitat: Epiphyte on *Tayloriella tenebrosa*, *Hypnea spicifera* and *Corallina* sp., in the lower eulittoral zone.

Namibian distribution: Rocky Point (Engledow, 1998); Möwe Bay, South Kunene (Map 54).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia. Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: The Namibian specimens agree well with the Stegenga (1986) and Stegenga *et al.* (1997) descriptions of this species, although they have determinate branchlets slightly longer.

Genus *Aristothamnion* J. Agardh (1892)

Aristothamnion collabens (Rudolphi) Papenfuss (Figs. 110-111)

Asperocaulon collabens Rudolphi (1831), p. 178.
Aristothamnion collabens (Rudolphi) Papenfuss (1968a), p. 268.
For the synonyms see Papenfuss (1968a).

Lectotype: Rudolphi specimen illustrated by Kützing (1862), pl. 15, fig. a.

Selected specimens: Langstrand, 6-07-1989, BCF-A 1139, with polysporangia, carposporangia and spermatangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 1186, with polysporangia, carposporangia and spermatangia; Swakopmund, beach, 8-07-1989, BCF-A 11866, with carposporangia and spermatangia; Mile 30, 7-07-1989, BCF-A 11867, with polysporangia; Mile 32, 7-07-1989, BCF-A 11868, with polysporangia; Möwe Bay, 5-02-1988, BCF-A 11869; Rocky Point, 24-02-1986, BCF-A 11396, with polysporangia; Angra Fria, 20-02-1986, BCF-A 11864, with polysporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 1141, with polysporangia, carposporangia and spermatangia.

References: Simons (1960a), Wollaston (1984), Stegenga (1986), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, forming elongate, more or less pyramidal tufts up to 7.5 cm high, consisting of an irregularly branched main axis attached to the substratum by a basal disc. Main axis uniseriate, completely corticated, (160-)220-580 µm in diameter, bearing ecorticate branchlets of limited growth spirally arranged, one in every cell; first order branches up to 1.5 cm long and 100-360 µm in diameter, arising from the upper part of the main axis cells; cells of the main axis cylindric, up to 1 mm in length, shorter in the lower than in the middle part of the plant; apical zone overtopped by the nearest branchlets of limited growth. Cortication more dense in the lower than in the upper part of the plant, consisting of multicellular rhizoidal filaments issuing from the basal cells of the branches; cells of rhizoidal filaments elongated, narrow, 40-320 x (6-) 12-20 µm; rhizoidal filaments growing upwards, downwards or surrounding the main axis. Branchlets of limited growth 55-100 µm in diameter in the middle part, alternately or pseudodichotomously branched, with the ramuli more or less distichously arranged; cells of the limited growth branchlets (24-) 56-213 x 24-79(-103) µm; apical cell conical, 8-32 x 8-32 µm.

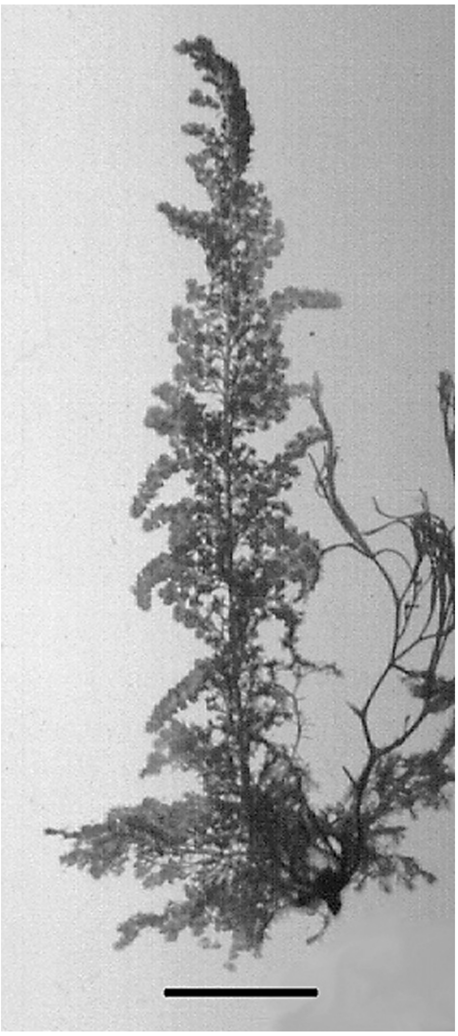

FIG. 110. – *Aristothamnion collabens*. Langstrand, 6-07-1989, BCF-A 11395. Scale bar = 1 cm.

Reproduction: Polysporangia ovate or round, 60-100 x 48-88 µm, sessile, adaxially arranged in the last order branchlets; polysporangia with 8-14 spores in surface view. Plant dioecious. Gonimoblasts globose, 134-440 x 80-340 µm, composed of two opposite lobes arising from the last branchlets cells; carposporangia ovate, elliptic or more or less triangular with rounded angles, (24-)32-48 x (18-)24-40 µm. Spermatangia in hemispherical clusters 63-88 µm in diameter, adaxially arranged in the last order branchlets.

Habitat: Epiphyte on several algae like *Chondria capensis*, *Hypnea spicifera*, *Polysiphonia virgata*,

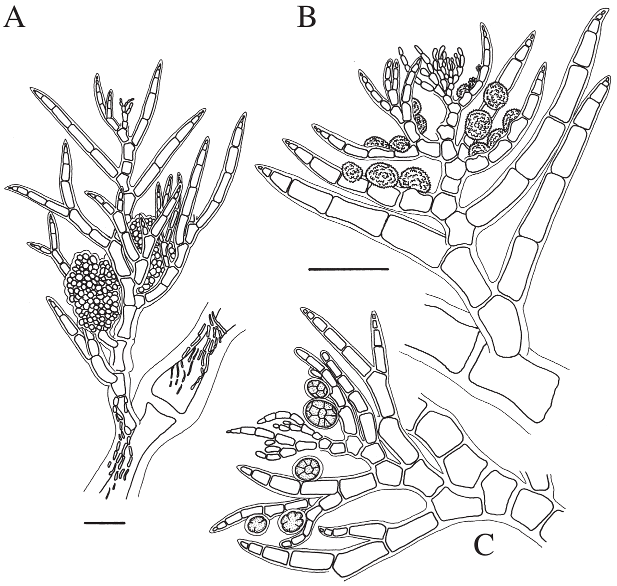

FIG. 111. – *Aristothamnion collabens*. A. Detail of a branch with a gonimoblast. B. Detail of a branch with hemispherical clusters of spermatangia. C. Detail of a branch with polysporangia. Scale bar = 200 µm.

Plocamium rigidum and *Pterosiphonia complanata*, in the lower eulittoral and the upper sublittoral zones; in tide pools, epiphyte on *Codium decorticatum* and *Streblocladia corymbifera*. Occurring also in drift material.

Namibian distribution: Elizabeth Bay, Grossebucht, Halifax Bay, Lüderitz, Swakopmund, Terrace Bay (Lawson *et al.*, 1990); Langstrand, Mile 30, Mile 32, Möwe Bay, Rocky Point, Angra Fria, South Kunene (Map 55).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa, Sri Lanka (Silva *et al.*, 1996).

Remarks: *Aristothamnion collabens* was described by Rudolphi (1831) as *Asperocaulon collabens* and, until Papenfuss (1968), it was the object of great taxonomical and nomenclatural confusion, a fact which is evident by the high number of synonyms. Stegenga (1986) remarked that there are no significant differences between young specimens of *A. collabens* and the type material of *Aristothamnion tysonii* Barton, the latter described by Barton (1893) on the basis of material collected at Sea Point (South Africa). On the other hand, Baardseth (1941) described *Aristothamnion ramellifera* from Tristan da Cunha and remarked that this species differs from *A. collabens* by the size and in having branched hairs. At present it is known that the presence of hairs depends on the environment (West, 1971) and is related to nutrient assimilation (DeBoer and Whoriskey, 1983; Reed, 1990; Oates and Cole, 1994). Therefore, it is probable that the Tristan specimens described as *A. ramellifera* actually belong to *A. collabens*.

Our specimens agree with the *Aristothamnion collabens* iconography and descriptions consulted, although they have larger polysporangia and spermatangial sori. Moreover, in agreement with Stegenga (1986) and unlike Simons (1960) and Wollaston (1984), we have not observed tetrasporangia in our specimens.

Genus *Ballia* Harvey (1840)

Ballia sertularioides (Suhr) Papenfuss
(Fig. 112)

Callithamnion sertularioides Suhr (1840), p. 282.
Ballia sertularioides (Suhr) Papenfuss (1940a), p. 222.

Selected specimens: Möwe Bay, 4-02-1988, BCF-A 11775; Möwe Bay, Suider Kust, 8-02-1988, BCF-A 11776; Rocky Point, 24-02-1986, BCF-A 9604.

References: Papenfuss (1940a), Baardseth (1941), Pujals (1967), Stegenga (1986), Rull Lluch and Gómez Garreta (1993), Adams (1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, 5-15 mm in length, consisting of a branched main axis bearing opposite and distichously arranged determinate laterals in every cell. Main axis uniseriate, ecorticate, 52-80 µm in diameter, with cells cylindric, 124-192 x 52-76 µm, 1.9-2.8 times longer than broad; some cells of the main axis without laterals; apical cell cylindric, with blunt apex, the diameter similar to the main axis; in some specimens, main axis ending in a sinuous filament devoid of laterals. Determinate laterals 32-40 µm in diameter, simple or often once pinnate, with opposite and distichously arranged branchlets in every cell of it lower half; upper half of determinate laterals without branchlets; basal cell of determinate laterals short and trapezoidal in shape, occasionally giving rise to multicellular rhizoidal filaments; apical cell tapered to acute, 20-32 x 12-16 µm.

Reproduction: Reproductive structures not seen.

Habitat: Among *Caulacanthus ustulatus* and *Centroceras clavulatum* in the lower eulittoral zone.

Namibian distribution: Lüderitz (Stegenga *et al.*, 1997); Guano Bay, Diaz Point (Engledow, 1998); Rocky Point (Rull Lluch and Gómez Garreta, 1993); Möwe Bay (Map 56).

World distribution: Atlantic Ocean: South Africa, Namibia, Tristan da Cunha, Argentina (Stegenga *et al.*, 1997). Pacific Ocean: Ross Sea (Cormaci *et al.*, 1991); (?)Chile (Pujals, 1967); New Zealand (Adams, 1994).

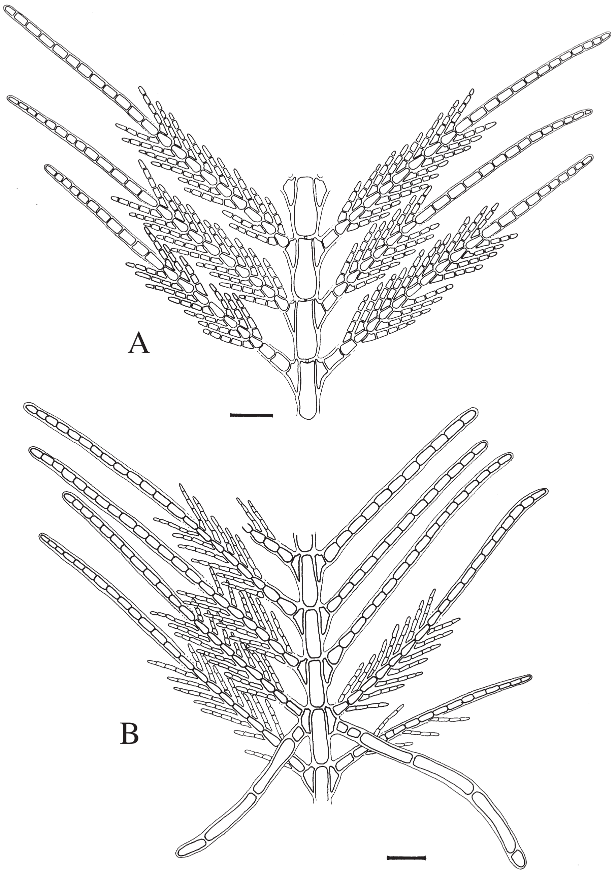

FIG. 112. – *Ballia sertularioides*. A. Detail of the median part of the plant. B. Fragment of the plant showing rhizoid filaments. Scale bar = 100 µm.

Remarks: Our specimens, although sterile, are compatible with the *Ballia sertularioides* descriptions and iconography consulted, which also are based on sterile material. However, both Pujals (1967) and Stegenga (1986) pointed out that *B. sertularioides* is a deep water species, whereas our specimens were collected in the eulittoral zone.

Genus *Bornetia* Thuret (1855)

Bornetia repens Stegenga
(Fig. 113)

Bornetia repens Stegenga (1985b), p. 163.

Type: BOL, Stegenga n. T 165 (slide). Hluleka Nature Reserve, Transkei.

Selected specimens: Möwe Bay, 4-02-1988, BCF-A 11870; Rocky Point, 24-02-1986, BCF-A 11871, with tetrasporangia.

References: Stegenga (1985b, 1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant consisting of uniseriate erect axes up to 2.5 cm high, ecorticate, dichotomously branched at intervals of 1-6 cells; erect axes 300-400 µm broad (460-600 µm broad at dichotomies), with cells cylindrical or slightly claviform, 1060-1600 µm long and 260-400 µm broad, those of dichotomies 760-900 x 420-600 µm; apical cell cylindrical with rounded apex, 240-400 µm long and 140-180 µm broad.

Reproduction: Tetrasporangia more or less pear-shaped, sessile, tetrahedrally divided, 60-92 x 48-76 µm, placed between branchlets up to 740 µm long that form clusters adaxially arranged on erect axes. Other reproductive structures not seen.

Habitat: Among the specimens of *Caulacanthus ustulatus* and *Nothogenia erinacea* in the lower eulittoral zone.

Namibian distribution: Rocky Point (Engledow, 1998); Möwe Bay (Map 57).

World distribution: Atlantic Ocean: South Africa (Stegenga el al., 1997); Namibia. Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: Stegenga (1985b) described this species on the basis of material from the south coast of South Africa, and remarked that it differs from the other *Bornetia* species in having prostate filaments from which the erect filaments arise. However, Sansón (1991) and Maggs and Hommersand (1993) pointed out the presence of prostrate axes in *B. secundiflora*. Stegenga (1985b) also remarked other typical features of *B. repens*, like the specimens size (it is the smallest species of the genus), the cell diameter and the length of the spermatangium stichidia. Moreover, the author also stated that the tetrasporangia of *B. repens* do not have significant differences from those of *B. tenuis*, the latter an Australian species very similar to *B. repens*.

The Namibian material is represented by tetrasporophytes without base and therefore, we can not assign them with certainty to *B. repens*. In this way, our specimens also partially agree with the descriptions by Lawson and John (1987) and Sansón (1991) of *B. secundiflora*, a species occurring in the European Atlantic and in the Mediterranean Sea. However, according to Sansón (1991), in this species the tetrasporangia are much smaller (36 µm in diameter in comparison with 60-92 µm in our specimens). On the other hand, according to the descriptions by Feldmann-Mazoyer (1940) and Maggs and Hommersand (1993), *B. secundiflora* is a more robust species composed of thicker cells (400-1000 µm in diameter; the apical ones 260-360 µm). Therefore, although incomplete, our specimens agree better with the descriptions of *B. repens* (Stegenga, 1985b, 1986; Stegenga *et al.*, 1997) than with

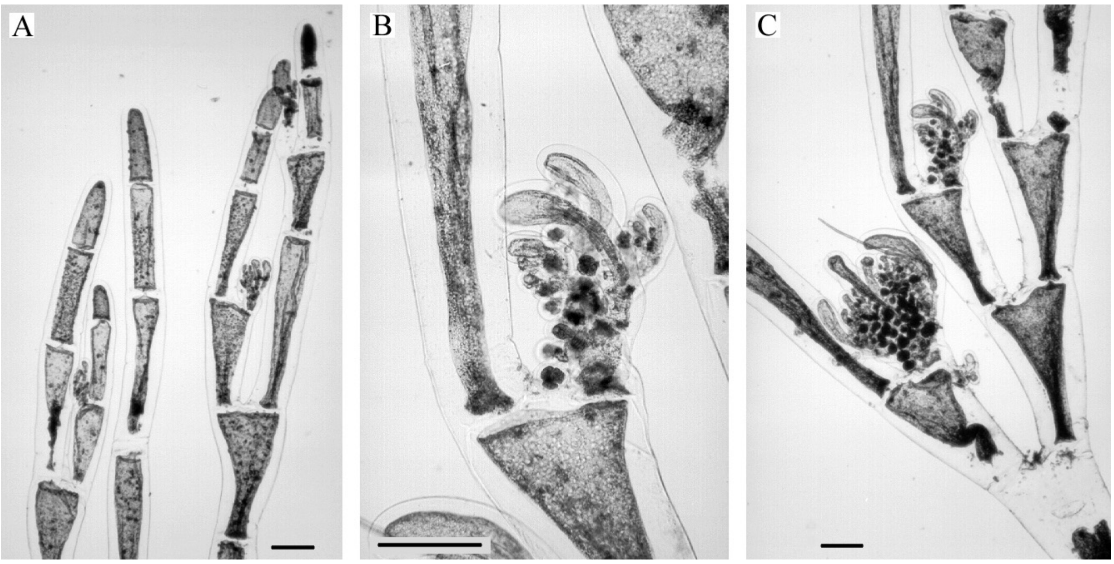

FIG. 113. – *Bornetia repens*. Rocky Point, 24-02-1986, BCF-A 11871. A. Detail of the apical part of the plant. B-C. Branches with tetrasporangia. Scale bar = 200 µm.

those of *B. secundiflora* and for this reason we have assigned them to the former species.

Until now, *B. repens* was only known from South-Africa, occurring from False Bay to Transkei and probably in Natal (Stegenga *et al.*, 1997).

Genus *Carpoblepharis* Kützing (1843)

Key to species of *Carpoblepharis*:

1. In cross section, branches bearing tetrasporangia with 6 pericentral cells ....*C. minima*
1. In cross section, branches bearing tetrasporangia with 8-10 pericentral cells ....*C. flaccida**

* *C. flaccida* was not observed. You can find more information about this taxon in Stegenga (1986) and Stegenga *et al.* (1997).

Carpoblepharis minima Barton
(Figs. 114-115)

Carpoblepharis minima Barton (1893), p. 114.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 1139, with tetrasporangia and spermatangia; Swakopmund, beach, 8-07-1989, BCF-A 11760, with tetrasporangia and carposporangia; Mile 30, 7-07-1989, BCF-A 11761, with tetrasporangia and carposporangia.

References: Stegenga (1986), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant epiphytic, up to 10 cm high, consisting of pinnately branched, compressed erect axes up to about 1 mm wide; attachment by means a basal disc from which numerous thin rhizoidal filaments arise, penetrating the structure of the support plant. Main axes 400-600(-800) µm broad, up to three times pinnately branched, with determinate and indeterminate branches; occasionally branching irregular or proliferous. Determinate branches compressed, 200-400 µm broad, usually linear with obtuse or truncate apex and constricted at insertion point. Plant com-

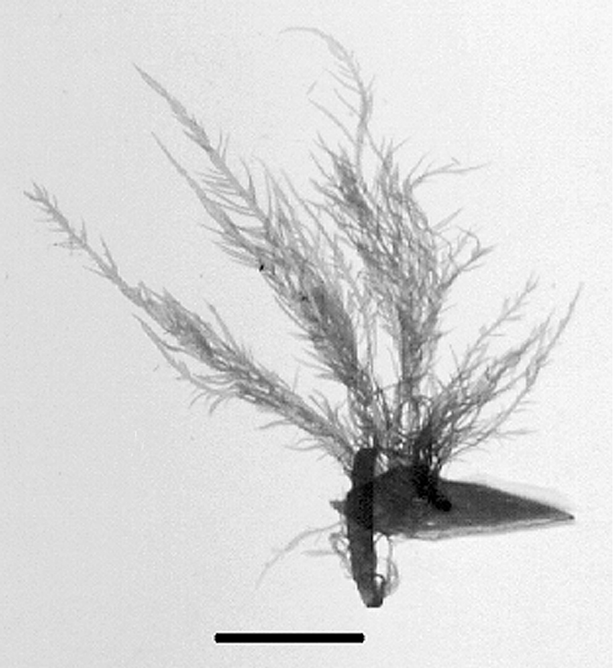

FIG. 114. – *Carpoblepharis minima*. Mile 30, 7-07-1989, BCF-A 11761. Scale bar = 1 cm.

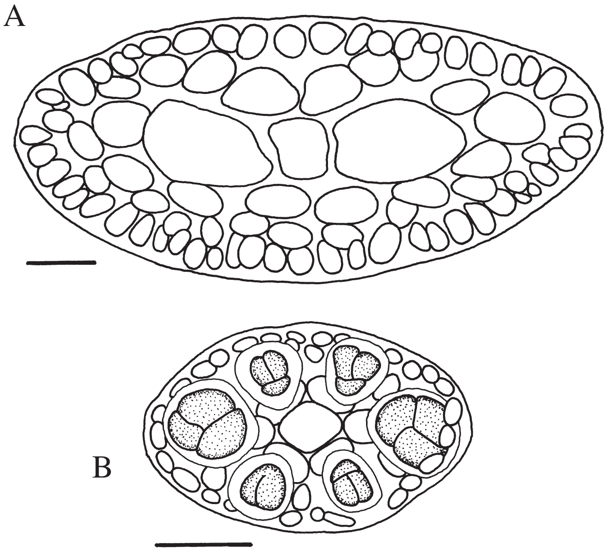

FIG. 115. – *Carpoblepharis minima*. A. Cross section of a main axis. B. Cross section of a branch with tetrasporangia. Scale bar = 50 µm.

pletely corticate. In surface view, cortical cells polygonal, elongated or isodiametric in the upper half of the plant, 13-30 x 10-22 µm, and more or less rhizoidal in the lower part and in the base of branches. In cross section, main axis composed of one axial cell 48-96 x 36-88 µm surrounded by six pericentral cells, two large and laterally arranged, 64-120 x 44-104 µm, and four smaller (two dorsal and two ventral), 48-88 x 24-80 µm; cortical cells 10-24 x 9-16 µm, more or less arranged in two layers.

Reproduction: Tetrasporangia tetrahedrally divided, globose or ovoid, 36-64 x 32-60 µm, formed in both determinate and indeterminate branches; branches bearing tetrasporangia with the same structure than the vegetative ones (one axial cell, six pericentral cells and a cortex 1-2 cell layers); tetrasporangia arranged in four longitudinal rows in surface view, the lateral ones not transversally aligned with the central ones; in cross section, tetrasporangia immersed, arising from the pericentral cells and arranged like them, six per axial cell. Plant dioecious. Gonimoblasts globose, 160-248 (-500) µm in diameter, with a long stalk cell and surrounded by up to five involucral filaments; gonimoblasts developed adaxially in determinate branches, 1-2 in each branch; carposporangia ovate, elliptic or more or less isodiametric, 28-60 x 20-40 µm. Spermatangia 4-6 µm in diameter in surface view, covering relatively large apical areas of axes.

Habitat: Epiphyte on both stipe and blade of *Laminaria pallida*. Also growing on *Chondria capensis*, but much less frequent.

Namibian distribution: Walvis Bay (Dinter, 1918); Swakopmund (Wynne, 1986); Mile 30 (Map 58).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997).

Remarks: According to Lawson *et al.* (1990) only two species of *Carpoblefaris* occur in Namibia: *C. flaccida* (C. Agardh) Kützing and *C. minima*. The latter differs mainly from the former by its smaller size (up to 50 mm high in comparison with several hundreds of millimetres in *C. flaccida*) and in having six pericentral cells (instead eight to ten as in *C. flaccida*) in the branches bearing tetrasporangia (Stegenga, 1986; Stegenga *et al.*, 1997). Moreover, according to these last authors, *C. flaccida* commonly grows on *Ecklonia* whereas *C. minima* grows on *Laminaria*.

Our specimens usually are between 1 and 3 cm high, although they can reach up to 10 cm, and they have six pericentral cells in all branches. Moreover, in agreement with Stegenga (1986), our taller specimens grew on the stipes of *Laminaria*, whereas the others were commonly found on the blade.

In Namibia, *C. minima* had only been previously recorded from Walvis Bay (Dinter, 1918) and Swakopmund (Wynne, 1986). However, according to Stegenga *et al.* (1997), this species occurs from Walvis Bay in Namibia to the southern Cape Peninsula (Buffels Bay). *C. flaccida* also has been previously recorded from Walvis Bay and Swakopmund (Lawson *et al.*, 1990). Taking into account that the Walvis Bay record of this species is a former citation based on Tyson Herbarium material (Delf and Michell, 1921), that Wynne (1986) do not cite this species but *C. minima*, and that some of our specimens could be mistaken, by size, with *C. flaccida*, we hold that both species could have been formerly mistaken in this geographical area. In this way, we agree with Price *et al.* (1986) who suggested that a critical revision of the genus *Carpoblepharis* should be carried out.

Although the ecology of *Carpoblepharis minima* was restricted to the epiphytism (or partial parasitism) on *Laminaria* (Delf and Michell, 1921; Wynne, 1986; Stegenga, 1986; Stegenga *et al.*, 1997) we also have found this species growing (with endophytic rhizoids) on *Chondria capensis*.

Genus *Centroceras* Kützing (1841)

Centroceras clavulatum (C. Agardh) Montagne (Fig. 116)

Ceramium clavulatum C. Agardh (1822), p. 2.
Centroceras clavulatum (C. Agardh) Montagne (1846), p. 140.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11872, with tetrasporangia; Swakopmund, beach, 8-07-1989, BCF-A 11398, with tetrasporangia; Terrace Bay, February 1986, BCF-A 11873, with tetrasporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11399; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11773, with tetrasporangia and carposporangia; Rocky Point, 24-02-1986, BCF-A 11772, with tetrasporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11875, with tetrasporangia.

References: Feldmann-Mazoyer (1940), Baardseth (1941), Hommersand (1963), Dawson (1964), Cordeiro-Marino (1978), Cordero (1981), Ardré (1987), Lawson and John (1987), Stegenga (1986), Santelices (1989), Sansón (1991), Adams (1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, fragile, up to 6 cm high, consisting of branched, uniseriate filaments with incurved apices; attachment by rhizoidal filaments; branching usually dichotomous; two small fertile branchlets (adventitious branchlets) decussately arranged often occurring at level of dichotomies; sometimes, branching irregular, opposite or more or less proliferous; occasionally, specimens with very open dichotomies. Filaments completely corticate, 140-277 µm in diameter in its middle part and 140-220 µm in the apical zone, without a clear distinction between nodes and internodes. Nodal zones slightly increased, more or less funnel-shaped (especially in tetrasporangial specimens), bearing one or more spines and sometimes rhizoids; spines 1-2 cells long, 20-80(-92) µm in length, arising from cortical cells and especially abundant in the apical zone of filaments, in which the abaxial ones are often more developed and forms a sort of crest; lower part of filaments often devoid of spines; cortical cells of nodal zones more or less square, 12-17 x 10-17 µm, becoming rectangular in basipetal direction. Cortical cells of internodal zones rectangular, (18-)26-56(-77) x 8-18 µm, arranged in straight longitudinal rows. In the upper zone of the plant, all cortical cells square and of same size. Axial cells up to 1300 µm in length in the middle part of filaments and 140-300 µm long in the upper part. Rhizoidal filaments multicellular, branched, 24-28 µm in diameter.

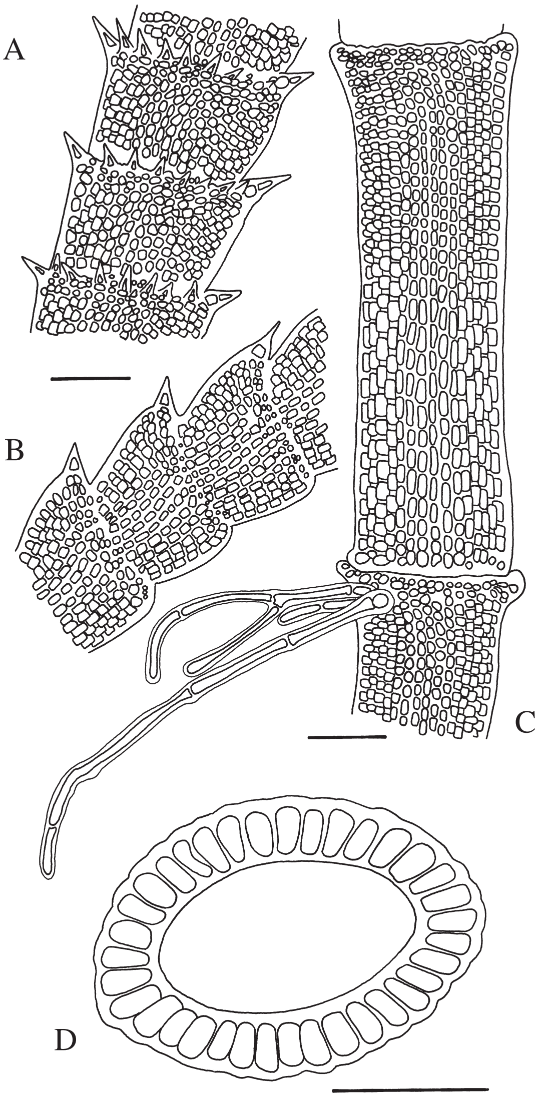

FIG. 116. – *Centroceras clavulatum*. A-B. Cortication and spines in two filament fragments of the upper half of the plant. C. Cortication and rhizoids in a filament fragment of the lower half of the plant. D. Cross section of a filament (internode). Scale bar = 100 µm.

Reproduction: Tetrasporangia tetrahedrally divided, ovate or pear-shaped, 52-88 x 44-69 µm, placed in whorls in the nodal zones, especially in adventitious branchlets, exserted, arising from the pericentral cells. Gonimoblasts 300 µm in greater diameter, composed of 1-3 lobes surrounded by involucral branchlets; carposporangia 22-48 x 18-34 µm. Spermatangia not seen.

Habitat: Epilithic or epiphytic on several algae, like *Corallina* sp., *Tayloriella tenebrosa*, *Ahnfeltiopsis glomerata*, *Caulacanthus ustulatus* and *Chondria capensis*. Often growing on Polychaeta tubes.

Namibian distribution: Elizabeth Bay, Lüderitz, Diaz Point (Lüderitz area), Swakopmund, Torra Bay, Terrace Bay, Möwe Bay, Rocky Point (Lawson *et al.*, 1990); South Kunene (Map 59).

World distribution: Widespread in warm temperate and tropical seas (Lawson and John, 1987).

Genus *Ceramium* Roth (1797) *nom cons.*

Key to species of *Ceramium*:

1. Nodes and internodes differentiated; cortication incomplete 2
1. Nodes and internodes not differentiated; cortication complete 6

2. Cortical cells of the nodal bands invading the immediately upper internode; nodal upper margin irregular ....*C. atrorubescens*
2. Cortical cells of the nodal bands not invading the immediately upper internode; nodes with well defined margins 3

3. Apices of filaments strongly incurved 4
3. Apices of filaments straight or only slightly incurved 5

4. Tetrasporangia in whorls ....*C. arenarium*
4. Tetrasporangia occurring singly or in adaxial clusters in the nodal bands ....*C. diaphanum**

5. Filaments 80-120 μm in diameter; internodes longer than the nodes in the middle part of the plant; upper nodes with more than two cortical cell rows ....*C. flaccidum*
5. Filaments 100-220 μm in diameter; internodes of same size as nodes in the middle part of the plant; upper nodes with 2-3 cortical cell rows ....*Ceramium* sp.

6. Filaments alternately branched, distichous; tetrasporangia exserted ....*C. planum*
6. Filaments pseudodichotomously branched, usually not distichous; tetrasporangia immersed...........7

7. Dichotomies at a wide angle; tetrasporangia occurring in a single whorl per node, in adventitious branchlets.................*C. obsoletum**
7. Dichotomies with a narrow angle; tetrasporangia occurring in one or more whorls per node of the main axes ....*C. capense**

* *C. diaphanum*, *C. obsoletum* and *C. capense* were not observed. More information about the first taxon can be found in Maggs and Hommersand (1993). For the other two taxa see Simons (1966) and Stegenga *et al.* (1997).

Ceramium arenarium Simons
(Figs. 117-118)

Ceramium arenarium Simons (1966), p. 159.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11876, with tetrasporangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11877, with tetrasporangia and spermatangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11879; Rocky Point, 24-02-1986, BCF-A 11878, with tetrasporangia.

References: Simons (1966), Wynne (1986), Stegenga *et al.* (1997).

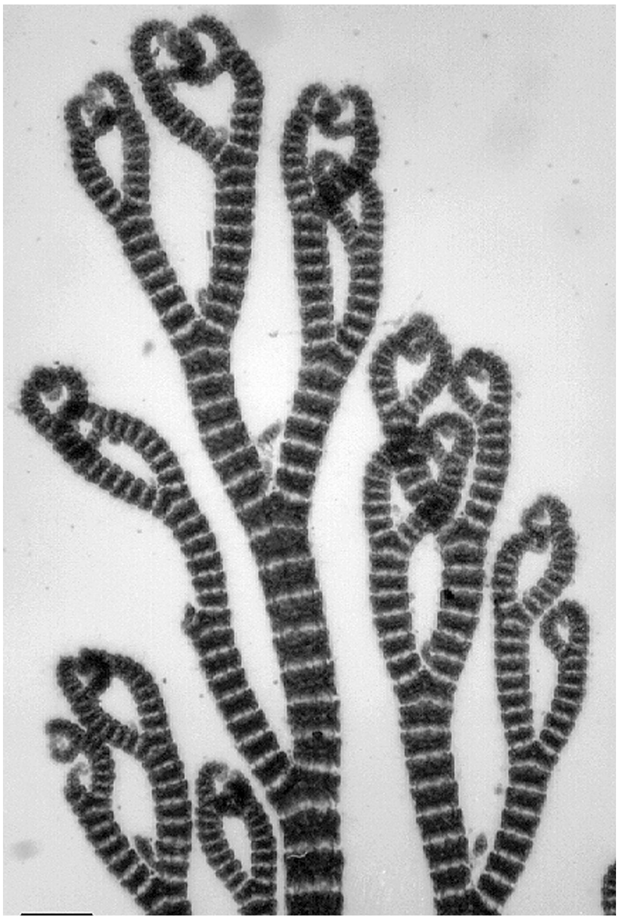

FIG. 117. – *Ceramium arenarium*. Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11879. Scale bar = 200 μm.

Habit and vegetative structure: Plant up to 15 mm high, consisting of uniseriate, incompletely corticate, branched filaments, 160-260 μm in diameter in its middle part, attached by rhizoidal filaments. Branching dichotomous at base, pseudodichotomous or alternate and more or less distichous in the upper half of the plant, often with 1-2 adventitious branchlets at dichotomies; last order branches 80-100 μm in diameter; apices of filaments strongly incurved. Nodes and internodes clearly differentiated along whole the plant; internodes very short (linear) in the basal and apical regions of the plant, and almost as long as the nodes in the middle part of filaments; nodes 0.3-0.6 times longer than broad. Cortical cells polygonal with rounded angles, 8-24 x 6-16 μm, loosely arranged; pericentral cells ovoid or subspherical in surface view, 26-40 x 20-28 μm, often visible in the centre of nodes; in cross section, nodes with 7-8 pericentral cells. Rhizoids multicellular, branched, arising from cortical cells.

Reproduction: Tetrasporangia cruciately divided, ovate, 56-64 x 40-52 μm, occurring in a single whorl

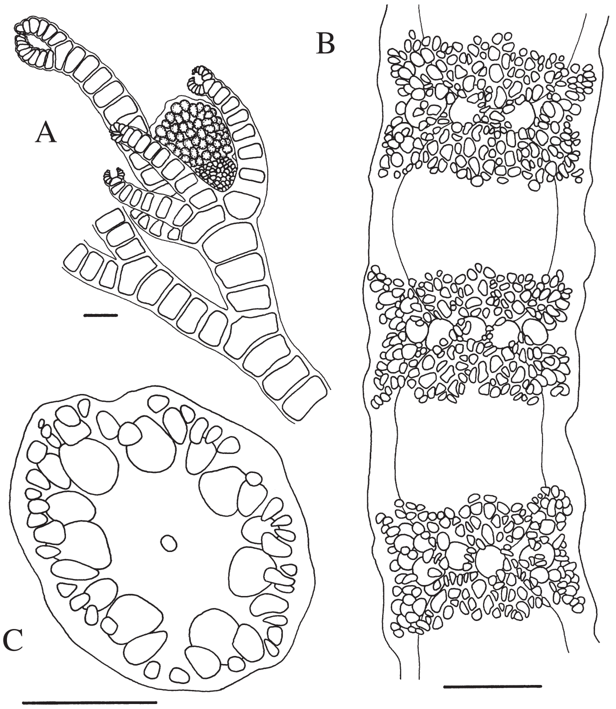

FIG. 118. – *Ceramium arenarium*. A. Fragment of the plant with one gonimoblast. B. Cortication in the median part of the plant. C. Cross section of a filament (node). Scale bar = 100 µm.

per node in the nodes of the upper part of the plant, somewhat exserted. Plant dioecious. Gonimoblasts globose, surrounded by involucral branchlets with forcipate apices; gonimoblasts composed of two lobes, a small and compact basal lobe, 140 x 100 µm, with carposporangia 16-24 x 12-16 µm, and a large, more loose upper lobe, 200-300 x 220-240 µm, with carposporangia 32-40 x 24-32 µm. Spermatangia 2-4 µm in diameter in surface view, covering the nodes of last order branches; in cross section, spermatangia more or less club-shaped, 5-6 x 3-4 µm, arising from cortical cells.

Habitat: Epiphyte on several algae, like *Codium fragile* subsp. *capense*, *Pterosiphonia complanata*, *Chondria capensis*, *Centroceras clavulatum* and *Plocamium rigidum*.

Namibian distribution: Lüderitz, Swakopmund (Lawson *et al.*, 1990); Langstrand, Möwe Bay, Rocky Point (Map 60).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Ceramium arenarium* was described by Simons (1966) on the basis of material from the west coast of South Africa. Subsequently, this species has been recorded from the South African east coast (Anderson and Stegenga, 1989) and from Swakopmund in Namibia (Wynne, 1986).

Our material is compatible with the *Ceramium arenarium* iconography and descriptions consulted. According to Simons (1966) and Wynne (1986), the near contiguity of nodes in the distal part of the plant, the strongly circinate apices, the pericentral cells centred in the nodes, and the partially exerted and verticillate arranged tetrasporangia characterize this species.

Ceramium atrorubescens Kylin
(Figs. 119-120)

Ceramium atrorubescens Kylin (1938), p. 15.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11400, with tetrasporangia and carposporangia; 5 km south of Swakopmund, 7-07-1989, BCF-A 11401, with tetrasporangia and carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11402, with tetrasporangia and carposporangia; Terrace Bay, February 1986, BCF-A 11874, with carposporangia; Möwe Bay, 4-02-1988, BCF-A 11767, with tetrasporangia and carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11768, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11769, with carposporangia; Rocky Point, 24-02-1986, BCF-A 11880.

References: Kylin (1938), Simons (1966), Wynne (1986), Sansón (1991, 1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 7 cm high, consisting of uniseriate, branched filaments 240-500 µm in diameter in its middle part, attached to the substratum by rhizoids. Branching dichotomous in the lower half of the plant and pseudodichotomous in the upper part, with adaxial adventitious branchlets often fertile in the dichotomies; adventitious branchlets sometimes numerous, giving to the plant a proliferous aspect; last order branches 100-200 µm in diameter; apices of filaments incurved. Cortication mainly acropetal; internodes invaded by the cortical cells of the node immediately below; lower part of filaments almost completely corticated; middle and upper parts of filaments with nodes and internodes more or less differentiated. Nodes of the middle part of filaments usually with a straight proximal margin and an irregular distal margin; well delimited nodes and scarcely invaded internodes occurring occasionally in some filaments; exceptionally, basipetal cortication relatively important; internodes 1-2 times longer than the nodes, but sometimes shorter; axes often constricted at lower nodal margins. Upper part of the plant with well defined nodes and very short internodes. Cortical cells of the nodes polygonal with rounded angles, 8-18 x 6-12 µm, usually arranged in small groups; cells that invade the internodes, elongated, 12-30(-58) x 8-12 µm; pericentral cells usually obscured. Rhizoidal filaments multicellular, simple

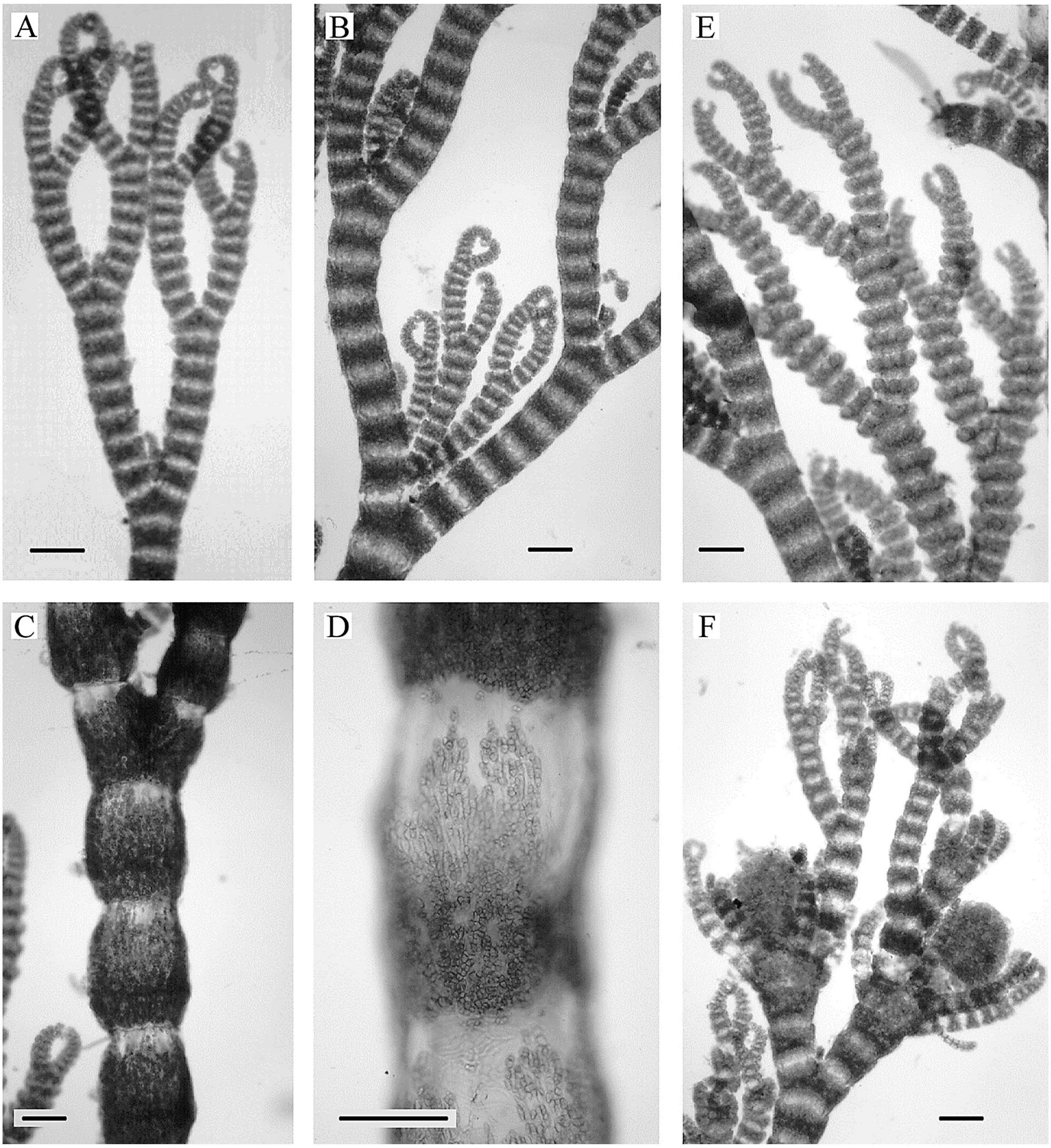

FIG. 119. – *Ceramium atrorubescens*. Langstrand, 6-07-1989, BCF-A 11400. A. Apical zone of the plant. B. Adventitious branchlets in the dichotomies. C. Cortication in the lower half of the plant. D. Detail of cortication in the median part of the plant. E. Branches with tetrasporangia. F. Branches with gonimoblasts. Scale bar = 200 µm.

or branched, 16-36 µm in diameter, arising from cortical cells. In cross section, nodes with 8 ovate or elliptic pericentral cells, 72-80 x 48-56 µm.

Reproduction: Tetrasporangia cruciate or decussate, elliptic, 48-76 x 40-56 µm, occurring in a single whorl per node, partly or completely covered by the cortical cells. Gonimoblasts globose, (150-)200-300 µm in diameter, usually composed of two lobes and surrounded by involucral branchlets with the apices often incurved; carposporangia rounded, elongated or more or less triangular, 24-68 x 20-44 µm. Spermatangia not seen.

Habitat: Epiphyte on several algae, especially on *Codium fragile* subsp. *capense* and *Centroceras clavulatum*, in the lower eulittoral and the upper sublittoral zones; also in tide pools.

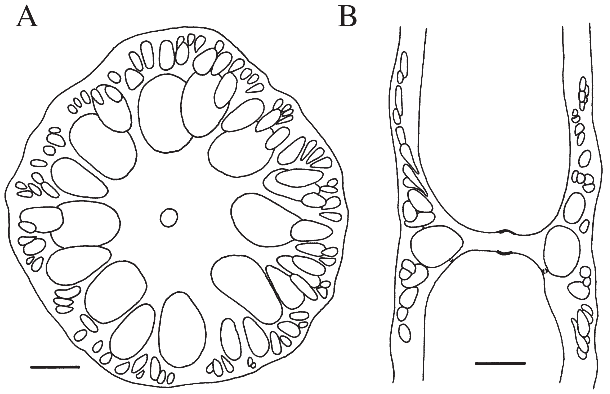

FIG. 120. – *Ceramium atrorubescens*. A. Cross section of a filament through a node. B. Longitudinal section of a filament through a node. Scale bar = 50 µm.

Namibian distribution: Lüderitz, Walvis Bay, Swakopmund, Unjab, Terrace Bay (Lawson *et al.*, 1990); Langstrand, Möwe Bay, Rocky Point (Map 61).

World distribution: Atlantic Ocean: South Africa, Namibia, Canary Islands (Sansón, 1994).

Remarks: Simons (1966) and Sansón (1994) remarked that *Ceramium atrorubescens* is similar to both *C. circinatum* (Kützing) J. Agardh and *C. arenarium*, and pointed out some features which distinguish *C. atrorubescens* from the other two species. *C. circinatum* occurs in the North Atlantic and in the Mediterranean Sea (Sansón, 1991) and has a cortication similar but inverse to that of *C. atrorubescens*, that is, mainly basipetal in the former species and basically acropetal in the latter. Concerning *C. arenarium*, Simons (1966) and Sansón (1994) pointed out that this species differs from *C. atrorubescens* in having circinate apices, pericentral cells centred in the nodes, continuous cortication in the upper part of the plant, numerous rhizoids along the axes, and partially exerted tetrasporangia. These differences are not so clear in our material. The more distinctive feature of our specimens is the presence, usually in the middle part of the plant, of internodes invaded by cortical cells coming from the node immediately below. In contrast, the apex morphology (perhaps not so notably circinate as in *C. arenarium*), the cortication in the upper part of the plant, the abundance of rhizoids, and the arrangement of the tetrasporangia do not distinguish clearly both species. For this reason, it is often difficult to determine incomplete specimens. On the other hand, Sansón (1994) also mentioned the occurrence of hyaline hairs in Canary material of *C. atrorubescens*. In contrast, these structures do not occur either in South African nor Namibian specimens of this species, probably due to the high nutrient richness of the waters in this region as a result of the upwelling. According to Price *et al.* (1986) research concerning these three species should be carried out in order to clarify its taxonomy.

Finally, concerning the cortication type, *C. atrorubescens* is also quite similar to *C. recissum* Kylin, a species recorded by Coppejans (1995) from the Atlantic coasts of France and Belgium.

Ceramium flaccidum (Kützing) Ardissone
(Figs. 121-122)

Hormoceras flaccidum Kützing (1862), p. 21, pl. 69 a-d.
Ceramium flaccidum (Kützing) Ardissone (1871), p. 40.
Ceramium papenfussianum Simons (1966), p. 159.

Lectotype: L 940.265.55. Harvey. Clare (Kilkee).

Selected specimens: Rocky Point, 24-02-1986, BCF-A 11881, with carposporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11406, with tetrasporangia, carposporangia and spermatangia.

References: Feldmann-Mazoyer (1940), Dawson (1950), Taylor (1960), Oliveira (1969), Itono (1972), Abbott and Hollenberg (1976), Cribb (1983), Lawson and John (1987), Millar (1990), Sansón (1991), Price and Scott (1992), Maggs and Hommersand (1993), Adams (1994).

Habit and vegetative structure: Plant 3-7 mm high, consisting of uniseriate, partially corticate, branched filaments 80-120 µm in diameter, attached to the substratum by rhizoids; branching alternate or pseudodichotomous; last order branches 56-80 µm in diameter; apices of filaments erect or slightly incurved. Nodes and internodes clearly differentiated along whole the plant; nodes 0.5-0.8 times longer than broad; internodes longer than nodes, except in the upper part of the plant, 0.4-3.9 times longer than broad. Cortical cells 12-20 x 8-14 µm, arranged in two horizontal bands among which the pericentral cells are partly visible; the lower band usually composed of two rows of more or less regularly arranged cells and the upper one consisting of cells irregularly arranged; pericentral cells elliptic or more or less isodiametric, 32-40 x 24-32 µm; some gland cells occasionally occurring in the upper boundary of the nodes. In cross section, nodes with 7 pericentral cells. Rhizoids unicellular, 12-36 µm in diameter, with or without digitate pads, arising from the pericentral cells of nodes of the lower half of the plant.

Reproduction: Tetrasporangia tetrahedrally divided, subspherical, 41-60 x 40-56 µm, occurring in whorls of 1-4 per node, more or less covered by the cortical cells and causing swelling of the nodes. Plant dioecious. Gonimoblasts globose, 103-180 x 87-160 µm, consisting of two lobes and surrounded by involucral branchlets; carposporangia 28-40 x

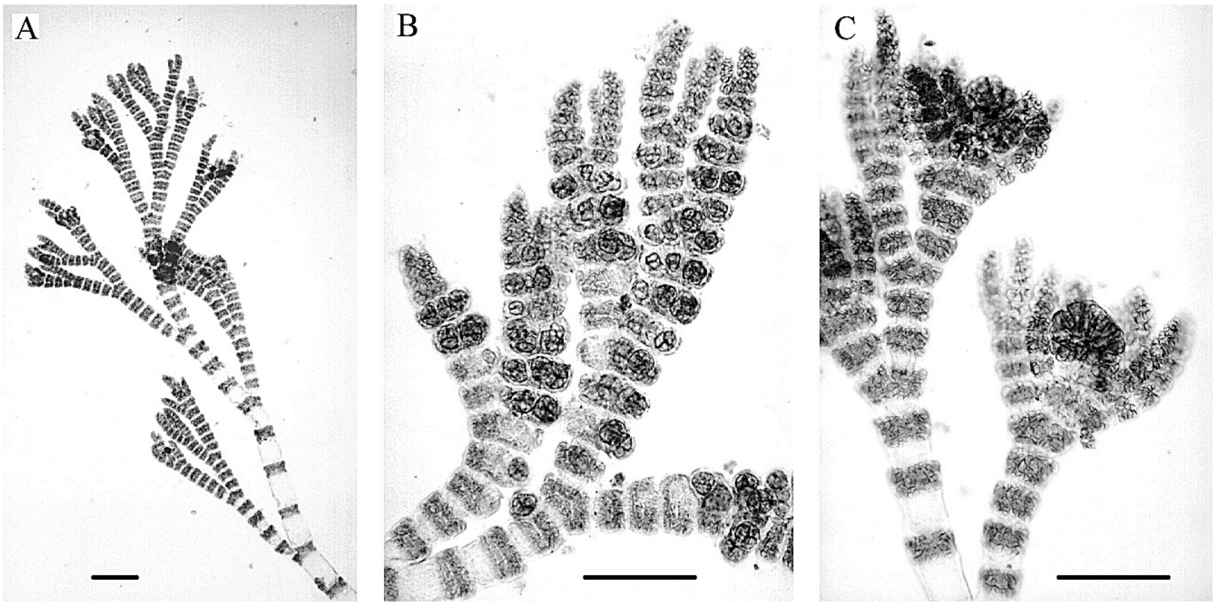

FIG. 121. – *Ceramium flaccidum*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11406. A. Habit. B. Branches with tetrasporangia. C. Branches with gonimoblasts. Scale bar = 200 µm.

24-36 µm. Spermatangia completely covering the nodes of the upper branches.

Habitat: Epiphytic on several algae in the lower eulittoral zone.

Namibian distribution: Grossebucht, Halifax Bay, Lüderitz, Honolulu, Kunene River (Lawson *et al.*, 1990); Rocky Point, South Kunene (Map 62).

World distribution: Probably widespread in warm temperate and tropical seas (Lawson and John, 1987; Sansón, 1991).

Remarks: Simons (1966) described *Ceramium papenfussianum* on the basis of material from South Africa and he pointed out that it differs from *C. flaccidum* (as *C. gracillimum* Griffiths and Harvey) in the arrangement of tetrasporangia (immersed in *C. papenfussianum* and exerted in *C. gracillimum*).

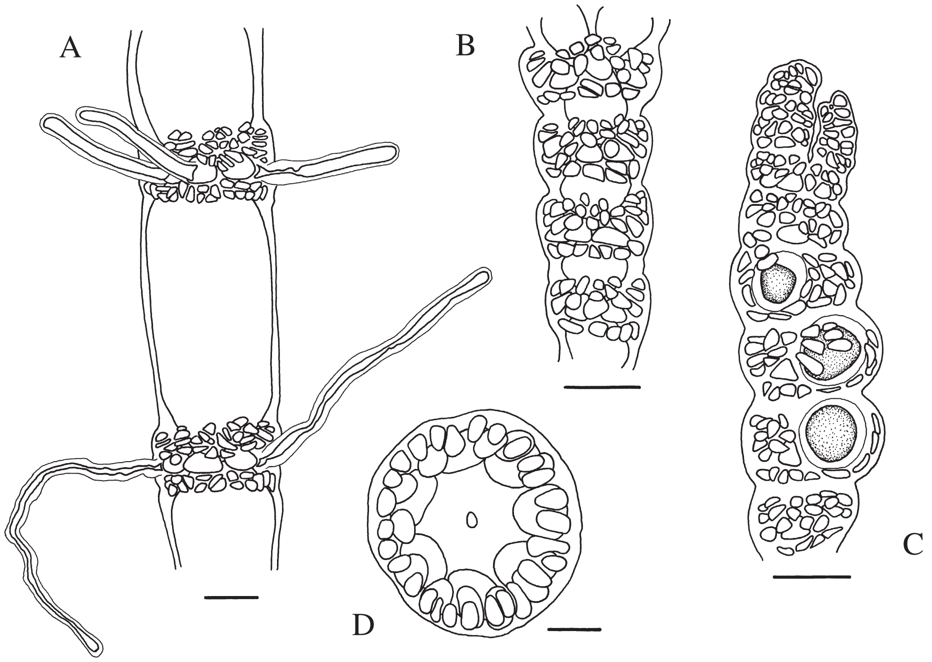

FIG. 122. – *Ceramium flaccidum*. A. Cortication and rhizoids in the median part of the plant. B. Cortication in the upper part of the plant. C. Apical part of a filament with tetrasporangia. D. Cross section of a filament through a node. A-C. Scale bar = 50 µm. D. Scale bar = 25 µm.

Subsequently, Price *et al.* (1986) remarked that *C. papenfussianum* was possibly a synonym of *C. flaccidum*, contrary to the opinion of Simons who provided reasons for not accepting the synonymy. However, some years later, *C. papenfussianum* was considered as a synonym of *C. flaccidum* in the work by Lawson *et al.* (1990) on the marine flora of Namibia, in which Simons is a coauthor. More recently, Stegenga *et al.* (1997) held that the variety of forms within the *C. flaccidum* group is best expressed in the recognition of more than one species, the distribution of which could depend on temperature. In this way, these authors remarked that in South Africa *C. papenfussianum* is a west coast species whereas *C. byssoideum* Harvey (considered as a synonym of *C. flaccidum* by several authors) is more characteristic of the east coast.

Since our specimens are compatible with the *C. flaccidum* descriptions consulted, we have assigned them tentatively to this species, waiting for subsequent studies to clarify the taxonomy of this species group.

Ceramium planum Kützing
(Figs. 123-124)

Ceramium planum Kützing (1849), p. 687.
Ceramium cancellatum C. Agardh (1824), p. 136, *nom. illeg*.
Pteroceras cancellatum (C. Agardh) Kützing (1849), p. 690.
Pteroceras flexuosum Kützing (1849), p. 690.
Ceramium flexuosum (Kützing) Grunow (1867), p. 64, *nom. illeg*.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11403, with tetrasporangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11404, with tetrasporangia and carposporangia; *ibid*., 7-07-1989, BCF-A 12122, with tetrasporangia; Swakopmund, beach, 8-07-1989, BCF-A 11405, with tetrasporangia; Mile 30, 7-07-1989, BCF-A 11882, with tetrasporangia.

Referències: Papenfuss (1952), Simons (1966, 1968), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous up to 6.5 cm high, consisting of uniseriate, completely corticate, branched filaments, often constricted at intervals, attached to the substratum by a basal disc bearing rhizoidal filaments. Main axes 260-800 µm in diameter, bearing branches of limited growth (pinnae) alternate and distichously arranged; pinnae also alternately branched, pseudodichotomous at distal part, complanate, about 1 cm in length and (140-)200-300 µm in diameter at its middle part; last order branchlets straight, 40-80 (-100) µm in diameter; adventitious branchlets abundant in some specimens. Cortication complete, without distinction of separate cortical bands; nodal zones with large inner cortical cells and small outer cortical cells, both of them loosely arranged in both acropetal and basipetal direction; outer cortical cells polygonal, triangular or elongate, 12-40 x 8-20 µm, meeting at the centre of axial cells forming a denser strip; in the branches of limited growth, the inner cortical cells lack in the internodal zones and the outer cortical cells not reach to meet in the centre of axial cells, but leave a narrow ecorticate strip, sometimes laterally closed. In cross section, axes consisting of an axial cell surrounded at nodal zones by 6 pericentral cells and a cortex of large inner cells and small outer ones.

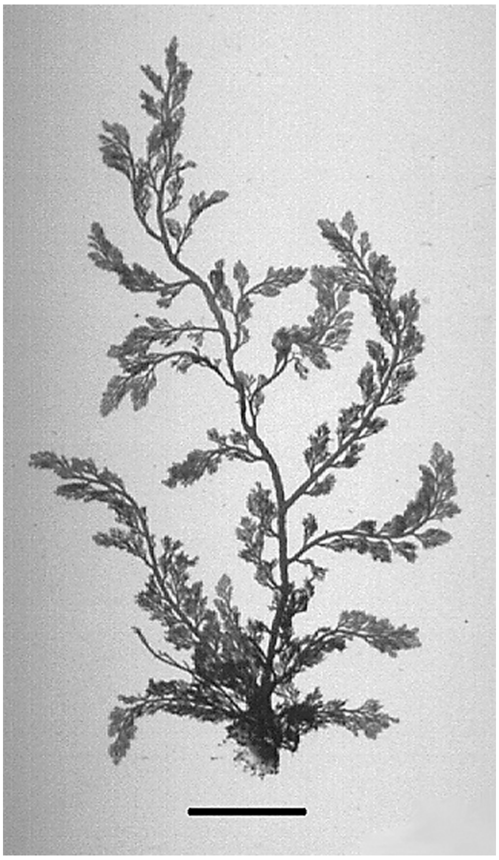

FIG. 123. – *Ceramium planum*. 5 km south of Swakopmund, 7-07-1989, BCF-A 12122. Scale bar = 1 cm.

Reproduction: Tetrasporangia decussately divided, oval or elliptic, 44-68 x 36-56 µm, placed in the nodes of last order branches, exserted, up to 4 per node. Gonimoblasts globose, 316 µm in diameter, surrounded by simple or branched, often bifurcate at apex, involucral branchlets, and placed in the adventitious branchlets and pinnae; carposporangia 44-68 x 28-40 µm. Spermatangia not seen.

Habitat: Epiphyte on *Codium spp*., *Chondria capensis*, *Polysiphonia virgata*, *Pterosiphonia complanata*, etc.; on *Laminaria pallida* haptera and *Plocamium rigidum* in drift material.

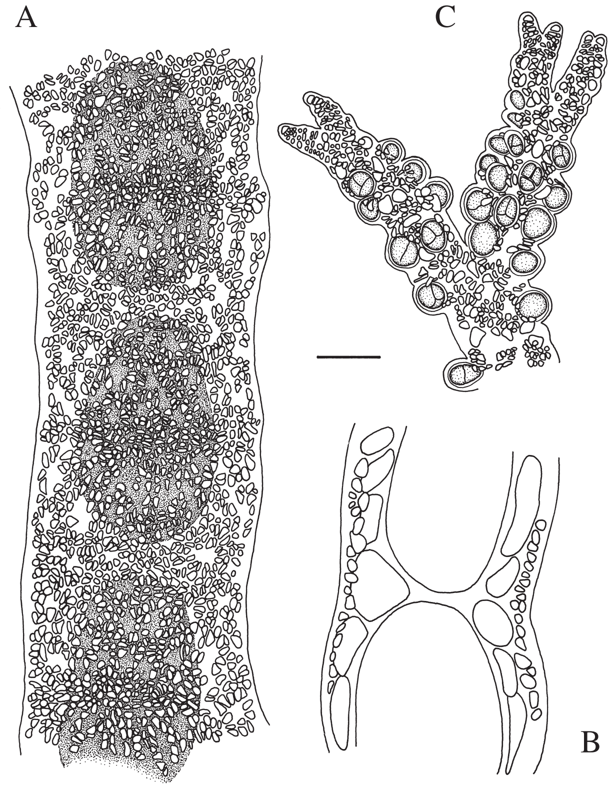

FIG. 124. – *Ceramium planum*. A. Cortication in the median part of the plant. B. Longitudinal section of a filament through a node. C. Tetrasporangia. Scale bar = 100 µm.

Namibian distribution: Lüderitz, Swakopmund (Lawson *et al.*, 1990); Langstrand, Mile 30 (Map 63).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: Mozambique (Silva *et al.*, 1996).

Remarks: Simons (1968) held that there are two forms in *C. planum* which can be assigned respectively to *C. cancellatum* sensu J. Agardh (1894) and *C. flexuosum* sensu J. Agardh (1894), and he treated them, as a whole, as *C. planum* sensu lato. Previously, Papenfuss (1952) had studied the type material of these three species and concluded that *C. cancellatum* and *C. flexuosum* are two forms of the same species, to which also belongs the type material of *C. planum*. Papenfuss (1952) proposed *C. planum* Kützing as the correct name for this species. However, Simons (1968) considered the possibility that Papenfuss (1952) overlooked some distinctive features when he studied the type material of these three taxa, and he suggested that this material was revised again.

On the other hand, Simons (1968) pointed out that *C. planum* sensu lato is very similar to *Campylaephora hypnaeoides* J. Agardh, a species whose distribution is limited to the coasts of Japan and Korea (Itono, 1977). According to this author, the main feature which distinguishs the genus *Ceramium* from *Campylaephora* is the existence of downward rhizoidal cells in the cortex of the species belonging to the second genus. In this way, Simons (1968) pointed out that the single difference between *C. planum* and *C. hypnaeoides* lies in the arrangement of the tetrasporangia, namely exerted in the former and immersed in the latter. Simons (1968) held that this feature is not important enough to distinguish genera, and remarked that *C. planum* sensu lato could belong to the genus *Campylaephora*. However, this author pointed out that the taxonomy of *C. planum* sensu lato will not be clear until the type material of these taxa had been revised. Subsequent works, like Seagrief (1984), Price *et al.* (1986), Wynne (1986), Jackelman *et al.* (1991) and Stegenga *et al.* (1997), referred to this taxon as *C. planum* Kützing, and only Lawson *et al.* (1990) referred to it as *C. planum* complex sensu Simons (1968).

Anderson and Stegenga (1989) cited *Ceramium planum* from the Indian coast of South Africa. Later, Stegenga and Bolton (1992) placed the eastern boundary of the distribution of this species as west of Cape Agulhas. Likewise, Stegenga *et al.* (1997) stated that the Anderson and Stegenga (1989) citation of *C. planum* is erroneous because the material on which it was based does not belong to this species.

Ceramium sp.
(Figs. 125-126)

Selected specimens: Langstrand, 6-07-1989, BCF-A 11884, with spermatangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11883, with spermatangia; Swakopmund, beach, 8-07-1989, BCF-A 11885; Mile 30, 7-07-1989, BCF-A 12148, with tetrasporangia; Mile 108, 13-07-1989, BCF-A 11886; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11887, with tetrasporangia, carposporangia and spermatangia.

References: Wynne (1986).

Habit and vegetative structure: Plant 4-15 mm high, consisting of uniseriate, partially corticate, branched filaments, attached to the substratum by rhizoids. Filaments 100-220 µm in diameter at its middle part, dichotomously branched at base and pseudodichotomous or alternate and more or less complanate at upper half of the plant; adventitious branchlets often abundant and usually fertile; last order branchlets 40-80 µm in diameter; apices straight, with the apical cell quite apparent, 10-16 x 10-16 µm. Nodes and internodes clearly differentiated along whole the plant; nodes well delimited, 0.3-0.6 times longer than broad; internodes usually of the same size of nodes, 0.2-0.6 times longer than

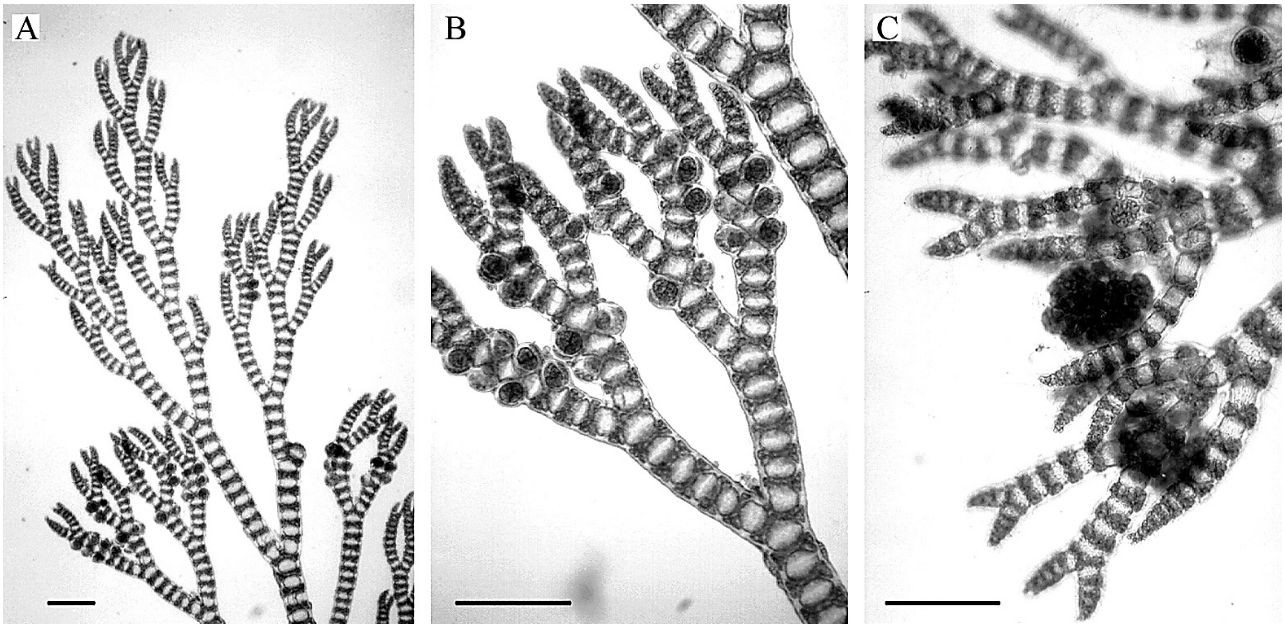

FIG. 125. – *Ceramium* sp. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11887. A. Habit. B. Branches with tetrasporangia. C. Branches with gonimoblasts. Scale bar = 200 μm.

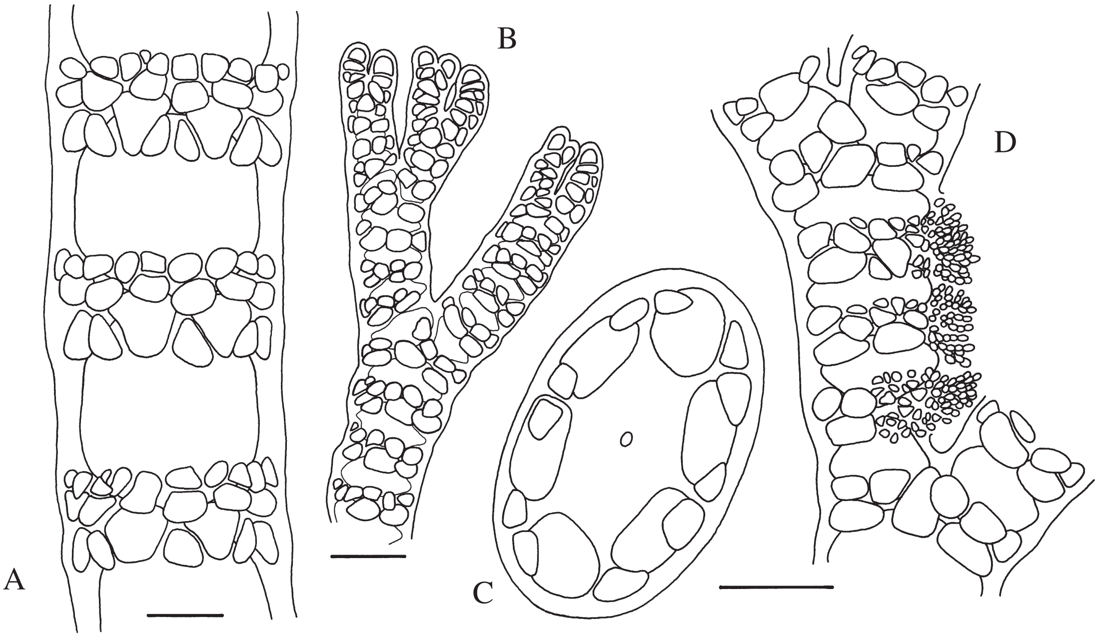

FIG. 126. – *Ceramium sp.* A. Cortication in the lower half of the plant. B. Apical zone. C. Cross section of a filament through a node. D. Spermatangia. Scale bar = 50 μm.

broad, but reaching up to 1.8 times longer than broad in some specimens. Cortical cells 12-36 x 6-28 μm, more or less arranged in 2-3 horizontal rows in the nodes of the middle part of the plant, leaving partly visible the pericentral cells in the lower part of the nodes; pericentral cells 32-60 x 24-42 μm; in some specimens, cortical cells more numerous and sometimes arranged in two horizontal bands among which the pericentral cells are partly visible; nodes of the upper part of the plant with 2(-3) horizontal rows of cortical cells, the lower ones often horizontally elongated. Rhizoids unicellular or multicellular, arising from the pericentral cells of lower nodes. In cross section, nodes with 6 pericentral cells periclinally elongated.

Reproduction: Tetrasporangia cruciate or decussate, elliptic or more or less isodiametric, 40-60 x 30-44 μm, occurring in whorls of 1-3 per node, covered by the cortical cells and causing swelling of the nodes. Plant dioecious. Gonimoblasts globose, 79-

221 µm in diameter, surrounded by involucral branchlets; carposporangia 24-32 x 16-28 µm. Spermatangia covering the nodes of the upper part of the plant.

Habitat: Epiphyte on *Tayloriella tenebrosa* in the lower eulittoral zone; growing on *Polysiphonia virgata* and *Plocamium rigidum*, in drift material.

Namibian distribution: Swakopmund (Wynne, 1986); Langstrand, Mile 30, Mile 108, South Kunene (Map 64).

World distribution: Atlantic Ocean: Namibia.

Remarks: Wynne (1986) mentioned the more important traits of some *Ceramium* specimens pointing out that they cannot be assigned to any of the species known for southern Africa. Likewise, this author remarked the differences with some close species, like *C. tenerrimum* (Mertens) Okamura and *C. fastigiatum* (Roth) Harvey f. *flaccidum* Petersen (at present, *C. cimbricum* Petersen f. *flaccidum* (Petersen) Furnari and Serio). According to Wynne (1986), the main features of this *Ceramium* sp. are the following:

- erect apices;
- distichous, alternate branching;
- cortical bands two cells broad in younger axes but several cells broad in older axes;
- lower row of cortical cells wider than long;
- nodal bands shorter than internodes;
- tetrasporangia borne singly or oppositely, partially exerted and provided with a sparse involucre;
- gland cells absent.

Our specimens generally present all these traits and they are compatible with the iconography of Wynne (1986). However, the nodes have approximately the same size as the internodes, instead of being shorter.

On the other hand, our specimens also agree more or less with the description by Stegenga *et al.* (1997) of some *Ceramium* specimens (as *Ceramium* sp. ind.) found in Port Nolloth (Atlantic coast of South Africa). They are plants with both erect apices and a cortication similar to that of the Namibian specimens, but having greater dimensions (up to 10 cm high and 400 µm in diameter, in comparison with 15 mm and 100-220 µm respectively in our specimens) and 5 pericentral cells (6 in Namibian plants).

In addition to *C. tenerrimum* and *C. cimbricum* f. *flaccidum*, species already commented on by Wynne (1986), the Namibian specimens also are reminiscent of *C. flaccidum*, but this species has thinner axes, internodes longer than nodes in the middle part of the plant, and nodes with a higher number of cells in the upper part.

Genus *Griffithsia* C. Agardh (1817) *nom. cons.*

Griffithsia confervoides Suhr
(Fig. 127)

Griffithsia confervoides Suhr (1840), p. 281.
Griffithsia caespitosa Harvey ex J. Agardh (1851), p. 82.
Griffithsia cymosa Simons (1970), p. 1.

Selected specimens: Terrace Bay, February 1986, BCF-A 11889, with tetrasporangia; Möwe Bay, 4-02-1988, BCF-A 11888, with carposporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11357, with tetrasporangia and carposporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11771; Rocky Point, 24-02-1986, BCF-A 11770.

References: Papenfuss (1940a), Simons (1970), Stegenga (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, forming tufts up to 3 cm high, consisting of uniseriate, branched filaments attached to the substratum by rhizoids. Branching irregular in the lower part of the plant, with branches interwoven and joined to each other by rhizoids; branches arising from the proximal or distal zones of cells, sometimes with a branch in each zone; branching dichotomous or trichotomous in the upper half of the plant. Cells of lower

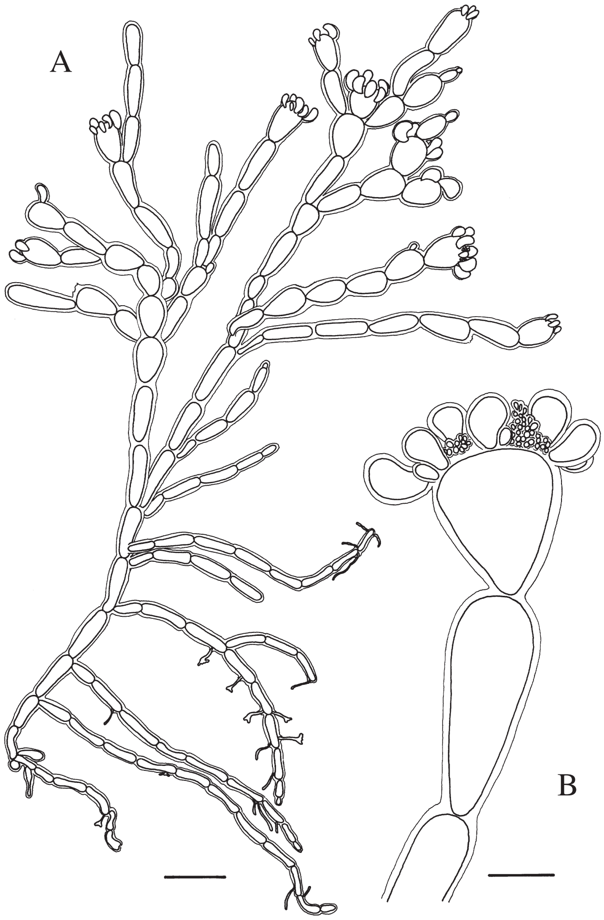

FIG. 127. – *Griffithsia confervoides*. A. Habit. Scale bar = 2 mm. B. Detail of a branch with tetrasporangia. Scale bar = 500 µm.

half of filaments more or less cylindric, 1200-2160 µm long, 340-440 µm broad at proximal end and 460-600 µm broad at distal end; cells of upper part of filaments club-shaped or obovoid, 900-2200 µm long, 220-620 µm broad at proximal end, and 240-1020 µm broad at distal end.

Reproduction: Tetrasporangia tetrahedrally divided, pear-shaped, 52-125 x 32-82 µm, placed in verticillate clusters at distal end of apical or subapical cells, and surrounded by an involucre of small cells arising from the vegetative cell bearing the tetrasporangial clusters; clusters of tetrasporangia consisting of a supporting cell bearing several tetrasporangia. Gonimoblasts globose, formed in apical cells and surrounded by an involucre of small cells; carposporangia 24-60 x 20-40 µm. Spermatangia not seen.

Habitat: Epiphyte on *Tayloriella tenebrosa* and other algae in the lower eulittoral zone and among the specimens of *Laminaria pallida* in the upper sublittoral zone; also growing on worm tubes and molluscs.

Namibian distribution: Toscanini, Torra Bay, Terrace Bay, Möwe Bay (Lawson *et al.*, 1990). Rocky Point (Map 65).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa, Mozambique (Silva *et al.*, 1996).

Remarks: Simons (1970) described *Griffithsia cymosa* on the basis of two features concerning the female reproductive structures of some specimens found in Toscanini (Namibia). Subsequently, Stegenga (1986) remarked on the possibility that *G. cymosa* and *G. confervoides* were conspecific. Later, in the work of Lawson *et al.* (1990) on the marine flora of Namibia, Simons included his species in *G. confervoides*.

Genus *Microcladia* Greville (1830)

Microcladia gloria-spei Stegenga
(Figs. 128-129)

Microcladia gloria-spei Stegenga (1986), p. 60.

Type : Stegenga no. Sa 488, Platboombaai, 3-II-1984.

Selected specimens: Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11890, with tetrasporangia.

References: Stegenga (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, 2.5 cm high, consisting of compressed erect axes, about 1 mm broad, branched, attached to the substratum by short and thin basal rhizoids. Erect axes alternately branched in the upper half (up to 3-4 times), complanate, more or less irregularly branched but also complanate downwards; adventitious branchlets numerous, laterally arranged, usually constrict-

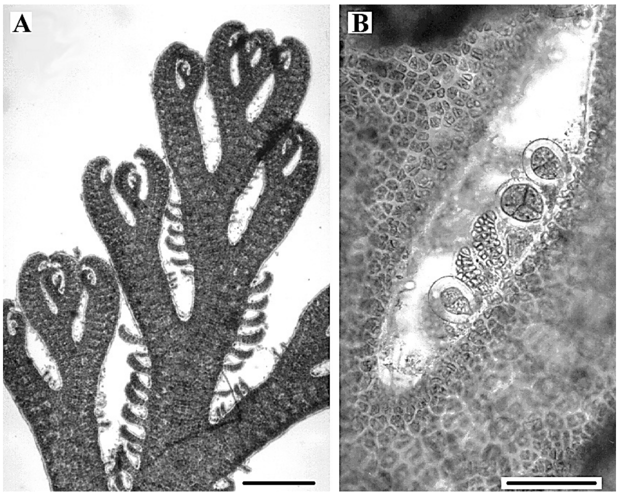

FIG. 128. – *Microcladia gloria-spei*. Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11890. A. Upper part of the plant. Scale bar = 400 µm. B. Tetrasporangia. Scale bar = 100 µm.

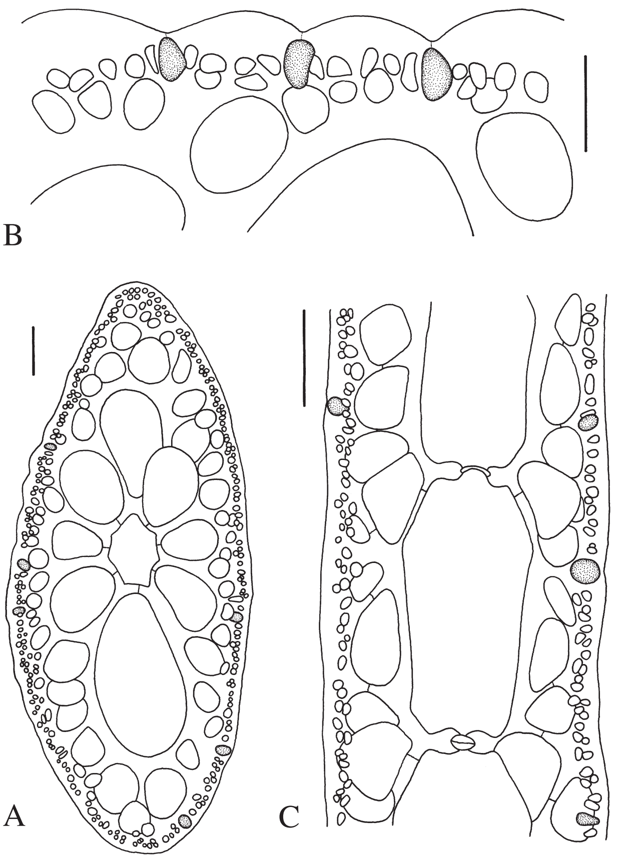

FIG. 129. – *Microcladia gloria-spei*. A. Cross section of an axis. B. Detail of cortical zone of an axis showing three gland cells, in cross section. C. Longitudinal section of an axis. A, C. Scale bar = 100 µm. B. Scale bar = 50 µm.

ed at base and curved upwards; young laterals incurved, overtopping the axes apex. Axes completely corticated. In surface view, axial cells not visible except in the upper part of the axes, where they are more or less isodiametric; outer cortical cells polygonal, triangular or rectangular, 10-20 x 8-14 µm, homogeneously arranged; gland cells numerous, refringent, elliptic or more or less isodiametric, 16-36 x 14-26 µm, scattered between the cortical cells. In cross section, axes showing an axial cell surrounded by 8 pericentral cells, 2 laterals, 3 dorsal and 3 ventral, and a cortical zone of two layers of cells; axial cell 158-198 x 111-158 µm; lateral pericentral cells more or less pear-shaped, 229-340 x 119-182 µm, the abaxial usually bigger than the adaxial; dorsal and ventral pericentral cells smaller than lateral ones, 119-166 x 95-119 µm; inner cortical cells globose, elliptic or isodiametric, 28-108 x 24-100 µm; outer cortical cells pigmented, 10-18 x 8-12 µm; gland cells 22-34 x 14-24 µm; cuticle usually depressed near to the gland cells. In longitudinal section, axial cells more or less cylindrical, 363-387 x 150-174 µm; pericentral cells arising from the distal part of the axial cells, shorter, giving rise to an acropetal cortication.

Reproduction: Tetrasporangia globose or subspherical, tetrahedrally divided, 60-68 x 52-60 µm, exserted, placed on the adaxial side of the last order branches. Other reproductive structures not seen.

Habitat: Growing among the specimens of *Nothogenia erinacea*.

Namibian distribution: Möwe Bay (Map 66).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia.

Remarks: *Microcladia gloria-spei* was described by Stegenga (1986) from the southwest coast of South Africa on the basis of material washed ashore. This author remarked that this species is similar to the other two *Microcladia* species occurring in South Africa, that is to say, *M. gelidii* Simons and *M. exserta* Wynne. Although Stegenga (1986) did not comment on the differences between *M. gelidii* and *M. gloria-spei*, he pointed out that both species share the possession of exserted tetrasporangia, a feature not found in other species of the genus. Concerning *M. exserta*, Stegenga (1986) stated that it differs from *M. gloria-spei* by its smaller size and its prostrate habit. *M. gelidii* is a South African east coast species and, according to Simons (1967), it has axial cells a little wider than high and 6-7(-9) pericentral cells; these features distinguish *M. gelidii* from the other two species. *M. exserta* was described by Wynne (1985a) from Natal, and its South African distribution is restricted to the east coast (Bolton and Stegenga, 1987; Anderson and Stegenga, 1989; Farrell *et al.*, 1993). According to Wynne's (1985a) iconography and description, this species is very similar to *M. gloria-spei* and, although Stegenga (1986) did not comment it, *M. exserta* also have exserted tetrasporangia. However, *M. exserta* can be differentiated from *M. gloria-spei* by the distinctive traits already commented by Stegenga (1986) and because in the former, the cortex consists only of a single layer of cells, whereas in the latter it consists of 2-4 cell layers (Stegenga, 1986).

Since our material, which consists of a single erect specimen, has cylindrical axial cells and a cortex composed of two cell layers, we have identified it as *M. gloria-spei*. In Namibia, this genus had been previously recorded, as *Microcladia* sp., from Terrace Bay (Lawson *et al.*, 1990).

Genus *Pleonosporium* Nägeli (1862) *nom. cons.*

Key to species of *Pleonosporium*:

1. Axes alternately branched, distichous; gonimoblasts surrounded by a single, branched involucral filament ....*P. filicinum*
1. Axes irregularly branched (branches alternate and distichously arranged only in the apical zone of the plant); gonimoblasts surrounded by more than one involucral filament ......*P. harveyanum**

* *P. harveyanum* was not observed. You can find more information about this taxon in Stegenga (1986) and Stegenga *et al.* (1997).

Pleonosporium filicinum (Harvey ex J. Agardh) De Toni (Figs. 130-131)

Halothamnion filicinum Harvey ex J. Agardh (1876), p. 54.
Pleonosporium filicinum (Harvey ex J. Agardh) De Toni (1903), p. 1308.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11407, with polysporangia and procarps; Möwe Bay, 4-02-1988, BCF-A 11891, with polysporangia.

References: Stegenga (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, up to 3.5 cm high, consisting of an uniseriate, branched main axis, 320-420 µm in diameter; lower portion of main axis with a loose rhizoidal cortication. Rhizoids multicellular, branched, 80-140 µm in diameter, arising from the basal cells of laterals.

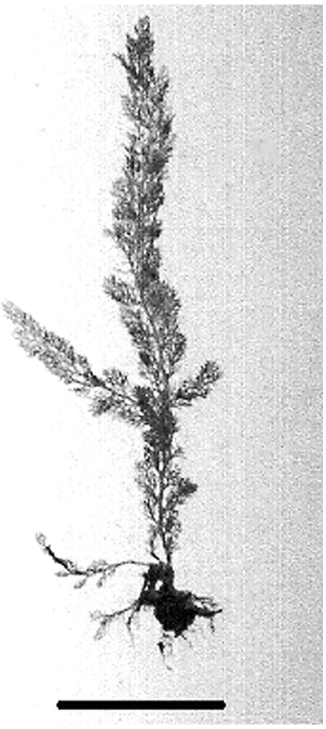

FIG. 130. – *Pleonosporium filicinum*. Möwe Bay, 4-02-1988, BCF-A 11891. Scale bar = 1 cm.

Branching alternate, up to 4-5 times, with the laterals distichously arranged, one on every cell; basal cell of third and forth order laterals often with two opposite branchlets, the adaxial one usually shorter and sometimes unicellular; occasionally, basal cell of third and fourth order laterals with 3-4 verticillate branchlets; branches of last order usually unilateral, adaxially arranged. Cells of main axis cylindrical, 1.7-3.1 times longer than broad, 500-1200 x 300-400 µm; cells of laterals 119-200 x 70-111 µm; apical cell 79-240 x 63-87 µm.

Reproduction: Polysporangia elliptic or pear-shaped, 111-158 x 87-134 µm, sessile, adaxial, usually solitary but sometimes seriate, with 7-9 spores in surface view. Procarps laterally arranged in last order branches, on the subapical cell of a 3-celled filament, the lowermost of them forming a single, repeatedly branched involucral filament. Spermatangia not seen.

Habitat: Growing on the holdfast and stipe of *Rhodymenia obtusa*, in the lower eulittoral zone.

Namibian distribution: Langstrand, Mile 8 (Engledow, 1998); Swakopmund, Möwe Bay (Map 67).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Pleonosporium filicinum* was described by J. Agardh (1876) as *Halothamnion filicinum* on the basis of material from Muizenberg (Cape peninsula) and, at present, it is known to occur on the south and east coasts of South Africa and in Namibia. The distinctive features of this species include the alternate and distichous branching (with a branchlet in every cell), the polysporangia with numerous spores (32-64), and the gonimoblasts surrounded by a single branched involucral filament.

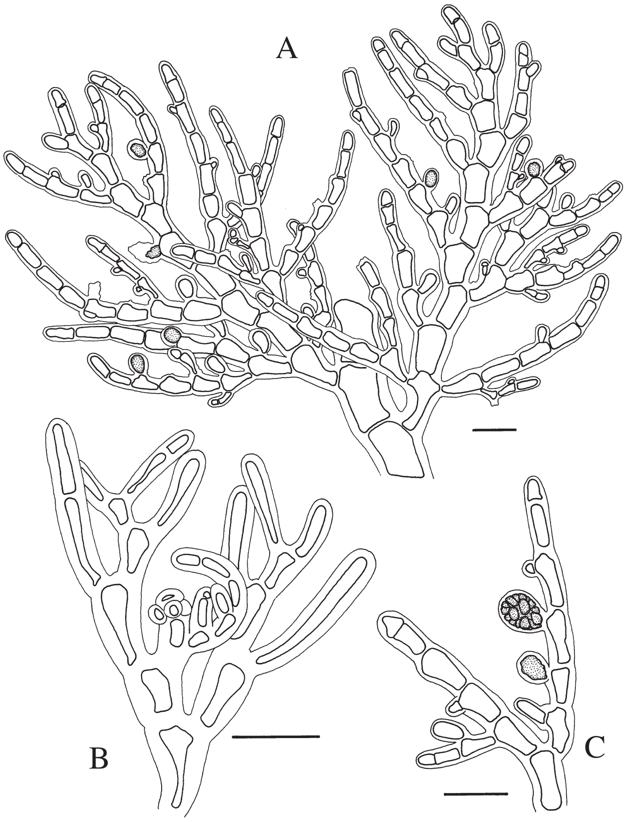

FIG. 131. – *Pleonosporium filicinum*. A. Detail of an axis and laterals. B. Procarp. C. Polysporangia. Scale bar = 200 µm.

In our specimens the branching is also alternate and distichous, but the basal cell of some branches often bears two opposite branchlets, as occurs in *Pleonosporium paternoster* Stegenga, an endemic species of South Africa which is very similar to *P. filicinum* (Stegenga, 1986). Like *P. paternoster*, the Namibian specimens also consist of thicker filaments (320-420 µm in diameter, in comparison with 200-250 µm in *P. filicinum*) and have polysporangia with a relatively low number of spores (7-9 spores in surface view; 16 spores according to Stegenga (1986) in *P. paternoster*). However, concerning the size of the polysporangia, our specimens are more similar to *P. filicinum* than to *P. paternoster*. Moreover, this last species has 6 involucral filaments surrounding the gonimoblasts, whereas in our specimens, like in *P. filicinum*, the gonimoblasts are surrounded by a single filament. On the other hand, a loose basal cortication composed of intertwined rhizoids issuing from the basal cells of the branches occurs in Namibian specimens. This feature is not mentioned in either Stegenga (1986) or Stegenga *et al.* (1997). In this way, our specimens are compatible with *P. harveyanum* (J. Agardh) De Toni, another South African species which, in this case, also occurs in the south coast of Namibia (Lawson *et al.*, 1990). Nevertheless, the branching pattern, the ultimate branchlets curved and overtopping the apical zone, and the gonimoblasts surrounded by several involucral filaments differentiate this species from both our specimens and *P. filicinum*. Moreover, in agreement with the Kylin (1956) and Itono (1977) descriptions of the genus *Pleonosporium*, *P. harveyanum* has two pericentral cells in the subapical cell of the female fertile filament, whereas *P. filicinum* and *P. paternoster* have three. In our specimens the procarps are abundant but the material preservation degree does not allow us to observe this feature safely.

All things considered, and since Stegenga *et al.* (1997) held that the only features which distinguish *Pleonosporium filicinum* from *P. paternoster* are those concerning the reproductive structures, we have preferred to assign our specimens to *P. filicinum*.

Genus *Ptilothamnion* Thuret in Le Jolis (1863)

Ptilothamnion polysporum Gordon-Mills and Wollaston in Wollaston (Fig. 132)

Ptilothamnion polysporum Gordon-Mills and Wollaston in Wollaston (1984), p. 293.

Holotype: UC (Papenfuss and Scagel PR-XXXV-116, International Indian Ocean Expedition, 28 Nov. 1962).

Selected specimens: Möwe Bay, 4-02-1988, BCF-A 11892, with polysporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11893, with polysporangia.

References: Wollaston (1984), Stegenga (1986), Bolton and Stegenga (1987), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, up to 15 mm high, consisting of prostrate and erect uniseriate, ecorticate filaments. Prostrate filaments 51-70 µm in diameter, branched, interwoven, attached to the substratum by rhizoids and forming a spongy base that retain sediment; cells of prostrate filaments cylindric, 2.2-4.6 times longer than broad, 95-253 x 44-71 µm. Rhizoids and erect filaments arising from the central zone of cells of prostrate filaments, sometimes in a opposite manner; rhizoids usually unicellular, simple, 30-40 µm in diameter, ending in a digitate haptera. Erect filaments 55-79 µm in diameter, simple or scarcely branched, usually short but sometimes longer and especially branched in the upper zone; cells of erect filaments cylindric, 1.4-3.1 times longer than broad, 79-245 x 47-79 µm; apical cell cylindric, 47-126 x 40-55 µm, with a rounded end.

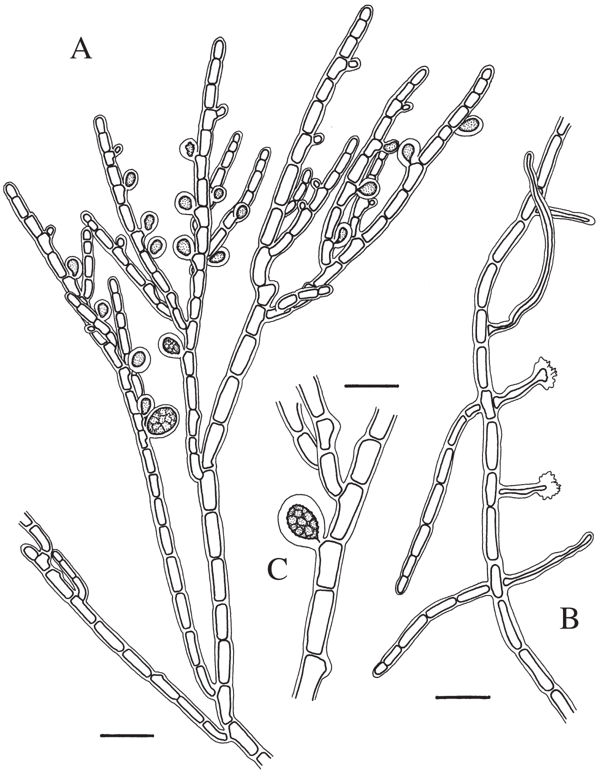

FIG. 132. – *Ptilothamnion polysporum*. A. Upper part of an erect filament with polysporangia. B. Prostrate filament. C. Polysporangia. A-B. Scale bar = 200 µm. C. Scale bar = 100 µm.

Reproduction: Polysporangia elliptic or subspherical, 87-126 x 71-111 µm, sessile, adaxially arranged on last order branches of greater specimens, with 6-9 spores in surface view. Other reproductive structures not seen.

Habitat: Epiphyte on *Griffithsia confervoides* in the lower eulittoral zone.

Namibian distribution: Möwe Bay. According to Stegenga *et al.* (1997) this species is found in Namibia, but the authors do not refer to any locality. (Map 68)

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: Australia, Mozambique, South Africa (Silva *et al.*, 1996).

Remarks: *Ptilothamnion polysporum* was described in the work of Wollaston (1984) on the basis of material collected during an international expedition to the Indian Ocean in 1962. At first, this species was recorded from western Australia, Mozambique and eastern South Africa, and later its distribution western boundary has enlarged to False Bay, on the southwest coast of South Africa (Stegenga *et al.*, 1997). Stegenga (1986) pointed out that east of Cap Agulhas and in False Bay this species occurs only in the relatively warm localities.

Our specimens agree quite well with the *P. polysporum* descriptions of Wollaston (1984), Stegenga (1986) and Stegenga *et al.* (1997), although they have relatively thicker filaments. In this way, the Namibian specimens are more close to the material of Stegenga (1986) and Stegenga *et al.* (1997) than to that of Wollaston (1984). On the other hand, our specimens are found in an area which is influenced by warm waters descending from Angola, a fact which agrees with the remark of Stegenga (1986).

Family DASYACEAE Kützing (1843)
Genus *Heterosiphonia* Montagne (1842) *nom. cons.*

Key to species of *Heterosiphonia*:

1. Axes with 4-5 pericentral cells.........*H. crispella*
1. Axes with more than 5 pericentral cells...........2

2. Axes with 6 pericentral cells; ultimate branchlets polysiphonous except for the terminal 2-3 segments.......................................*H. pellucida**
2. Axes with 8 pericentral cells; ultimate branchlets monosiphonous....................................*H. dubia*

*In addition to the species included in this key, *H. crispa* has also been recorded from Namibia (Lüderitz, Möwe Bay) by Engledow (1998). This species is very similar to *H. crispella* and both could be conspecific (see the remark in the latter species). *H. pellucida* was not observed. More information about this taxon can be found in Stegenga *et al.* (1997).

Heterosiphonia crispella (C. Agardh) Wynne
(Figs. 133-134)

Callithamnion crispella C. Agardh (1828), p. 183.
Heterosiphonia crispella (C. Agardh) Wynne (1985b), p. 87.

Holotype: LD 44225 (C. Agardh Herbarium).

Selected specimens: Terrace Bay, February 1986, BCF-A 11902, with tetrasporangia; Möwe Bay, 4-02-1988, BCF-A 11798, with tetrasporangia and carposporangia; *ibid.*, BCF-A 11800, with tetrasporangia; Möwe Bay, 25-02-1986, BCF-A 9605, with tetrasporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11387, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11799, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11388, with tetrasporangia.

FIG. 133. – *Heterosiphonia crispella*. Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11799. Scale bar = 1 cm.

References: Dawson (1963), Schnetter and Bula Meyer (1982), Oliveira (1969), Cordeiro-Marino (1978), Taylor (1960), Coppejans (1983), Børgesen (1930), Lawson and John (1987), Rull Lluch and Gómez Garreta (1993), Jaasund (1976), Cribb (1983), Price and Scott (1992).

Habit and vegetative structure: Plant up to 3 cm high, consisting of a polysiphonous, ecorticate, branched main axis, 140-260 µm in diameter, bearing alternate and distichously arranged branches of limited growth every other segment; attachment by means of rhizoidal filaments ending, or not, in an attachment pad. Branches of limited growth polysiphonous at base (1-2 segments) and monosiphonous upwards, alternately branched every other cell, with the branchlets distichously arranged; the lowermost branchlet simple and slightly longer than the others; specimens with some branchlets particularly long, especially in the upper part of the plant, occasionally occur; branches of limited growth 71-103 µm in diameter just above the polysiphonous region; cells of the last order branches cylindric, 0.9-1.9 times longer than broad, 47-103 x 40-71 µm; apical cell 13-44 x 13-36 µm. In cross section, main axis composed of an axial cell and 4-5 pericentral cells.

Reproduction: Tetrasporangia tetrahedrally divided, 36-68 x 28-56 µm, immersed in stichidia; estichidia conical to cylindrical, 387-780(-948) µm

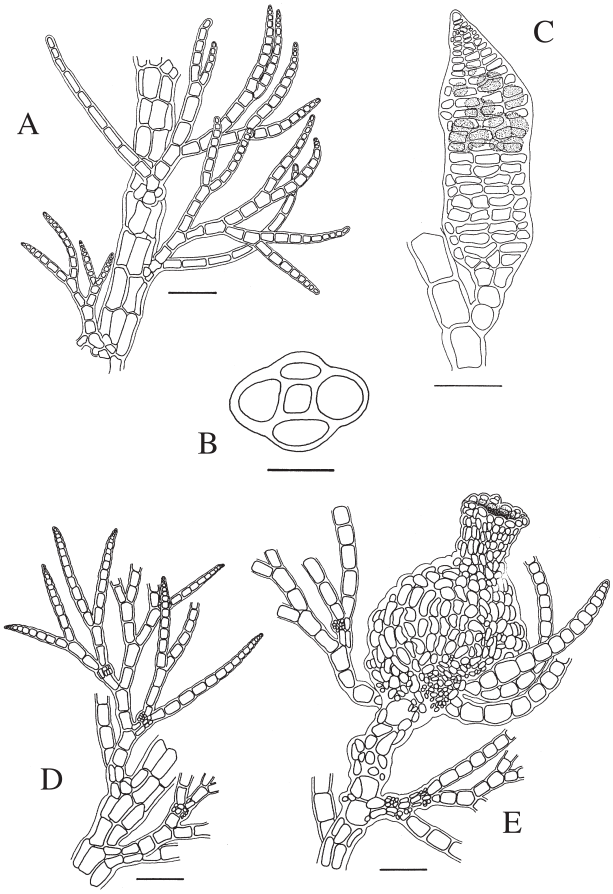

FIG. 134. – *Heterosiphonia crispella*. A. Detail of main axis and determinate branches. B. Cros section of a main axis. C. Stichidium with tetrasporangia. D. Determinate branches with procarps. E. Cystocarp. A, D, E. Scale bar = 200 µm. B-C. Scale bar = 100 µm.

long and 119-142 µm broad, with a pedicel of 2-3 cells, sometimes polysiphonous at base. Procarps developing just below the dichotomies of limited growth branches, giving a polysiphonous aspect to this part of branchlets; cystocarps more or less urceolate, 560-700 µm in diameter, with a fairly prominent neck 260-300 µm in length. Spermatangia not seen.

Habitat: Epiphyte on *Centroceras clavulatum*, *Plocamium rigidum*, *Tayloriella tenebrosa* and *Ahnfeltiopsis vermicularis*, among other algae, in the lower eulittoral zone and among the specimens of *Laminaria pallida*.

Namibian distribution: Möwe Bay (Rull Lluch and Gómez Garreta, 1993); Terrace Bay, Rocky Point (Map 69).

World distribution: Widespread from boreal-antiboreal to tropical seas (Lawson and John, 1987). The distribution includes *H. crispella* var. *laxa* (Børgesen) Wynne (1985b), p. 87.

Remarks: The presence of long and thin branches (55-63 µm in diameter just above the polysiphonous region), with cells 3-6.3 times longer than broad (Fig. 135), as well as of main axes composed of 4 pericentral cells, occur with a certain frequency in some of our specimens (BCF-A 9605 and 11800). These features are distinctive of *H. crispella* var. *laxa* (Børgesen) Wynne, taxon to which these specimens could be assigned, although its general appearance does not differs significantly from the others (Rull Lluch and Gómez Garreta, 1993).

When Wynne (1985b) and Price *et al.* (1992) commented on the distribution of *Heterosiphonia crispella*, they treated both varieties of this species (var. *crispella* and var. *laxa*) as a whole. On the other hand, Falkenberg (1901) and Dawson (1963) held that the var. *laxa* could represent a different species.

According to the literature consulted, the var. *laxa* differs from the var. *crispella* mainly in having 4 pericentral cells [4-6 according to Lawson and John (1987)] and a more lax appearance due to the presence of longer and thinner branches. In contrast, the var. *crispella* has 5-6 pericentral cells and a more squarrose appearance. Moreover, according to Falkenberg

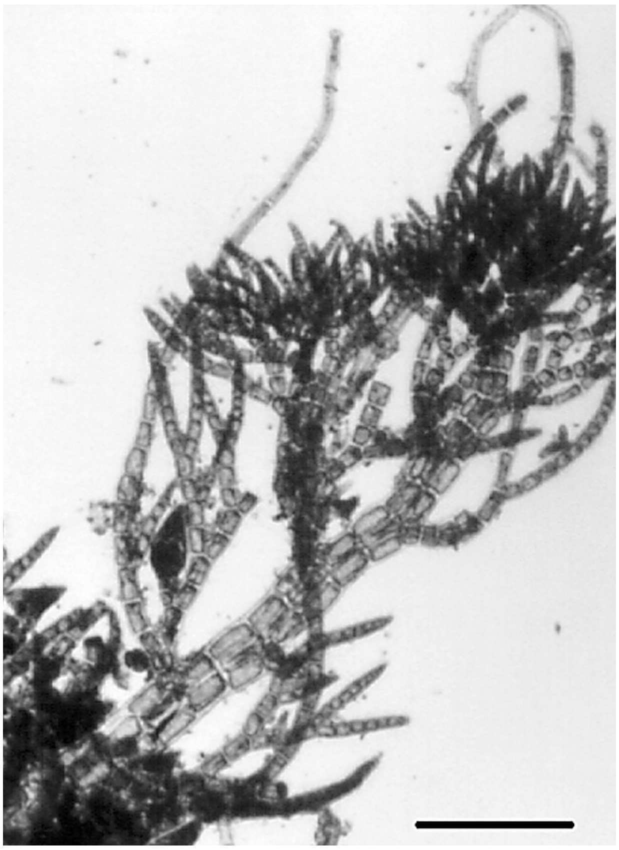

FIG. 135. – *Heterosiphonia crispella* var. *laxa*. Möwe Bay, 25-02-1986, BCF-A 9605. Scale bar = 500 µm.

(1901) and Børgesen (1930) the ecology of both varieties is different: whilst the var. *laxa* grows in the depth and in sheltered places, the var. *crispella* occurs mainly in surface and in exposed sites. In Namibia both varieties show the same ecology and they are difficult to distinguish, reasons for which we hold that perhaps they should be considered as a single taxon.

Heterosiphonia crispella is very similar to *H. crispa* (Suhr) Falkenberg, a South African endemic species according to Stegenga *et al.* (1997). These authors include *H. capensis* Falkenberg in *H. crispa* pointing out that there appears to be no logical basis for distinguishing more than one *Heterosiphonia* species with four pericentral cells in the South African coasts. In this way, we hold that there are no significant differences between *H. crispa* (on the basis of the Falkenberg (1901) and Stegenga *et al.* (1997) iconography and descriptions of this species) and *H. crispella*, and therefore, it is possible that both taxa could be conspecific. However, we think that a thorough study including all these species should be carried out in order to clarify its taxonomy.

Heterosiphonia dubia (Suhr) Falkenberg
(Fig. 136)

Dasya dubia Suhr (1840), p. 280.
Heterosiphonia dubia (Suhr) Falkenberg (1901), p. 639.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11391, with tetrasporangia and carposporangia; Möwe Bay, 5-02-1988, BCF-A 11895, with procarps and spermatangia.

References: Falkenberg (1901), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 2 cm high, consisting of a polysiphonous, ecorticate, branched main axis, 160-276 µm in diameter at its middle part, bearing alternate branches of limited growth distichously arranged every other segment; segments 0.6-0.8 times longer than broad. Attachment by multicellular rhizoids. Branches of limited growth polysiphonous, bearing pinnulae 400-600 µm long also alternate and distichously arranged every other segment; pinnulae branched of the same manner, with the axis polysiphonous, 63-79 µm in diameter, and the ultimate branchlets monosiphonous, 40-55 µm in diameter; apical cell 12-28 x 14-22 µm. In cross section, main axis composed of an axial cell surrounded by 8 pericentral cells.

Reproduction: Tetrasporangia tetrahedrally divided, 40-60 x 36-52 µm, formed in stichidia conical to cylindrical; in cross section, stichidia with 6 tetrasporangia per segment. Plant dioecious. Cystocarps more or less spherical, mucronate, 520-860 x 400-740 µm; carposporangia elliptic or more or less isodiametric, 44-64 x 40-56 µm. Spermatangia covering the last order branches, which seems conical to cylindrical stichidia 168-320 µm long and 60-80 µm broad; branchlets bearing spermatangia simple or branched, often unilaterally arranged.

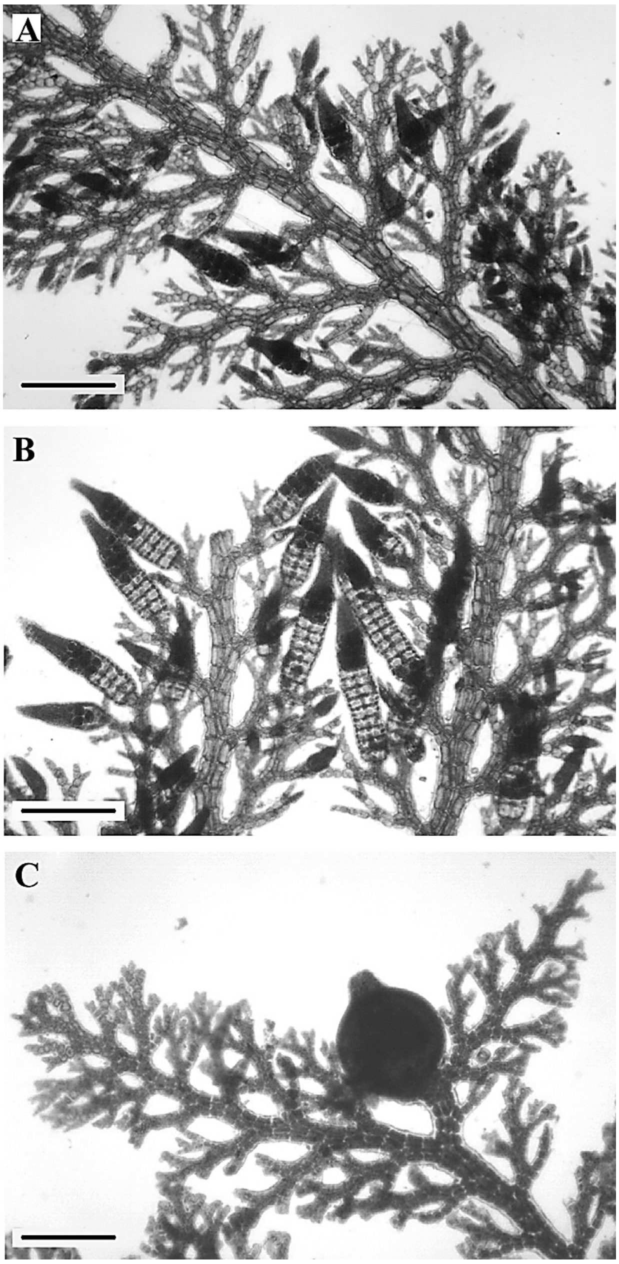

FIG. 136. – *Heterosiphonia dubia*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11391. – A-B. Tetrasporophyte. A. Main axis and determinate branches. B. Stichidia. C. Cystocarp. Scale bar = 400 µm.

Habitat: Growing on the base of *Pterosiphonia complanata*, together with *Griffithsia confervoides* and *Centroceras clavulatum*, in the lower eulittoral zone; epiphyte on *Cladophora hospita*, *Plocamium* *rigidum* and *Rhodymenia obtusa*, in drift material.

Namibian distribution: Swakopmund (Wynne, 1986); Möwe Bay (Map 70).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia (Wynne, 1986). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Heterosiphonia dubia* was described as *Dasya dubia* by Suhr (1840) on the basis of material from False Bay. Later, Falkenberg (1901) transferred the species to the genus *Heterosiphonia*, but he considered some specimens from Algoa Bay (Indian coast of South Africa) as the original material of this species (Silva *et al.*, 1996). The present distribution of *H. dubia* includes mainly the south and east coasts of South Africa, albeit this species has also been recorded from northern Namibia.

Our specimens are compatible with the Falkenberg (1901) and Stegenga *et al.* (1997) descriptions of *Heterosiphonia dubia* and with the illustrations of this species showed by Wynne (1986). On the other hand, our material is also very similar to that of the east coast of South Africa described by Bolton and Stegenga (1987) as *Heterosiphonia* sp. However, the latter has 6-7 pericentral cells, whereas in our specimens the pericentral cells are 8.

Family DELESSERIACEAE Bory de Saint Vincent (1828)

Genus *Acrosorium* Zanardini in Kützing (1869)

Key to species of *Acrosorium*:

1. Plant with pale spots scattered over the blade surface ....*A. maculatum**
1. Plant without pale spots over the blade surface ..2
2. Blade much divided, with the lobes contorted and overlapping each other, giving a globose and ruffled aspect to the plant............*A. cincinnatum*
2. Blade with the lobes not over lapping each other ....*A. acrospermum**

* *A. maculatum* and *A. acrospermum* were not observed. More information about these taxa can be found in the remarks on *A. cincinnatum* below, and in the works of Wynne (1986) and Stegenga *et al.* (1997).

Acrosorium cincinnatum Wynne (Figs. 137-138)

Acrosorium cincinnatum Wynne (1986), p. 319.

Holotype: Wynne 7479 in MICH, 5 km south of Swakopmund, 7.iv.1983.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12217; Swakopmund, beach, 8-07-1989, BCF-A 11896, with spermatangia; Terrace Bay, February 1986, BCF-A 11899, with tetrasporangia; Möwe Bay, 4-02-1988, BCF-A 11898, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11897, with tetrasporangia.

References: Wynne (1986).

Habit and vegetative structure: Plant foliaceous, forming globose tufts 1.5-4 cm in diameter, consisting of a flat or slightly channelled blade repeated divided to ending in rounded, contorted and overlapping lobes (1-)2-5 mm broad, giving a ruffled aspect; blade margin entire or bearing some proliferation; a short stipe occur in some specimens. Attachment by more or less abundant, simple or branched, pseudoparenchymatic rhizoids arising from either the blade surface or margin, as much in

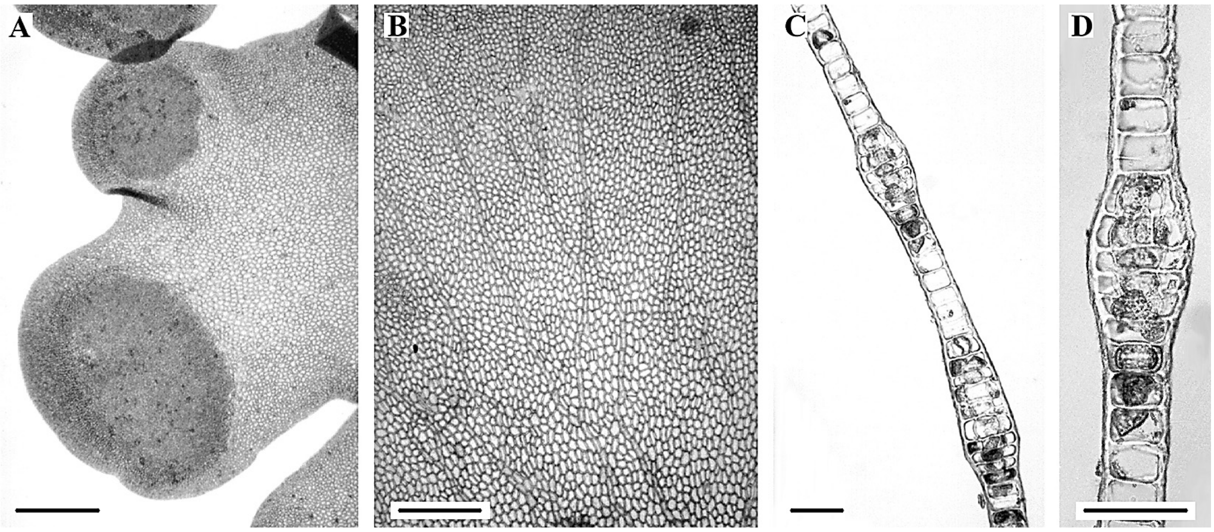

FIG. 137. – *Acrosorium cincinnatum*. A. Spermatangial sorus. B. Microscopic veins in surface view. C-D. Cross section of the blade. A-B: Scale bar = 400 µm. C-D: Scale bar = 100 µm.

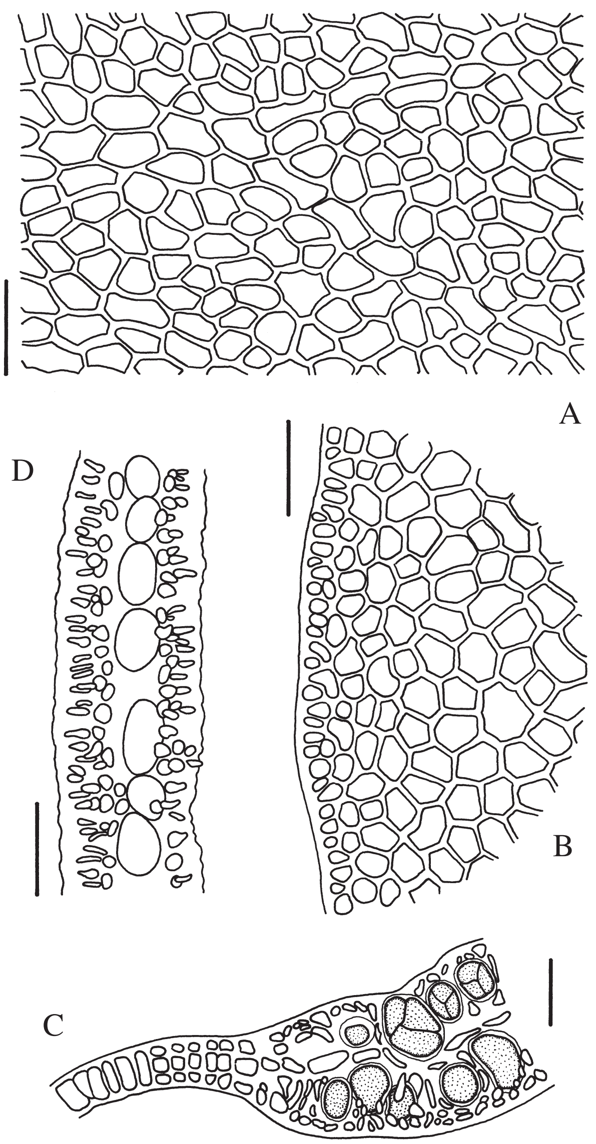

FIG. 138. – *Acrosorium cincinnatum*. A. Blade in surface view. B. Marginal apical zone. C. Cross section of the blade through a tetrasporangial sorus. D. Cross section of the blade through a spermatangial sorus. A, C. Scale bar = 100 µm. B, D. Scale bar = 50 µm.

the basal part of the plant as in the upper one; blades sometimes coalescent. In surface view, blade cells polygonal, usually elongate, 32-88 x 24-48 µm, with a reticulate, parietal plastid; microscopic veins branched, composed of polygonal, elongate cells 48-140 x 17-36 µm, and more or less abundant depending on the specimens; marginal cells divided by a longitudinal septum. In cross section, blade usually monostromatic except in the microscopic veins, 40-80 µm thick, consisting of square to rectangular cells anticlinally arranged; in the microscopic vein zones, blade slightly thicker, 72-132 µm thick, consisting of a central layer of square to rectangular, anticlinally arranged large cells and 1-2 layers of small cells above and below; all these cells arranged in regular vertical rows.

Reproduction: Tetrasporangia tetrahedrally divided, more or less isodiametric, 60-88 x 52-88 µm, occurring in sori in the blade lobes, sometimes deforming the blade; in cross section, tetrasporangia arranged in two rows. Spermatangia spherical in surface view, 3-6 µm in diameter, formed in sori in both sides of the blade lobes; in cross section, spermatangia elongate, (7-)10-14 x 2-5 µm. Female reproductive structures not seen.

Habitat: Epilithic or epiphytic on several algae, especially on *Corallina* sp. and *Ahnfeltiopsis glomerata* in the lower eulittoral zone, and among the *Laminaria pallida* specimens in the upper sublittoral.

Namibian distribution: Swakopmund (Wynne, 1986); Terrace Bay, Möwe Bay, Rocky Point (Map 71).

World distribution: Atlantic Ocean: Namibia.

Remarks: *Acrosorium cincinnatum* was described by Wynne (1986) on the basis of material from a locality a few kilometres south of Swakopmund, and until now, had not been recorded again. According to Wynne (1986) the feature which distinguishes *A. cincinnatum* from the other species of this genus is its highly ruffled and congested appearance.

As a whole, our material agrees quite well with Wynne's (1986) description, although some specimens show some morphological or anatomical differences. On the one hand, there are specimens (5 km south of Swakopmund, 7-07-1989, BCF-A 12214) which do not have the typical ruffled appearance but are rather flattened, although anatomically they do not differ significantly from the others. On the other hand, there are plants (5 km south of Swakopmund, 6-07-1989, BCF-A 12216; Swakopmund, beach, 8-07-1989, BCF-A 11316) with the typical ruffled appearance but having a slightly different structure. They are specimens consisting of relatively thicker blades (142-174 µm thick) which are composed of 3-5 cell layers in the basal zone, remaining monostromatic only in both the margins and the upper zone.

In addition to *A. cincinnatum* and *Acrosorium* sp., Lawson *et al.* (1990) cited *A. acrospermum* (J. Agardh) Kylin and *A. maculatum* (Kützing) Papenfuss from the Namibian coasts. They are two typical species of the south and east coasts of South Africa, although the second occurs also in southern Angola (Lawson and John, 1987). The more distinctive trait of *A. maculatum* is the presence of pale spots on the blade (Papenfuss, 1940a; Stegenga *et al.*, 1997), which distinguishs this species from *A. cincinnatum*. However, the differences between *A. cincinnatum* and *A. acrospermum* do not seem so clear. According to Wynne (1986) *A. acrospermum* differs from *A. cincinnatum* by its taller stature and because the blades lie in one plane. According to this, a part of our material (those specimens lacking the typical ruffled appearance of *A. cincinnatum*) could be assigned to *A. acrospermum*. However, according to Stegenga *et al.* (1997) this species also has the blade somewhat convoluted and contorted. On the other hand, these authors remarked that, except for the presence or absence of pale spots, there appear to be few differences between *A. acrospermum* and *A. maculatum*.

According to the available information, the features which distinguish *A. cincinnatum* from *A. acrospermum* do not seem solid enough taxonomically. On the other hand, Wynne (1986) cited *A. cincinnatum* as the single species of this genus in the Swakopmund area and, as the morphological and anatomical differences observed occur in material from the same area, we prefer treat it as a whole and assign it tentatively to this species. However, we hold that the differences between the species of *Acrosorium* cited from Namibia are not clear, and that a critical revision of this genus (and in general of the family Delesseriaceae) should be carried out in this geographical area.

Genus *Myriogramme* Kylin (1924)

Myriogramme livida (Hooker and Harvey) Kylin (Fig. 139)

Nitophyllum livida Hooker and Harvey (1845), p. 253.
Myriogramme livida (Hooker and Harvey) Kylin (1924), p. 58.

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11805.
References: Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliaceous, up to 2.5 cm high, consisting of a flat, more or less dichotomously divided blade, with entire margin and ending in lobes 4-5 mm broad. Macroscopic veins present, branched, easily visible by transparency, 3-4 cells broad in the lower part of the plant and 1-2 cells broad in the upper part; vein cells elongate, 92-180 x 28-44 µm; blade cells usually polygonal with rounded corners, 60-100 x 32-68 µm; plastids numerous, discoidal or elliptic; marginal apical cells divided by a longitudinal septum. In cross section, blade usually monostromatic except in the veins, 100 µm thick, with rectangular cells 72-100 µm high per 40-60 µm broad; veins 120-140 µm thick, consisting of 3-5 cell layers regularly arranged in both vertical and horizontal rows; central cells of the veins more or less square, 28-44 x 28-44 µm; outer cells 16-40 µm high per 32-44 µm broad.

Reproduction: Reproductive structures not seen.

Habitat: In the lower eulittoral zone.

Namibian distribution: Swakopmund (Stegenga *et al.*, 1997); South Kunene (Map 72).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); South Argentina, Falkland Islands (Pujals, 1963); ?South Georgia (John *et al.*, 1994); Macquarie Island (Ricker, 1987).

Remarks: *Myriogramme livida* was initially described as *Nitophyllum livida* by Hooker and Harvey (1845) on the basis of material from the Falkland Islands. Subsequently, Kylin (1924) transferred the species to the genus *Myriogramme*. The present distribution of this taxon is mainly restricted to the Antarctic and subantarctic regions. John *et al.* (1994) included a Skottsberg's (1941) citation of *M. livida* in their work on the marine flora of South Georgia, but they considered it doubtful since nei-

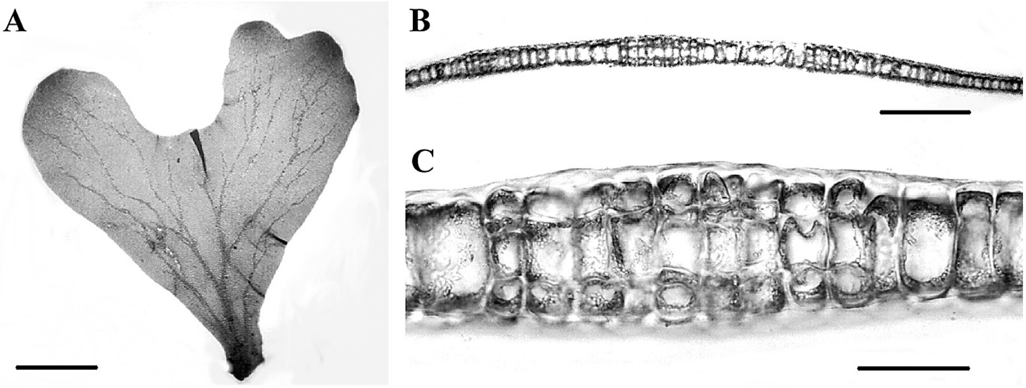

FIG. 139. – *Myriogramme livida*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11805. A. Habit. Scale bar = 3 mm. B. Cross section of the blade. Scale bar = 400 µm. C. Cross section of the blade through a vein. Scale bar = 100 µm.

ther did Skottsberg (1941) specify any locality, nor Papenfuss (1964) cited it in his catalogue of Antarctic and subantarctic algae. On the other hand, Stegenga *et al.* (1997) pointed out that on southern African coasts the species occurs from Swakopmund to Kommetjie (Cape peninsula).

Our material is represented by sterile specimens and therefore, it is difficult to identify with certainty. Nevertheless, as the vegetative traits are compatible with those of *Myriogramme livida*, we have assigned them tentatively to this species. It is important to point out, however, that our specimens are smaller (up to 2.5 cm high and lobes 4-5 mm broad) than those described by Stegenga *et al.* (1997), which can reach up to 10 cm high (up to 50 cm in sheltered localities) and have lobes 3(-12) cm broad.

Our specimens also are more or less reminiscent of *Hymenena venosa* (Linnaeus) Krauss, a species occurring on the west coast of South Africa and in Namibia, and that also presents macroscopic veins. However, this species consists of elongate blades, up to 30 cm high, usually composed of 3 cell layers (Stegenga *et al.*, 1997). In contrast, in our specimens the blades are polistromatic at veins only.

The Namibian plants also have certain similarity to *Cryptopleura ramosa* (Hudson) Kylin ex Newton, a species occurring mainly in the northeastern Atlantic but recorded also from Brazil (Maggs and Hommersand, 1993). However, according to these authors, *C. ramosa* has thinner monostromatic zones (40 µm thick in comparison with 100 µm in our specimens) and microscopic veins, the latter lacking in our specimens.

Genus *Platysiphonia* Børgesen (1931)

Key to species of *Platysiphonia*:

1. Flanking cells of stichidia undivided..*P. intermedia*
1. Flanking cells of stichidia divided....*P. delicata**

* *P. delicata* was not observed. More information about this taxon can be found in Silva and Cleary (1954) and Womersley and Shepley (1959).

Platysiphonia intermedia (Grunow) Wynne
(Figs. 140-141)

Sarcomenia intermedia Grunow (1867), p. 92.
Platysiphonia intermedia (Grunow) Wynne (1983), p. 446.

Selected specimens: Terrace Bay, february 1986, BCF-A 11901, with tetrasporangia; Möwe Bay, 4-02-1988, BCF-A 11810, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11809, with tetrasporangia and carposporangia.

References: Silva and Cleary (1954), Wynne *et al.* (1984), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 4 cm high, consisting of linear or ensiform, compressed, branched, uncorticated erect axes 158-430 µm broad in its middle part, arising from prostrate axes attached to the substratum by rhizoids; branching unilateral, adaxial, with the branches arising from the central line of the flattened part of the axes and longitudinally lined up. Pericentral cells elongate in surface view, 148-413 x 24-92 µm, longitudinal-

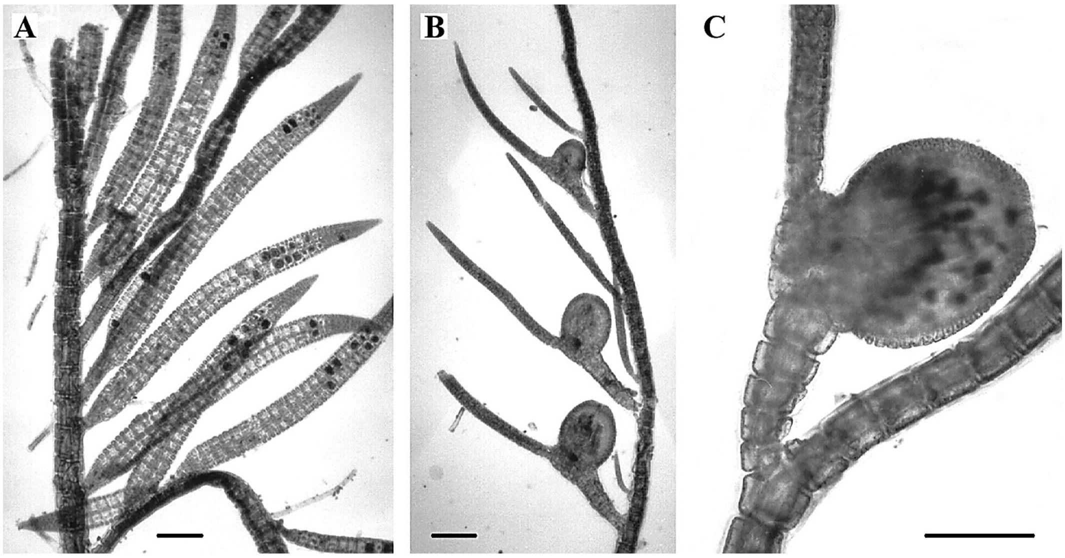

FIG. 140. – *Platysiphonia intermedia*. Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11809. A. Tetrasporangial stichidia. B. Cystocarps. C. Detail of a cystocarp. Scale bar = 200 µm.

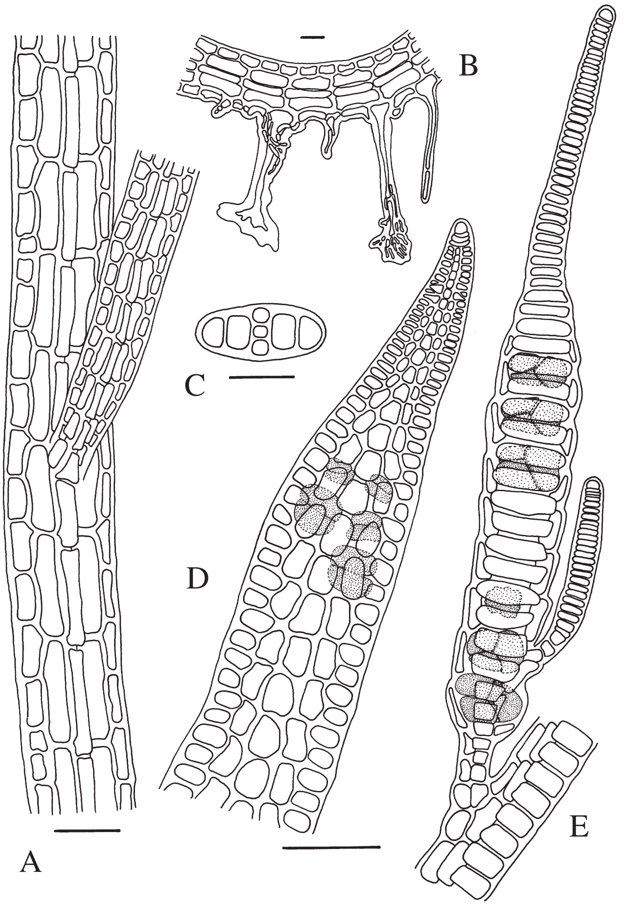

FIG. 141. – *Platysiphonia intermedia*. A. Branching. B. Detail of a prostrate axis with rhizoids. C. Cross section of an erect axis. D. Upper part of a tetrasporangial stichidium in surface view. E. Tetrasporangial stichidium in a lateral view. Scale bar = 100 µm.

ly arranged in three central rows and flanked by a longitudinal row of shorter cells on both sides; flanking cells half as long as pericentral cells, 72-215 x 40-60 µm, so two flanking cells correspond to each lateral pericentral cell; flanking cells exceptionally divided in some specific place of axes. Central pericentral cell of a segment bearing a branch shorter than lateral ones, and central pericentral cell of the branch basal segment more or less trapezoidal in shape. Rhizoids unicellular or multicellular, often ending in a discoid attachment pad, arising from the flanking cells. Cells of the upper part of the plant usually with 2-3 large refringent inclusions; plastids numerous, discoidal or bacilliformis. In cross section, axes elliptic, 100-160 µm thick, consisting of a more or less square axial cell 24-26 x 20-26 µm, 4 pericentral cells (2 lateral and 2 transversal) and 2 flanking cells (one in each side); lateral pericentral cells 60-96 x 40-80 µm; transversal pericentral cells 28-64 x 24-52 µm; flanking cells 52-68 x 36-40 µm.

Reproduction: Tetrasporangia tetrahedrally divided, 40-73 x 36-65 µm, arranged in two longitudinal rows in stichidia morphologically similar to vegetative branches, with undivided flanking cells. Cystocarps ovoid or ellipsoidal, sessile, adaxial, 300-480 x 260-440 µm, with an ostiole 40 µm in diameter; pericarp composed of two cell layers, the inner one with the cells periclinally arranged, and the outer one with the cells more or less anticlinally arranged; carposporangia terminal, club-shaped, 70-92 x 16-24 µm. Spermatangia not seen.

Habitat: Epiphytic mainly on *Centroceras clavulatum* and *Caulacanthus ustulatus*, in the lower eulittoral zone.

Namibian distribution: Elizabeth Bay, Essy Bay, Lüderitz, Hottentot Bay, Möwe Bay (Engledow, 1998); Terrace Bay (Map 73).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: Australia, St. Paul Island (Silva *et al.*, 1996).

Remarks: *Platysiphonia intermedia* was described by Grunow (1867) as *Sarcomenia intermedia* and subsequently was transferred to the genus *Platysiphonia* by Wynne (1983). At present, its distribution includes the Atlantic coasts of South Africa, Namibia, Australia and Saint Paul Island.

Until a few years ago, *Platysiphonia intermedia* had been confused with *P. miniata* (C. Agardh) Børgesen (at present, *P. delicata* (Clemente) Cremades), a species widespread in warm temperate and tropical seas (Lawson and John, 1987). Possibly for this reason Lawson *et al.* (1990) cited *P. miniata* instead of *P. intermedia* from several localities along the Namibian coast.

In the genus *Platysiphonia*, the flanking cells of the branches bearing tetrasporangia can be divided or not, and this fact, together with the division type of these cells when it is the case, are features used to distinguish the uncorticated species in this genus (Silva and Cleary, 1954; Womersley and Shepley, 1959). Of the eleven species included at present in the genus *Platysiphonia*, only *P. intermedia*, *P. parva* Silva and Cleary and *P. marginalis* Wynne, Millar and Kraft are ecorticate and have the flanking cells of the stichidia undivided (Wynne *et al.*, 1984; Ballantine and Wynne, 1985). This last feature distinguishes *P. intermedia* from *P. miniata*, since in the latter the flanking cells of the branches bearing tetrasporangia are divided (Silva and Cleary, 1954; Womersley and Shepley, 1959).

Platysiphonia intermedia is similar to both *P. parva* and *P. marginalis* in being ecorticate plants and in having undivided flanking cells in the stichidia. *P. intermedia* differs from *P. parva*, a species from the northern Pacific, mainly by the structure of the branch insertion zone (Silva and Cleary, 1954). That is to say, in *P. intermedia* the upper pericentral cell of the axis bearing the branch is shorter than the lateral ones, and the basal central (abaxial) pericentral cell of the branch is more or less trapezoidal in shape. In *P. parva*, in contrast, the upper pericentral cell of the axis bearing the branch has the same size as the lateral ones. Concerning *P. marginalis*, a species occurring on the east coasts of Australia, the branch insertion type is similar to that of *P. intermedia* (Wynne *et al.*, 1984). In this case, and according to these authors, the difference between both species lies in the size of the plant, in the rhizoids arrangement and in the morphology of the stichidia. Regarding this last feature, *P. marginalis* has the tetrasporangia placed in the enlarged distal part of the stichidia, whereas in *P. intermedia* they are placed along the whole of the branch, which tapers progressively towards the apex.

Delesseriaceae ind. 1
(Figs. 142-144)

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11311; Möwe Bay, 5-02-1988, BCF-A 11803; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11802, with spermatangia; Rocky Point, 24-02-1986, BCF-A 11804, with tetrasporangia.

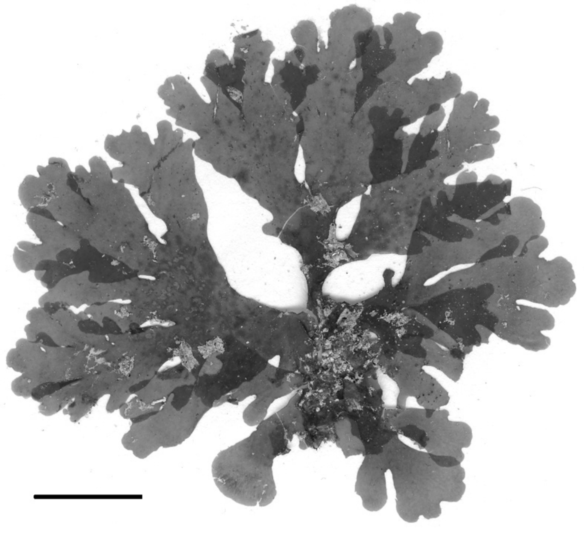

FIG. 142. – Delesseriaceae ind. 1. 5 km south of Swakopmund, 6-07-1989, BCF-A 11311. Scale bar = 1 cm.

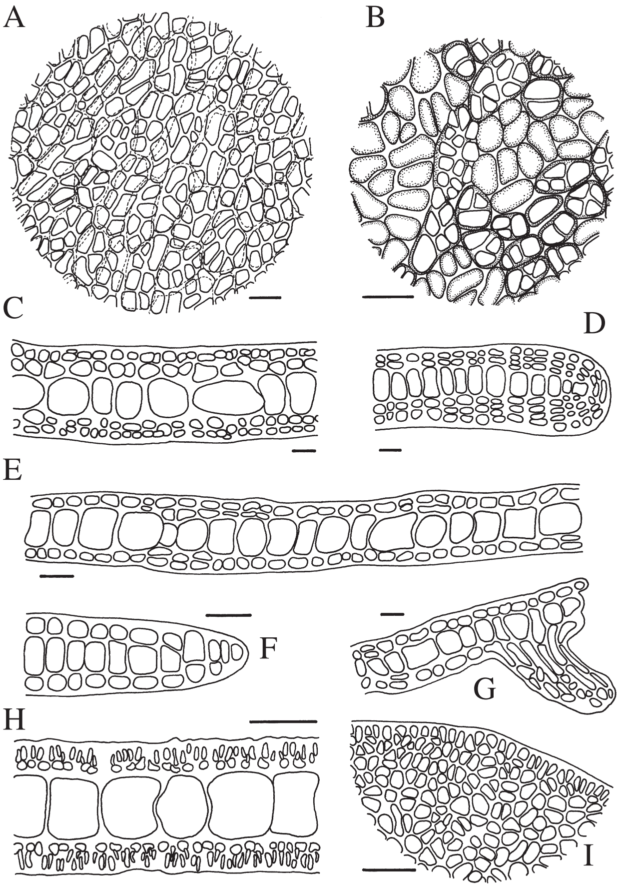

FIG. 143. – Delesseriaceae ind. 1. A-B. Portion of blade in surface view, in median (A) and upper (B) parts of the plant. C-H. Blade cross sections. C-D. Lower part of the plant. E-F. Median part of the plant. G. Rhizoid. H. Through a spermatangial sorus. I. Apical marginal zone of the blade. Scale bar = 50 µm.

Habit and vegetative structure: Plant foliaceous, up to 5 cm high, progressively divided up to end in rounded lobes 2-7(-10) mm wide, lying in one plane; blade surface flat, often bearing scattered dark spots corresponding to cells or cell clusters with dark contents; margin entire, sometimes eroded; in some specimens, lower part of the plant thin and flat, similar to a short stipe. Attachment by means of pseudoparenchymatic rhizoids arising from the blade surface, mainly in the lower part of the plant. Macroscopic veins occurring in some specimens; microscopic veins short and ill-defined, irregular, in some places consisting of 3-4 cells in width; vein cells usually elongate, 87-292 x 40-63 µm; cells of zones between the veins, polygonal, 63-119 x 40-79 µm. In surface view, lower half of the plant composed of a continuous layer of small polygonal cells 20-52 x 12-34 µm, that usually allow to see by transparency the larger inner cells; upper part of the plant (lobes) with the small cells placed solely on the large vein cells. Marginal apical cells divided by an oblique septum. Cells with a single,

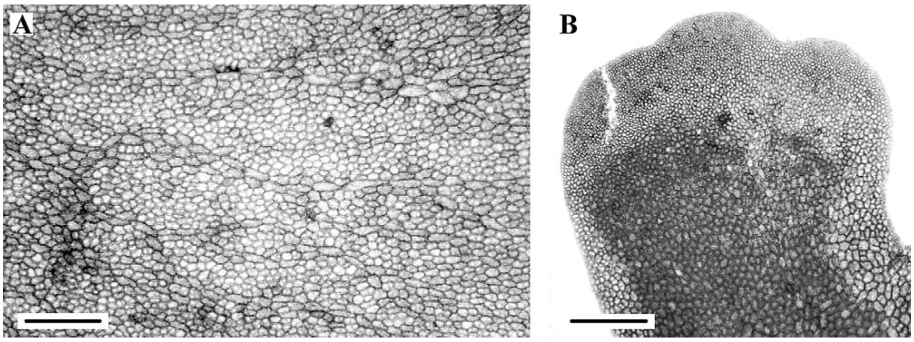

FIG. 144. – Delesseriaceae ind. 1. A. Blade in surface view, in the median part of the plant. B. Blade lobe with a spermatangial sorus. Scale bar = 400 µm.

parietal, reticulate plastid, or with numerous, more or less discoidal, plastids. In cross section, blade 112-160 µm thick in the middle part of the plant (up to 221 µm at the base) composed of a central layer of square to rectangular cells, 52-116 µm high per 36-100 µm broad, and 1-2 layers of small cortical cells above and below, increasing to 2-3 layers of cortical cells in each side in the lower part of the plant; cells arranged only in horizontal rows; cortical cells 12-40 µm high per 20-60 µm broad.

Reproduction: Tetrasporangia tetrahedrally divided, elliptic or more or less isodiametric, 52-88 x 44-72 µm, placed in sori; in cross section, sori 220-260 µm thick, with the tetrasporangia placed in the cortical zone. Spermatangia 3-4(-5) µm in diameter in surface view, formed in sori in the blade lobes; in cross section, spermatangia cylindric, clavate or more or less conical, 8-14 x 2-4 µm. Female reproductive structures not seen.

Habitat: Epiphytic on *Corallina* sp. and *Ahnfeltiopsis vermicularis*, in the lower eulittoral zone; between the *Laminaria pallida* haptera, in drift material.

Namibian distribution: Swakopmund, Möwe Bay, Rocky Point (Map 74).

Remarks: By lacking a differentiated apical cell, and by having a polystromatic blade without midrib and with the cells arranged in horizontal rows but not in columns, our specimens are reminiscent of the genus *Platyclinia*. This genus was described by J. Agardh (1898) and its distribution is limited to the southern hemisphere. According to Kylin (1924), *Platyclinia* does not have microscopic veins and has the tetrasporangia scattered over the blade. On the contrary, our specimens have microscopic veins and the tetrasporangia placed in sori in the blade lobes. According to this, we could assign the Namibian specimens to the genus *Acrosorium* but, unlike our specimens, in this genus the blade is monostromatic except in the base, in which it can be composed of 5-7 layers of cells arranged in both horizontal and vertical rows.

Anatomically, our specimens also are reminiscent of *Neuroglossum binderianum* Kützing, a species recorded from southern Namibia (Lawson *et al.*, 1990), South Africa and St. Paul Island (Stegenga *et al.*, 1997). However, this taxon is different in having a differentiated midrib and lacking veins.

Delesseriaceae ind. 2
(Figs. 145-146)

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11808, with carposporangia and spermatangia.

Habit and vegetative structure: Plant foliaceous, up to 2 cm high, consisting of stipitate, simple or divided, usually lanceolate blades 2-3 mm broad, with slightly undulate, entire margin and a little defined midrib; midrib 900 µm broad, easily visible in the lower half of the plant and disappearing upwards; stipe 400-500 µm in diameter; attachment by a basal disc. Cells of the blade polygonal with rounded angles, elongate or more or less isodiametric in surface view, 20-52 x 14-32 µm, joined by secondary pit connections; marginal cells smaller, 12-28 x 10-20 µm; some cells of the blade darker than the others, forming dark spots scattered over the blade; marginal cells of the apical region divided by an oblique septum; apical cell only differentiated in the apex of small laminar proliferations. Plastids numerous. In cross section, blade 80-180 µm thick in the central zone, composed of 3-7 cell layers; cells squarish, usually broader than high, 12-28 x 16-40 µm, arranged in regular horizontal and vertical rows; blade margin monostromatic, 40 µm thick, with cells higher than broad or almost squarish, 28-40 x 16-32 µm; blade margin exceptionally composed of 3 cell layers in some places.

Reproduction: Plant dioecious. Cystocarps hemispherical, 500-1100 µm in diameter, mucronate,

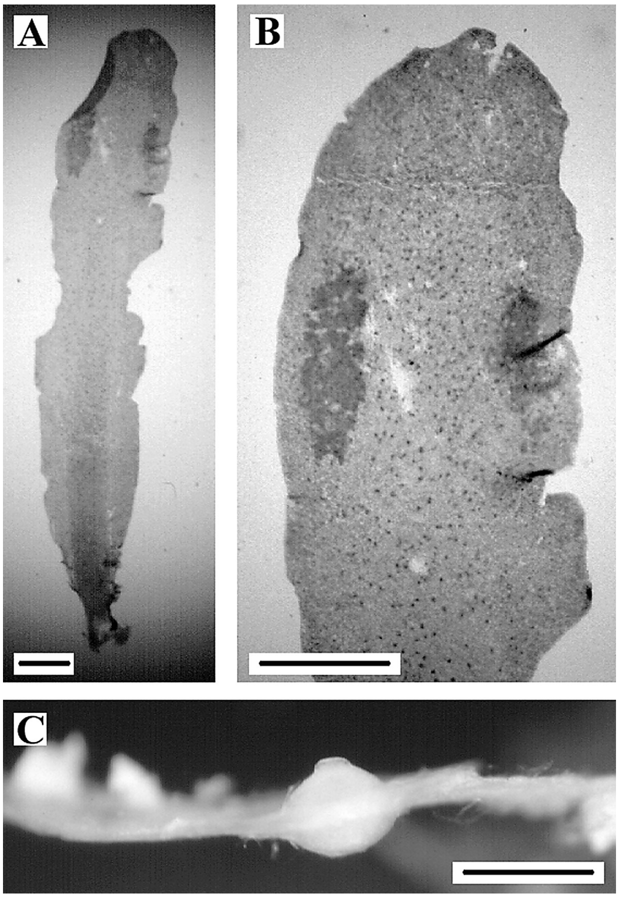

FIG. 145. – Delesseriaceae ind. 2. – 5 km south of Swakopmund, 6-07-1989, BCF-A 11808. A. Detail of a blade. B. Upper part of a blade with two spermatangial sori. C. Cystocarp in a lateral view. Scale bar = 1 mm.

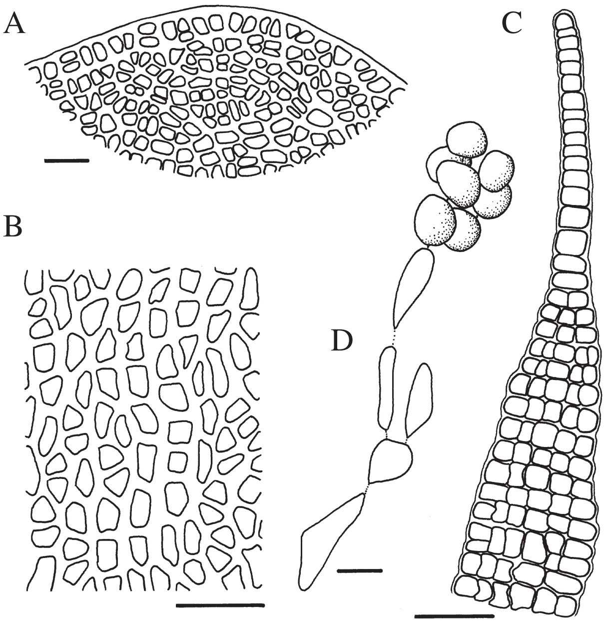

FIG. 146. – Delesseriaceae ind. 2. A. Apical marginal zone of the blade. B. Portion of blade from the median part of the plant, in surface view. C. Portion of a cross section of the blade. D. Gonimoblast filaments with carposporangia. A, D. Scale bar = 25 µm. B-C. Scale bar = 100 µm.

with ostiole, deforming both sides of the blade; carposporangia 32-64 x 24-40 µm, in groups. Spermatangia in marginal, elongate sori 1600 x 500 µm, placed in the upper half of the blades; in surface view, spermatangial mother cells 5-7 x 4-6 µm and spermatangia spherical, 2-4 µm in diameter. Tetrasporangia not seen.

Habitat: Epiphytic on *Rhodymenia capensis* in a tide pool; specimens almost completely covered by bryozoans.

Namibian distribution: Swakopmund (Map 75).

Remarks: By the division type of the cells in the apical region, the arrangement of carposporangia in clusters or in chains, and by having the blade polystromatic only in the midrib region, our specimens could be assigned to the genus *Myriogramme*. On the Atlantic coasts of southern Africa this genus is represented, at present, by *M. livida* (Hooker and Harvey) Kylin and *M. eckloniae* Stegenga, Bolton and Anderson (John *et al.*, 1994; Stegenga *et al.*, 1997). The former, which occurs in South Africa and Namibia (see page 132), lacks a midrib and have macroscopic veins in the lower half of the blade (Stegenga *et al.*, 1997), quite contrary to our specimens. Concerning *M. eckloniae*, a species recently described from the west coast of South Africa by Stegenga *et al.* (1997), the plant habit is very different to that of our specimens.

On the other hand, our material is very similar to some of the specimens of *Haraldiophyllum bonnemaisonii* (Greville) Zinova of Wynne (1986). This author cited this species on the basis of male, cystocarpic and tetrasporic specimens collected near Swakopmund, and he stated that a great morphological variation is expressed in his material. However, in our specimens, which have been collected practically in the same area as those of Wynne (1986), the carposporangia are arranged in clusters or in chains, whereas in *H. bonnemaisonii* they are terminal (Wynne, 1983, 1996; Maggs and Hommersand, 1993; Stegenga *et al.*, 1997). Moreover, according to Maggs and Hommersand (1993), the genus *Haraldiophyllum* has cystocarps with non-projecting ostiole, unlike our specimens in which the cystocarps are mucronate. Likewise, the South African plants assigned to this species by Stegenga *et al.* (1997) also have mucronate cystocarps. Regarding the inner structure of the blade, our material agrees quite well with the descriptions of both Maggs and Hommersand (1993) and Stegenga *et al.* (1997) of *H. bonnemaisonii*. It is important to point out, however, that these last authors, like Wynne (1986), assigned their specimens tentatively to this species. In this way, it is also important to point out that Maggs and Hommersand (1993) suggested the possibility that Wynne's (1986) specimens do not belong to *H. bonnemaisonii* but another taxon.

Taking all this into account, we prefer do not assign our specimens to any of these genera, waiting for future studies which will allow us to compare them with those of Wynne (1986).

Family RHODOMELACEAE Areschoug (1847)
Genus *Chondria* C. Agardh (1817) *nom. cons.*

Chondria capensis (Harvey) Askenasy
(Figs. 147-148; Plate IV)

Laurencia capensis Harvey (1847), p. 86.
Chondria capensis (Harvey) Askenasy (1888), p. 48.
Rhabdonia violacea J. Agardh (1876), p. 595.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11421, with carposporangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 11424, with carposporangia; *ibid.*, BCF-A 11425, with tetrasporangia; Swakopmund, beach, 8-07-1989, BCF-A 11423, with tetrasporangia; Mile 32, 7-07-1989, BCF-A 11422; Terrace Bay, February 1986, BCF-A 11903; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11781, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11427, with tetrasporangia; Angra Fria, 20-02-1986, BCF-A 11419, with tetrasporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11420, with tetrasporangia.

References: Harvey (1847), Simons (1969, 1976), Branch and Branch (1981), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 23 cm high, consisting of several branched erect axes arising from a common discoidal base with which the plant attaches to the substratum; erect axes cylindric or often compressed, 1.5-3 mm broad in its middle part, constricted at base and with acute apex; branching irregularly sparse, with numerous spindle-shaped or more or less clavate branchlets usually ending in multicellular, branched trichoblasts; clusters of branches arising from the same point often present. In surface view, outer cortical cells generally elongate, 16-72 x (7-)12-28 µm. In cross section, axes composed of an axial cell surrounded by 5 pericentral cells (structure not always visible); inner medullary cells colourless, more or less isodiametric, 55-87 x 32-79 µm; outer medullary cells colourless, elliptic, larger, 79-261 x 63-134 µm, usually radially arranged; cortical cells pigmented, the outer ones quadrangular or rectangular, 14-44 x 8-24 µm. In longitudinal section, axial filament often visible; inner medullary cells elongate, 240-482 x 55-119 µm; outer medullary cells more or less rounded, 132-356 x 79-182 µm.

FIG. 147. – *Chondria capensis*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11424. Scale bar = 3 cm.

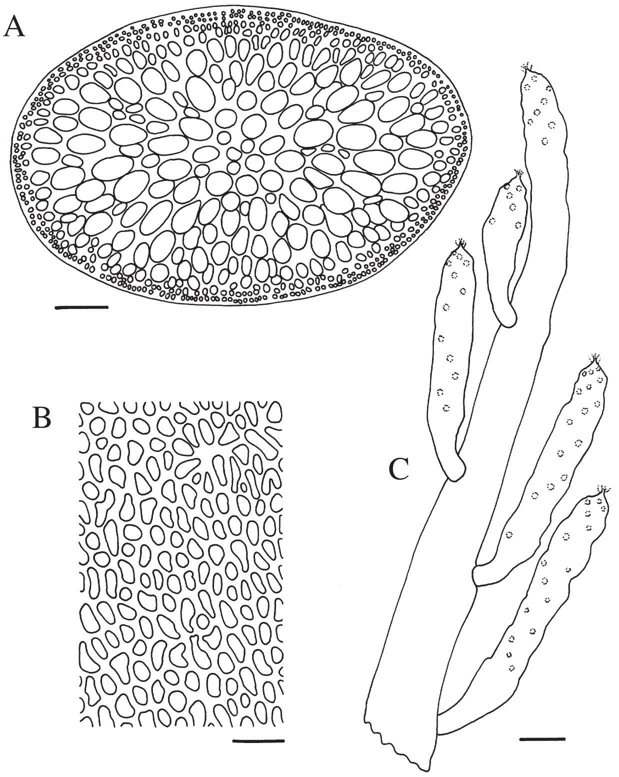

FIG. 148. – *Chondria capensis*. A. Cross section of a branch. Scale bar = 200 µm. B. Outer cortical cells in surface view. Scale bar = 50 µm. C. Apical zone of the plant. Scale bar = 500 µm.

Reproduction: Tetrasporangia tetrahedrally divided, 95-182 x 79-142 µm, immersed in the apical zone of short branchlets; tetraspores often segmented inside the tetrasporangia. Cystocarps globose, 660-1120 µm in diameter, shortly pedicellate, with ostiole, placed in the upper part of short branchlets; carposporangia clavate, 160-212 x 40-72 µm. Spermatangia not seen.

Habitat: Epilithic or epiphytic on *Laminaria pallida* haptera, in the lower eulittoral and upper sublittoral zones; also in tide pools; growing on mussel shells, in drift material.

Namibian distribution: Lüderitz, Walvis Bay, Swakopmund, Torra Bay, Terrace Bay, Möwe Bay, Rocky Point, Cape Frio (Lawson *et al.*, 1990); Langstrand, Mile 32, Angra Fria, South Kunene (Map 76).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); Angola (Price *et al.*, 1986). Indian Ocean: St. Paul Island, Amsterdam Island, South Africa, Madagascar (Silva *et al.*, 1996).

Remarks: According to Stegenga *et al.* (1997) *Chondria capensis* occurs from Namibia to just east of Cape Agulhas in South Africa, although it is especially abundant in the southern part of the range. Papenfuss (1940b) remarked on the existence of a Gueinzius specimen from Port Natal (east coast of South Africa), but he pointed out that it is a very doubtful citation, since *C. capensis* is a cold water species growing in the south and west coasts of South Africa, and no other author had collected it in the Port Natal area. In contrast, Silva *et al.* (1996) included Madagascar, Amsterdam Island and St Paul Island in the Indian Ocean distribution of this species. On the other hand, Price *et al.* (1986) cited this species from Angola on the basis of the work of Lawson *et al.* (1975), although the latter did not refer to *C. capensis* in any place. However, we hold that this species can be found in southern Angola due to the fluctuation of the boundary between the cold Benguela current and the warm waters from Angola.

Genus *Ophidocladus* Falkenberg in Schmitz and Falkenberg (1897)

Ophidocladus simpliciusculus (P. Crouan and H. Crouan) Falkenberg in Schmitz and Falkenberg (Figs. 149-150)

Polysiphonia simpliciuscula P. Crouan and H. Crouan (1852), n. 302.
Ophidocladus simpliciusculus (P. Crouan and H. Crouan) Falkenberg in Schmitz and Falkenberg (1897), p. 461.
Polysiphonia obscura Harvey (1854), p. 541, *nom illeg*.
Polysiphonia corallioides Suhr in Kützing (1864), p. 18.
Rhodosiphonia californica Hollenberg (1943), p. 573.
Ophidocladus californica (Hollenberg) Kylin (1956), p. 542.
Ophidocladus herposiphonioides Joly and Cordeiro in Joly, Cordeiro and Yamaguishi (1963), p. 60.

Lectotype: PM s/n Ex Herb. Crouan, Algues Marines du Finistère, n. 302.

Selected specimens: 5 km south Swakopmund, 6-07-1989, BCF-A 11783, with carposporangia and spermatangia; Swakopmund, beach, 8-07-1989, BCF-A 11383, with tetrasporangia; Mile 32, 7-07-1989, BCF-A 11570; Mile 108, 13-07-1989, BCF-A 11550; Rocky Point, 24-02-1986, BCF-A 11907; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11382.

References: Oliveira (1969), Ardré (1970), Saenger (1971, 1973), Abbott and Hollenberg (1976), Cordeiro-Marino (1978), Wynne (1986), Bolton and Stegenga (1987), Wynne (1995), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant caespitose, differentiated into prostrate and erect axes, the latter arising endogenously from the former; axes terete, polysiphonous, ecorticate. Prostrate axes branched, dorsiventral organized, 134-277 µm in diameter, often with the apex curved upwards, without trichoblasts; segments 0.3-1.2 times longer than broad. Erect axes up to 3 cm high and 140-284 µm in diameter in its middle part, issuing from every 2-5 or more segments of the prostrate axes; erect axes con-

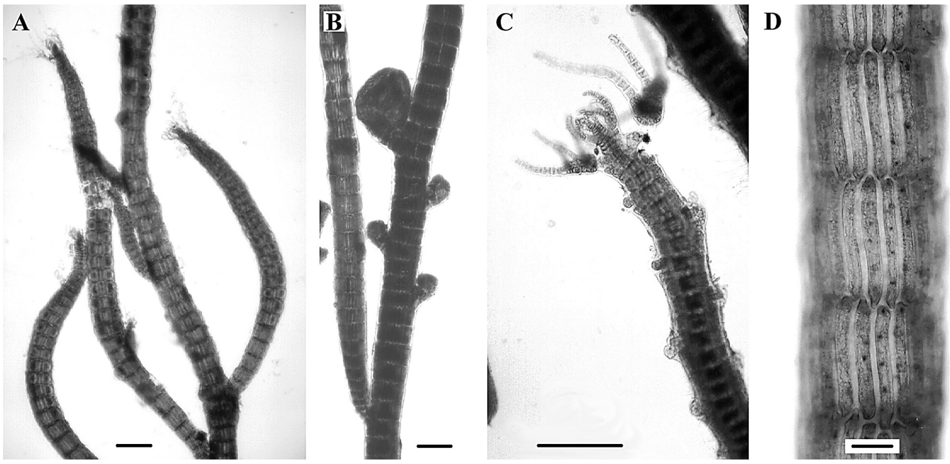

FIG. 149. – *Ophidocladus simpliciusculus*. A. Upper part of an erect axis (tetrasporophyte). B. Branch with cystocarps. C. Branch with spermatangial stichidia. D. Portion of an erect axis in surface view. A-C. Scale bar = 200 µm. D. Scale bar = 50 µm.

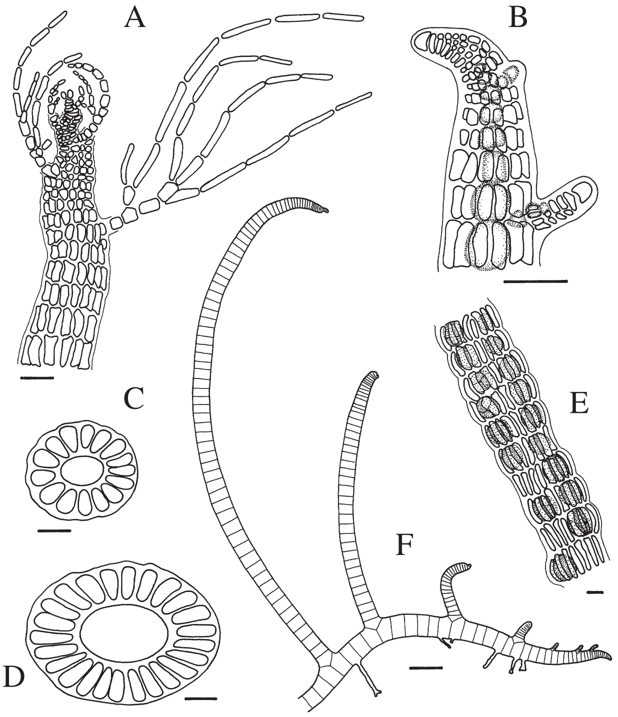

FIG. 150. – *Ophidocladus simpliciusculus*. A. Apical zone of an erect axis (tetrasporophyte). B. Apical zone of a prostrate axis with endogenous branching. C. Cross section of a prostrate axis. D. Cross section of an erect axis. E. Portion of a branch with tetrasporangia. F. Portion of a prostrate axis with several erect axis and rhizoids. A-E. Scale bar = 50 µm. F. Scale bar = 250 µm.

stricted at base and initially curved at apex, often truncate, usually unbranched or scarcely branched; sometimes, branching abundant, alternate, sparse or proliferous; segments 0.3-1 times longer than broad; trichoblasts occurring in fertile specimens. Attachment by means unicellular rhizoids ending or not in an attachment disc; rhizoids 24-40 µm in diameter, arising from the ventral pericentral cells of prostrate axes and cut off from them by a septum. In cross section, prostrate axes composed of an axial cell 52-84 µm in diameter and 12-15 pericentral cells; erect axes with an axial cell 108-158 µm in diameter and 24-27(-28) pericentral cells.

Reproduction: Tetrasporangia tetrahedrally divided, more or less spherical, 64-92 x (44-)60-80 µm, immersed, arranged in two longitudinal rows in the upper part of the branches, two tetrasporangia in every segment. Plant dioecious. Cystocarps ovoid, 360-600 x 300-540 µm, shortly pedicellate, turning to the branch apex and more or less distichously arranged; carposporangia club-shaped, 84-140 x 24-52 µm. Spermatangia developed in stichidia placed at base of branched trichoblasts; stichidia 119-277 x 79-150 µm, irregularly branched, pedicellate, ending in one or more hairs and distichously arranged; pedicel usually unicellular.

Habitat: In the lower eulittoral zone, among the *Nothogenia erinacea* specimens, together with *Gelidium pusillum* and *Centroceras clavulatum*; growing together with *Acrossorium cincinnatum* in tide pools.

Namibian distribution: Swakopmund (Wynne, 1986); Mile 32, Mile 108, Rocky Point, South Kunene (Map 77).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); Senegal, Mauritania (John *et al.*, 1994); Canary Islands to Brittany coast of France (Ardré, 1970). Brazil (Cordeiro-Marino, 1978). Mediterranean Sea (Gallardo *et al.*, 1985; Giaccone *et al.*, 1985). Pacific Ocean: Mexico, California (Abbott and Hollenberg, 1976); Australia (Ardré, 1970). Indian Ocean: South Africa, Mozambique, Seychelles (Silva *et al.*, 1996).

Remarks: According to Saenger (1971) the distribution of *Ophidocladus simpliciusculus* is limited to the strip comprised between the latitudes 25 and 45 in both hemispheres, remaining excluded from the tropics. However, Oliveira's (1969) record, albeit nearby to the tropic of Capricorn, is included within the tropical zone. Subsequently, *O. simpliciusculus* has been recorded from other tropical zones, like Mexico (Abbott and Hollenberg, 1976), Namibia (Wynne, 1986), Senegal and Mauritania (John *et al.*, 1994) and Seychelles (Wynne, 1995).

Our citations expand the distribution of *O. simpliciusculus* in the Atlantic coast of southern Africa, placing its northern limit to few kilometres south of the Kunene river mouth, near Angola and within the tropical zone. This distribution, which does not agree with the temperate nature of this species (Saenger, 1971, 1973), could be explained by the combined effect of the cold Benguela current and the upwelling occurring in specific places of the coast during the greatest part of the year.

Genus *Placophora* J. Agardh (1863)

Key to species of *Placophora*:

1. Fertile axes less than 1 mm high...........*P. binderi*
1. Fertile axes up to 10 mm high......*P. monocarpa**

* *P. monocarpa* was not observed. More information about this taxon can be found in Scagel (1953), Pocock (1953) and Stegenga *et al.* (1997).

Placophora binderi (J. Agardh) J. Agardh
(Figs. 151-152)

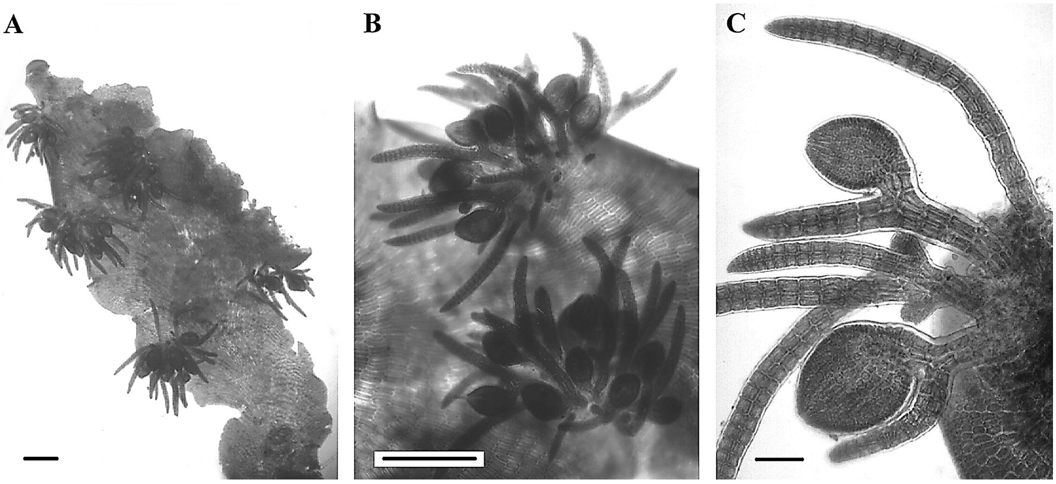

FIG. 151. – *Placophora binderi*. Möwe Bay, 4-02-1988, BCF-A 11915. – A. Habit. B. Two groups of branches with cystocarps. C. Cystocarps. A-B. Scale bar = 500 µm. C. Scale bar = 100 µm.

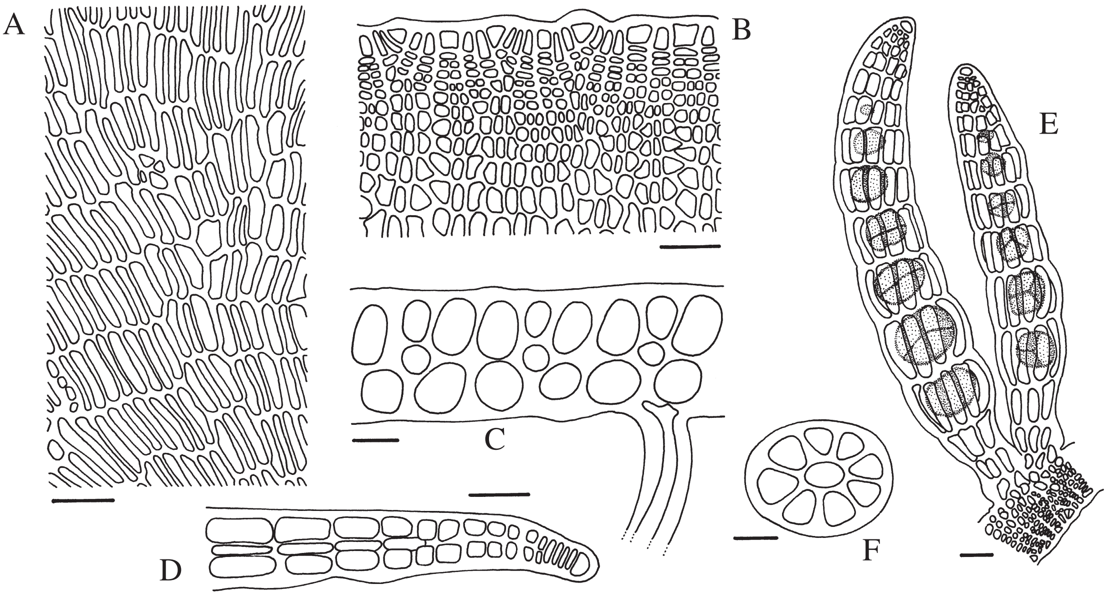

FIG. 152. – *Placophora binderi*. A. Central zone of the blade in surface view. B. Blade margin in surface view. C. Portion of a cross section of the blade. D. Portion of a blade section perpendicular to the margin. E. Branches with tetrasporangia. F. Cross section of a fertile branch. A. Scale bar = 100 µm. B-F. Scale bar = 25 µm.

Amansia binderi J. Agardh (1841), p. 26.
Placophora binderi (J. Agardh) J. Agardh (1863), p. 1138.

Selected specimens: Möwe Bay, 4-02-1988, BCF-A 11915, with tetrasporangia and carposporangia.

References: Falkenberg (1901), Scagel (1953), Adams (1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliaceous, 1 cm in length per 3 mm in width, prostrate, with small flabellate marginal lobes, attached to the substratum by rhizoids arising from the ventral side of the blade; fertile specimens bearing marginal clusters of short erect branches 400-800 µm high; erect branches polysiphonous, ecorticate, simple, without trichoblasts, containing the reproductive structures. In surface view, blade cells elongate, more or less rectangular, 76-212 x 8-24 µm, shorter towards the marginal zones, arranged in irregular horizontal tiers; marginal cells triangular or squarish, divided by an oblique or transversal septum. In cross section, blade 56-80 µm thick, consisting of several polysiphonous axes laterally confluent; each axis composed of an axial cell 12-16 µm in diameter and 5 pericentral cells, three dorsal (the central one smaller than the others) and two ventral; dorsal pericentral cells 20-32 x 16-24 µm, the central one 16-24 x 12-16 µm; ventral pericentral cells 20-36 x 20-28 µm; erect axes cylindric, 60-84 µm in diameter, composed of an axial cell and 7-8 pericentral cells.

Rhizoids unicellular, 16-28 µm in diameter, ending or not in a discoidal attachment pad, and issuing from the ventral pericentral cells.

Reproduction: Tetrasporangia tetrahedrally divided, spherical, 36-52 x 32-44 µm, immersed in short marginal erect branches usually curved at the apices; one tetrasporangium in every segment, deforming the branches. Cystocarps ellipsoid, 237-356 x 174-237 µm, shortly pedicellate, some of them slightly mucronate; cystocarps laterally arranged in short marginal erect branches, usually one in every branch; carposporangia club-shaped, 80-110 x 20-26 µm. Spermatangia not seen.

Habitat: Growing on prostrate axes of *Pterosiphonia complanata*, in the upper sublittoral zone.

Namibian distribution: Möwe Bay (Map 78).

World distribution: Atlantic Ocean: Tristan da Cunha, South Africa (Stegenga *et al.*, 1997); Namibia. Pacific Ocean: New Zealand (Adams, 1994); Japan, Peru (Scagel, 1953). Indian Ocean: Australia, Timor (?), South Africa, Mozambique (Silva *et al.*, 1996).

Remarks: *Placophora binderi* was described by J. Agardh (1841), as *Amansia binderi*, on the basis of material from the Cape of Good Hope. Subsequently, this species was recorded from other South African localities and from other zones of the southern hemisphere, as well as from Japan in the northern hemisphere. In the Atlantic Ocean, *P. binderi* was known only from Tristan da Cunha and the South African south coast.

Our specimens are compatible with Scagel's (1953) description of *P. binderi*, although our specimens do not have trichoblasts. According to Scagel (1953) the trichoblasts are evanescent and occur in the erect branches, being often visible only at the very tip.

Placophora binderi is similar to *P. monocarpa* (Montagne) Papenfuss, the other species of this genus. The latter, which is endemic from southern Africa (Stegenga *et al.*, 1997), differs from the former mainly in having taller fertile axes. Like this, whereas in *P. binderi* the fertile branches do not exceed 1 mm in height, in *P. monocarpa* they can reach up to 1 cm (Scagel, 1953; Pocock, 1953; Stegenga *et al.*, 1997).

Genus *Polysiphonia* Greville (1823) *nom. cons.*

Key to species of *Polysiphonia*:

1. Axes with 4 pericentral cells 2
1. Axes with 8-14 pericentral cells 4

2. Branching endogenous; plant differentiated into prostrate and erect axes ....*P. scopulorum*
2. Branching exogenous; plant chiefly erect 3

3. Trichoblasts or scar-cells every other segment..... ....*P. namibiensis*
3. Trichoblasts or scar-cells in every segment.......... ....*P. incompta*

4. Axes corticate, with 13-14 pericentral cells ....*P. virgata*
4. Axes ecorticate, with 8-12 pericentral cells........5

5. Trichoblasts and spermatangial stichidia placed one in every segment; tetrasporangia arranged in spiral series ....*P. nigra*
5. Trichoblasts and spermatangial stichidia not placed one in every segment; tetrasporangia arranged in rectilinear series ....*P. urbana**

* *P. urbana* was not observed. More information about this taxon can be found in Stegenga *et al.* (1997) and in the remark of *P. nigra*.

Polysiphonia incompta Harvey
(Figs. 153-154)

Polysiphonia incompta Harvey (1847), p. 44.
Polysiphonia sertularioides sensu Barton (1896), p. 198.
Polysiphonia urceolata sensu Delf and Michell (1921), p. 113.

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11786, with tetrasporangia.

References: Harvey (1847), Kylin (1938), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, 2-4 cm high, consisting of polysiphonous, ecorticate, branched axes, prostrate and interwoven at base; attachment by means of numerous rhizoids. Axes 240-360 µm in diameter in the prostrate part, with segments 0.4-0.8 times longer than broad; erect part of axes 200-240 µm in diameter in its median part, sparsely branched, fastigiate, more or less pseudodichotomous in the basal zone, with segments 0.4-1.1 times longer than broad; branching exogenous; branches often constricted at the insertion point and tapered in the apex, originating in lieu of trichoblasts; last order branches 80-100 µm in diameter; pericentral cells joined with each other and with the axial cell by means of pit connections. Apical cell clearly visible, 14-20 µm in diameter. Trichoblasts 12-16 µm in diameter, branched, short, spirally arranged in the apical zone of branches, one in every segment; scar-cells radially elongate, occur-

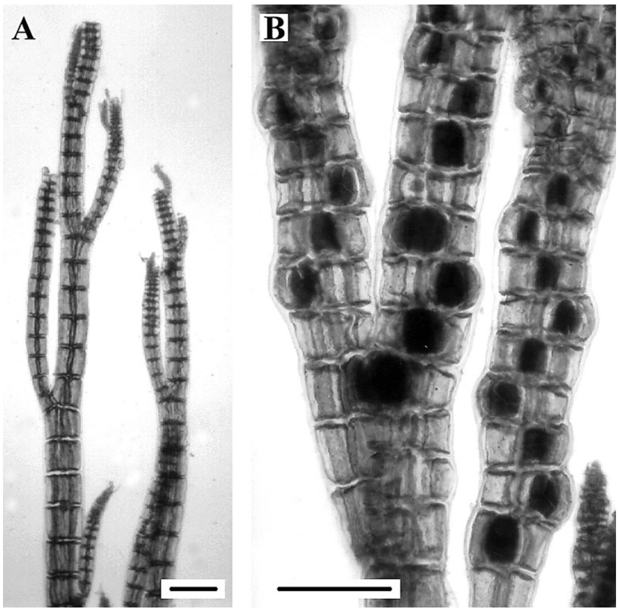

FIG. 153. – *Polysiphonia incompta*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11786. A. Upper part of the plant. B. Branches with tetrasporangia. Scale bar = 200 µm.

ring one per segment in approximately 90º spiral sequence on erect as well as prostrate parts of axes. In cross section, axes composed of an axial cell 40-60 µm in diameter and 4-6 pericentral cells in the prostrate part of axes, and an axial cell 40-44 µm in diameter and 4 pericentral cells in the erect part of axes. Rhizoids unicellular, 40-120 µm in diameter, with or without digitate tips, arising from the pericentral cells, with which they are joined by pit connections.

Reproduction: Tetrasporangia tetrahedrally divided, usually spherical, 60-88 x 56-84 µm, immersed, spirally arranged in the upper part of branches, one in every segment, distending them. Gametophytic reproductive structures not seen.

Habitat: Epiphytic on *Gelidium pusillum* in the lower eulittoral zone, among the specimens of *Nothogenia erinacea*.

Namibian distribution: Hottentots Bay (Engledow, 1998); South Kunene (Map 79).

World distribution: Atlantic Ocean: South Africa (Stegenga *et al.*, 1997); Namibia. Indian Ocean: South Africa, Mozambique (Silva *et al.*, 1996).

Remarks: *Polysiphonia incompta* was described by Harvey (1847) on the basis of material from Muizenberg (False Bay), and nowadays is considered as a southern African endemic species (Stegenga *et al.*, 1997).

Stegenga *et al.* (1997) remarked that this species should be critically compared with other similar species from the European Atlantic and the Mediterranean Sea. In this way, *P. incompta* had been formerly mistaken for both *P. urceolata* (Lightfoot ex Dillwyn) Greville and *P. sertularioides* (Grateloup) J. Agardh (Papenfuss, 1968a). According to the literature consulted, *P. incompta* differs from *P. urceolata* (at present, *P. stricta* (Dillwyn) Greville) by the diameter of the prostrate

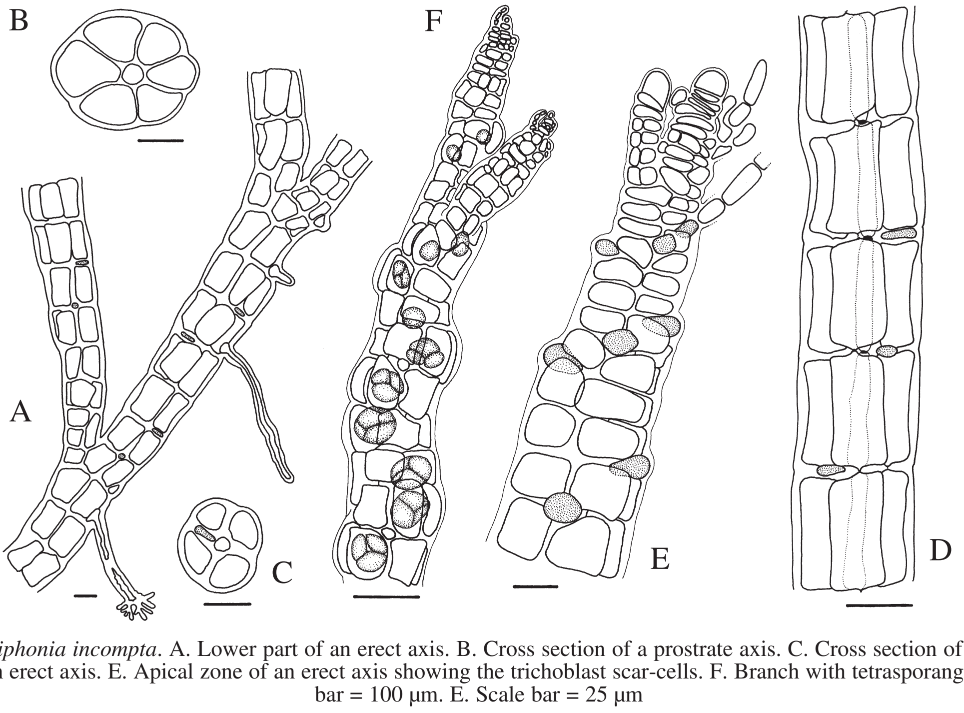

FIG. 154. – *Polysiphonia incompta*. A. Lower part of an erect axis. B. Cross section of a prostrate axis. C. Cross section of an erect axis. D. Median part of an erect axis. E. Apical zone of an erect axis showing the trichoblast scar-cells. F. Branch with tetrasporangia. A-D, F. Scale bar = 100 µm. E. Scale bar = 25 µm

axes, the type of rhizoids and the arrangement of trichoblasts. Like this, *P. incompta* has thicker prostrate axes (up to 400 µm in diameter in comparison with 50-100 µm in *P. stricta*), rhizoids cut off by a cross wall from the pericentral cells (in open connection with the pericentral cells in *P. stricta*), and trichoblasts in every segment (of a different manner in *P. stricta*). Concerning *P. sertularioides*, the differences do not seem so clear, and both species should be studied in more detail.

Polysiphonia namibiensis Stegenga and Engledow in Stegenga, Bolton and Anderson (Figs. 155-156)

Polysiphonia namibiensis Stegenga and Engledow in Stegenga, Bolton and Anderson (1997), p. 550.

Holotype: Engledow v. 11 (BOL), Hottentots Bay, Namibia, 7-06-1990.

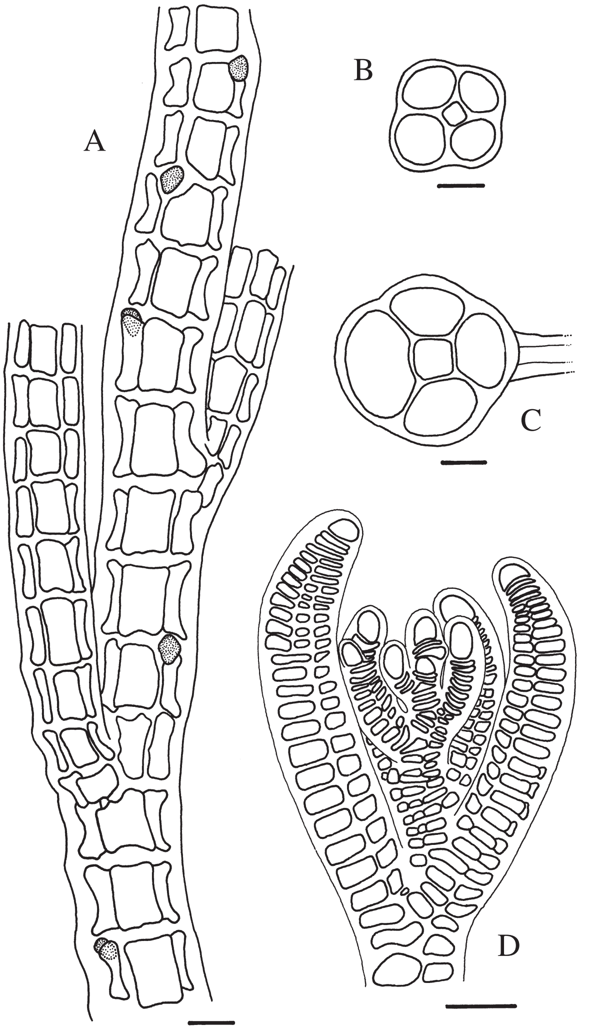

FIG. 155. – *Polysiphonia namibiensis*. A. Erect part of a main axis showing trichoblast scar-cells and two branches. B-C. Cross sections of the erect (B) and prostrate (C) parts of a main axis. D. Apical zone. A-C. Scale bar = 50 µm. D. Scale bar = 25 µm.

Selected specimens: Möwe Bay, 5-02-1988, BCF-A 11908, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11909; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11784.

References: Stegenga *et al.* (1997).

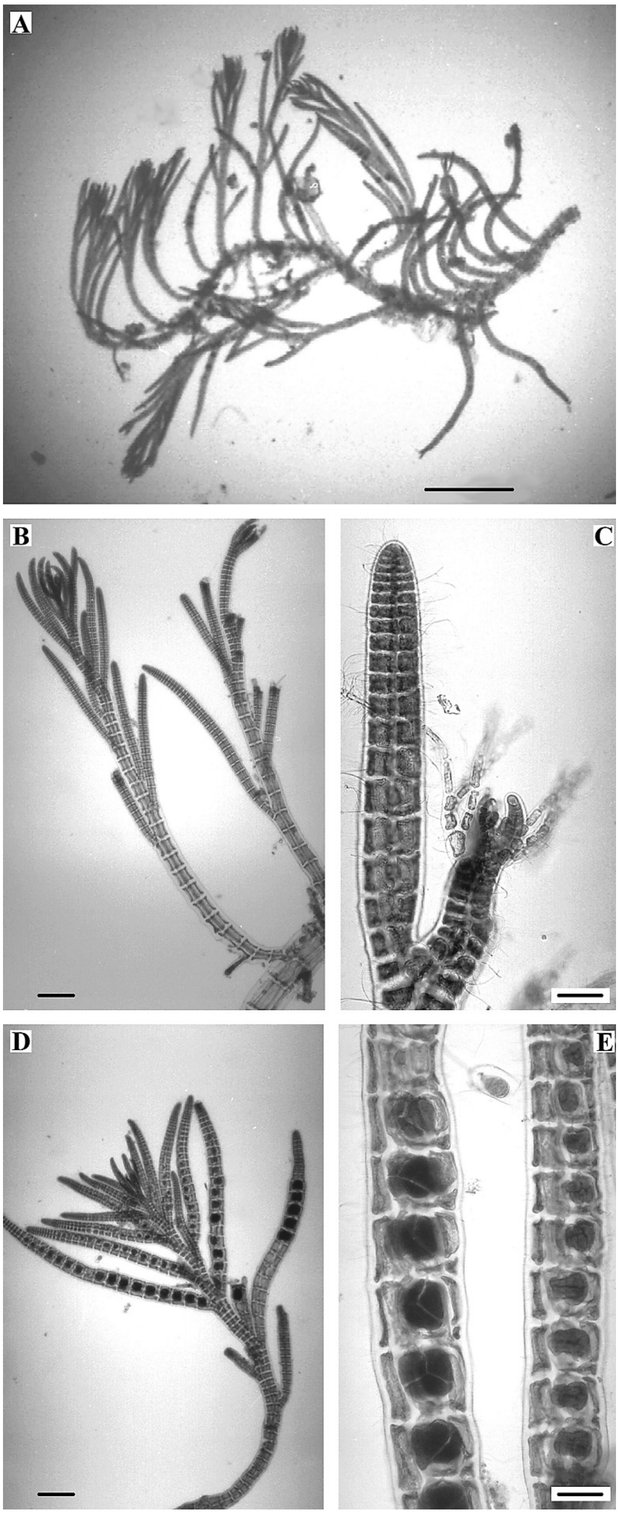

FIG. 156. – *Polysiphonia namibiensis*. Möwe Bay, 5-02-1988, BCF-A 11908. A. Habit. B. Branches of unlimited growth. C. Apical zone. D. Branch of unlimited growth with tetrasporangia. E. Detail of two branches with tetrasporangia. A. Scale bar = 1 mm. B, D. Scale bar = 200 µm. C, E. Scale bar = 50 µm.

Habit and vegetative structure: Plant up to 1 cm high, consisting of a cylindric, polysiphonous, ecorticate, branched, partly prostrate main axis, 160-240 µm in diameter, attached to the substratum by rhizoids. Rhizoids unicellular, 40-120(-200) µm in diameter, ending or not in an attachment disc, and arising from the pericentral cells, with which they remain in open connection. Branching sparse, exogenous, with branches of limited and unlimited growth; branches of limited growth simple, 50-100 µm in diameter in its median part, often constricted at base and tapering towards the apex; branches of unlimited growth 100-160 µm in diameter, sparsely branched like the main axis; branches of prostrate part of axes turned upwards, erect, up to 7 mm high; segments 0.5-1.2 times longer than broad. Apical zone radial; trichoblasts or scar-cells occurring every other segment in some branches of fertile specimens, spirally arranged; apical cell dome-shaped. In cross section, axes ecorticate, composed of an axial cell 28-32 x 24-28 µm in the erect part of axes and 48 x 40-44 µm in the prostrate part, and 4 pericentral cells.

Reproduction: Tetrasporangia tetrahedrally divided, spherical, 60-68 µm in diameter, immersed, occurring one in every segment in the branches. Other reproductive structures not seen.

Habitat: Epiphytic on *Plocamium rigidum* and *Ahnfeltiopsis glomerata* in the lower eulittoral zone.

Namibian distribution: Grossebucht, Hottentots Bay, Torra Bay (Stegenga *et al.*, 1997; Engledow, 1998); Möwe Bay, South Kunene (Map 80).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997).

Remarks: *Polysiphonia namibiensis* was described by Stegenga *et al.* (1997) on the basis of material from southern Namibia. According to these authors, this species also occurs on the south coast of South Africa, and it is abundant in Torra Bay (Namibia). On the other hand, Stegenga *et al.* (1997) pointed out that *P. namibiensis* is very similar to the Tristan da Cunha species *P. boergesenii* Baardseth, from which it differs in that trichoblasts are absent except in sexually reproductive plants.

Polysiphonia nigra (Hudson) Batters
(Figs. 157-159)

Conferva nigra Hudson (1762), p. 481.
Polysiphonia nigra (Hudson) Batters (1902), p. 81.
Conferva atrorubescens Dillwyn (1809), pl. 70.
Polysiphonia atrorubescens (Dillwyn) Greville (1824), p. 308.

Neotype: BM. Durham (Marsden), 12-06-1971, P. Edwards.

FIG. 157. – *Polysiphonia nigra*. Walvis Bay, Lagoon, 9-07-1989, BCF-A 11759. Scale bar = 2 cm.

Selected specimens: Walvis Bay, Lagoon, 9-07-1989, BCF-A 11759, with tetrasporangia, carposporangia and spermatangia.

References: Harvey (1847, 1853), Rosenvinge (1924), Taylor (1957), Maggs and Hommersand (1993), Coppejans (1981, 1995).

Habit and vegetative structure: Plant erect, 15-20 cm high, consisting of several terete, polysiphonous, ecorticate, much-branched axes converging downwards in a more or less spongy basal zone with numerous rhizoids. Branching sparse, fastigiate; branches slightly constricted at insertion point, developing in axils of trichoblasts. Rhizoids unicellular, 40-80 µm in diameter, ending in an attachment pad and cut off by a cross-wall from the pericentral cells. Erect axes 200-340 µm in diameter, with segments more or less as long as broad in the basal part and up to 5 times longer than broad in the median part of axes; joints slightly swollen; in surface view,

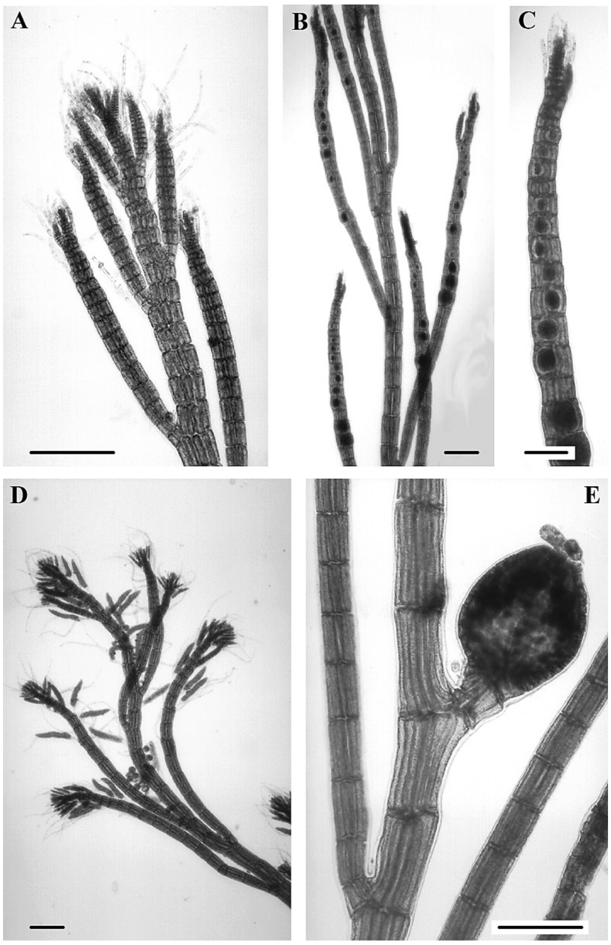

FIG. 158. – *Polysiphonia nigra*. A. Apical zone. B. Branches with tetrasporangia. C. Detail of a branch with tetrasporangia. D. Branches with spermatangial stichidia. E. Cystocarp. A-B, D, E. Scale bar = 200 µm. C. Scale bar = 100 µm.

pericentral cells straight in the lower part of axes and commonly spirally twisted towards the median and upper parts of the plant; last order branches 80-100 µm in diameter, with segments 1-2 times longer than broad. Apical zone with numerous branched trichoblasts spirally arranged, one per segment; trichoblasts 14 µm in diameter; scar-cells visible along the axes; apical cell dome-shaped, 10-14 x 10-12 µm. In cross section, axes composed of an axial cell 75 x 61 µm and 10 pericentral cells (9 in the basal part).

Reproduction: Tetrasporangia tetrahedrally divided, spherical or elongate, 52-92 x 48-84 µm, immersed, spirally arranged in the ultimate branches, one in every segment. Plant dioecious. Cystocarps urceolate, 260-360 x 240-300 µm, shortly pedicellate, arising adaxially at the base of trichoblasts; carposporangia club-shaped, 88-148 x 32-48 µm. Spermatangia formed in conical or cylindro-conical stichidia, 180-216 x 36-40 µm, replacing one of the two basal branches of trichoblasts, spirally arranged in the upper part of ultimate branches, one in every segment.

Habitat: Growing in sheltered and shallow waters.

Namibian distribution: Lüderitz (Lawson *et al.*, 1990); Walvis Bay (Map 81).

World distribution: Atlantic Ocean: Falkland Islands (Pujals, 1963); Namibia; Portugal to Noruega and New Jersey to Newfoundland Island (South and Tittley, 1986).

Remarks: *Polysiphonia nigra* is widespread in the north Atlantic (South and Tittley, 1986), but is

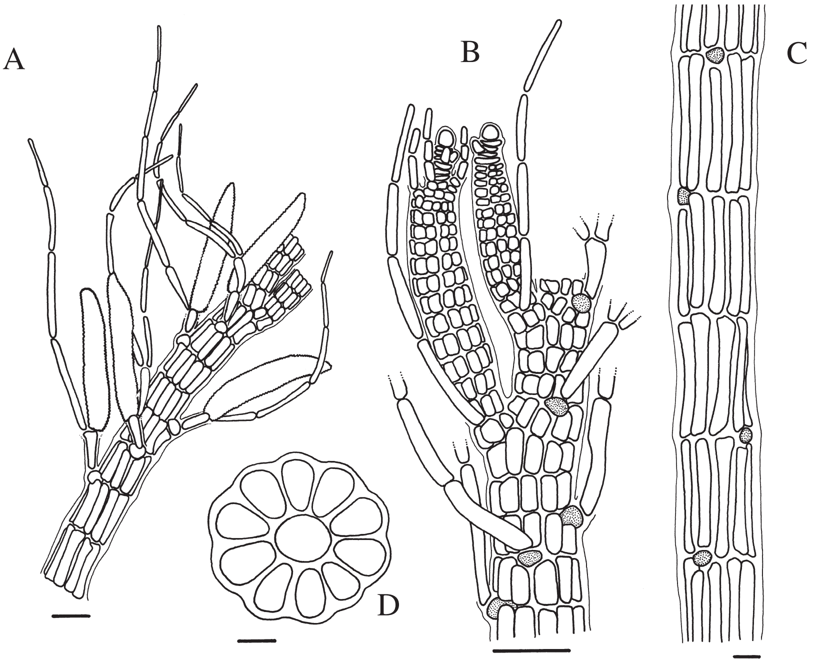

FIG. 159. – *Polysiphonia nigra*. A. Branch with spermatangial stichidia. B. Apical zone of the plant showing two branches issuing from trichoblast axils. C. Upper part of an axis showing the trichoblast scar-cells. D. Cross section of an axis. Scale bar = 50 µm.

rarely recorded from southern Atlantic, where its references, as *Polysiphonia atrorubescens*, are very old (Harvey, 1847; Barton, 1893; Delf and Michell, 1921; Pujals, 1963; etc.). Harvey (1847) described some specimens of this species from the Cape of Good Hope pointing out that they were identical to those from the British Isles. On the other hand, when Seagrief (1984) referred to this species in his catalogue of South African marine algae, he remarked: «little seems to be known about it».

Our specimens are compatible with the descriptions of *P. nigra* made by Taylor (1957), Maggs and Hommersand (1993) and Coppejans (1995) except for the size of cystocarps, which are smaller in the Namibian material (240-300 µm in diameter in comparison with 400-500 µm).

In Namibia *P. nigra* was recorded from Lüderitz (as *P. atrorubescens*) by Lawson *et al.* (1990). Likewise, these authors cited *P. urbana* Harvey, a species very similar to *P. nigra*, from several localities of this country. According to Stegenga *et al.* (1997) *P. urbana* is a southern African endemic species.

According to the literature consulted, *P. urbana* differs from *P. nigra* by the arrangement of either trichoblasts, spermatangium stichidia and tetrasporangia. Like this, whereas in *P. nigra* both trichoblasts and spermatangium stichidia are placed one in every segment (Rosenvinge, 1924; Maggs and Hommersand, 1993), in *P. urbana* these structures are not situated in every segment (Stegenga *et al.*, 1997). Concerning the tetrasporangia, in *P. nigra* they are spirally arranged (Maggs and Hommersand, 1993), whereas in *P. urbana* they are placed in short rectilinear series (Stegenga *et al.*, 1997).

Polysiphonia nigra was formerly recorded (as *P. atrorubescens*) from the Atlantic coast of South Africa (Harvey, 1847; Delf and Michell, 1921) and included in the catalogue of marine algae of this country by Seagrief (1984). In this way, it is surprising that Stegenga *et al.* (1997) did not refer to this taxon in their study on seaweeds of the South African west coast, especially when it is a species very similar to *P. urbana*. Despite the above mentioned differences, we hold that a more detailed comparative study of both species should be carried out.

Polysiphonia scopulorum Harvey
(Figs. 160-161)

Polysiphonia scopulorum Harvey (1855), p. 540.
Falkenbergiella caespitosa Pocock (1953), p. 41.
Polysiphonia caespitosa (Pocock) Hollenberg (1968a), p. 79.

Selected specimens: Mile 32, 7-07-1989, BCF-A 11904, with tetrasporangia and carposporangia; Rocky Point, 24-02-1986, BCF-A 11905, with tetrasporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11906, with tetrasporangia and carposporangia.

References: Pocock (1953), Hollenberg (1968a), Pérez-Cirera *et al.* (1989b), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant caespitose, with dorsiventral organization, differentiated into prostrate and erect axes, both polysiphonous and ecorticate. Prostrate axes 60-90 µm in diameter, tapered and curved at the apex, branched, with segments 0.5-1.8 times longer than broad, attached to the substratum by rhizoids; branching endogenous, given rise to both prostrate and erect axes. Erect axes 3-7 mm high, commonly unbranched, 50-80 µm in diameter in its median parts and 40-55 µm in diameter in the insertion point, straight or curved in the apical zone, slightly inclined towards the apex of the prostrate axes, arising every (1-)2-5 or more segments; segments 1.2-3.2 times longer than broad; branching endogenous, particularly abundant in fertile specimens; trichoblasts or scar-cells occurring only in some fertile specimens. Rhizoids unicellular, 32-60 µm in diameter, ending in a digitate attachment disc, arising from the pericentral cells of prostrate axes and remaining in open connection with

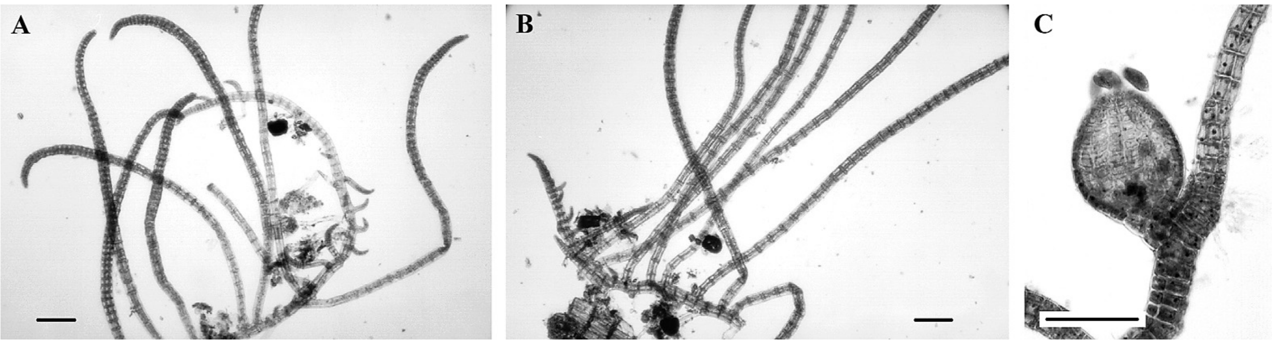

FIG. 160. – *Polysiphonia scopulorum*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11906. A-B. Habit. C. Cystocarp. Scale bar = 200 µm.

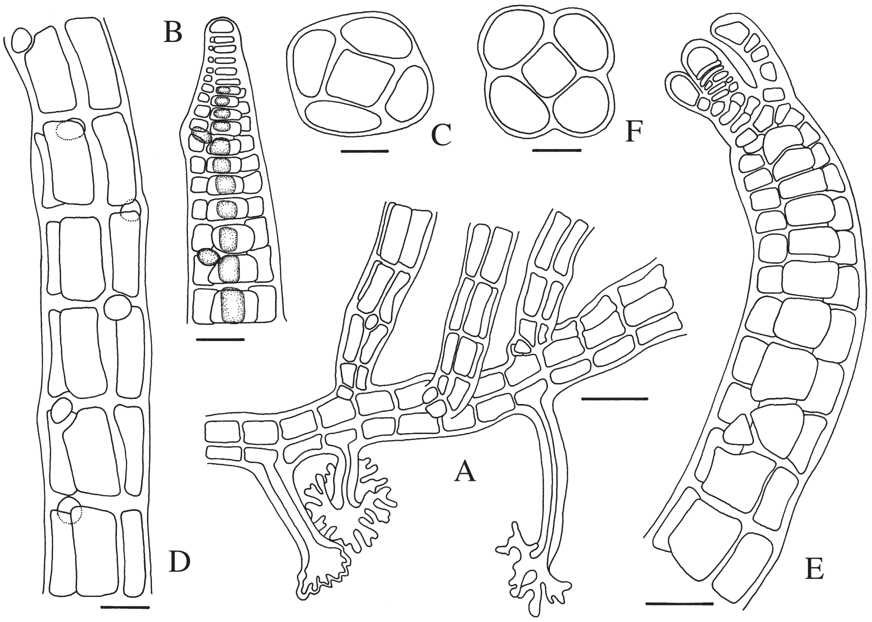

FIG. 161. – *Polysiphonia scopulorum*. A. Portion of a prostrate axis with three rhizoids and the basal part of three erect axes. B. Apical zone of a prostrate axis. C. Cross section of a prostrate axis. D. Portion of the upper part of an erect axis. E. Apical zone of an erect axis. F. Cross section of an erect axis. A. Scale bar = 100 µm. B-F. Scale bar = 25 µm.

them. Plastids numerous, discoidal or more or less rod-shaped. In cross section, axes composed of a more or less squarish axial cell, 34 x 26 µm in the prostrate axes and 24 x 22 µm in the erect ones, and 4 pericentral cells; basal segment of erect axes composed only of 2 pericentral cells abaxially arranged.

Reproduction: Tetrasporangia tetrahedrally divided, spherical, 40-54(-80) x 34-52(-80) µm, immersed in the upper part of erect axes, one in every segment, distending them. Cystocarps ovoid, 220-284 x 182-269 µm, shortly pedicellate, with ostiole; carposporangia ellipsoid or club-shaped, 48-120 x 18-40 µm. Spermatangia not seen.

Habitat: Epilithic, among the specimens of *Nothogenia erinacea*, being part of the grass composed of *Gelidium pusillum* and *Ophidocladus simpliciusculus*; also growing at base of *Gracilariopsis longissima*.

Namibian distribution: Mile 4, Mile 8 (Engledow, 1998); Mile 32, Rocky Point, South Kunene (Map 82).

World distribution: Widespread in tropical to temperate seas (Stegenga *et al.*, 1997).

Remarks: Pocock (1953) described *Falkenbergiella caespitosa* on the basis of material from the south and east coasts of South Africa. Subsequently, Hollenberg (1968a) doubted about the validity of the genus *Falkenbergiella* since, in his opinion, the main distinctive features of this genus, that is to say, the lack of trichoblasts in sterile specimens and the position of the pericentral cells, are of very questionable value. In this way, and on the basis of the lack of trichoblasts in some sterile specimens of *Polysiphonia*, Hollenberg (1968a) transferred *F. caespitosa* to this genus, pointing out that it is a large genus which may need to be divided further.

On the other hand, Norris (1992b) reduced the genus *Falkenbergiella* to a synonym of *Lophosiphonia*, pointing out that the features which distinguish the first genus from the second are trivial; at the same time, this author transferred *F. capensis* Kylin, the type species of the genus *Falkenbergiella*, to *Lophosiphonia*.

Lophosiphonia is very similar to *Polysiphonia* and usually, the only feature used in order to distinguish both genera has been the presence or not of a prostrate habit (Hollenberg, 1968b). Besides this feature, *Lophosiphonia* differs from *Polysiphonia* in having a dorsiventral organization in all branches, and because the branches are formed only of an endogenous manner (Hollenberg, 1968b; Norris, 1992b; Maggs and Hommersand, 1993).

Our specimens are compatible with the Pocock (1953) and Pérez-Cirera *et al.* (1989b) descriptions of *F. caespitosa*, and some of them also bear *Aiolocolax pulchellus* Pocock as a parasite, as it occurs in the material from both South Africa (Pocock, 1956) and the northwestern coast of the Iberian Peninsula (Pérez-Cirera *et al.*, 1989b). Our specimens have prostrate axes from which endogenous erect axes arise dorsally and attachment rhizoids arise ventral-ly. The branching of erect axes, when it occurs, is sparse and also endogenous. Moreover, some fertile specimens have deciduous short trichoblasts, which are spirally formed as may be deduced from the arrangement of its scar-cells (Fig. 161D). As a result of this radial arrangement of both the branches and trichoblasts, the erect axes are not dorsiventral and, as dorsiventrality is one of the main distinctive features of the genus *Lophosiphonia* according to Hollenberg (1968b), we agree with this author in placing this plant in the genus *Polysiphonia*.

On the other hand, Pérez-Cirera *et al.* (1989b) remarked that there is a great similarity between *Falkenbergiella caespitosa* from the northwest of the Iberian Peninsula and *Lophosiphonia scopulorum* (Harvey) Womersley from Portugal, and they held the possibility that both species had been mistaken on the European Atlantic coasts.

According to Hollenberg (1968b), Cribb (1983) and Price and Scott (1992), *L. scopulorum* has simple or sparsely branched erect axes, and for this reason, in agreement with these authors, we hold that the correct name for this plant must be *Polysiphonia scopulorum* Harvey. On the other hand, Pérez-Cirera *et al.* (1989b) remarked that *P. scopulorum* and *P. caespitosa* could be conspecific, and more recently, Stegenga *et al.* (1997) treated *Falkenbergiella caespitosa* as a synonym of *Polysiphonia scopulorum*.

Finally, Wynne (1986) cited a *Polysiphonia* sp. from Swakopmund, which consists of erect and prostrate axes, 38-50 µm in diameter, with 4 pericentral cells and without trichoblasts, that could correspond to this taxon.

Polysiphonia virgata (C. Agardh) Sprengel
(Figs. 162-164)

Hutchinsia virgata C. Agardh (1824), p. 157.
Polysiphonia virgata (C. Agardh) Sprengel (1827), p. 350.
Tayloriella virgata (C. Agardh) Papenfuss (1940b), p. 14.
Carradoria virgata (C. Agardh) Kylin (1956), p. 503.
Carradoriella virgata (C. Agardh) P. Silva in Silva *et al.* (1996), p. 920.
Polysiphonia fuliginosa Rudolphi (1831), p. 177.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11374, with tetrasporangia, carposporangia and spermatangia; Swakopmund, beach, 8-07-1989, BCF-A 11375, with tetrasporangia, carposporangia and spermatangia.

References: Kützing (1863), Falkenberg (1901), Simons (1976), Branch and Branch (1981), Wynne (1986), Stegenga *et al.* (1997).

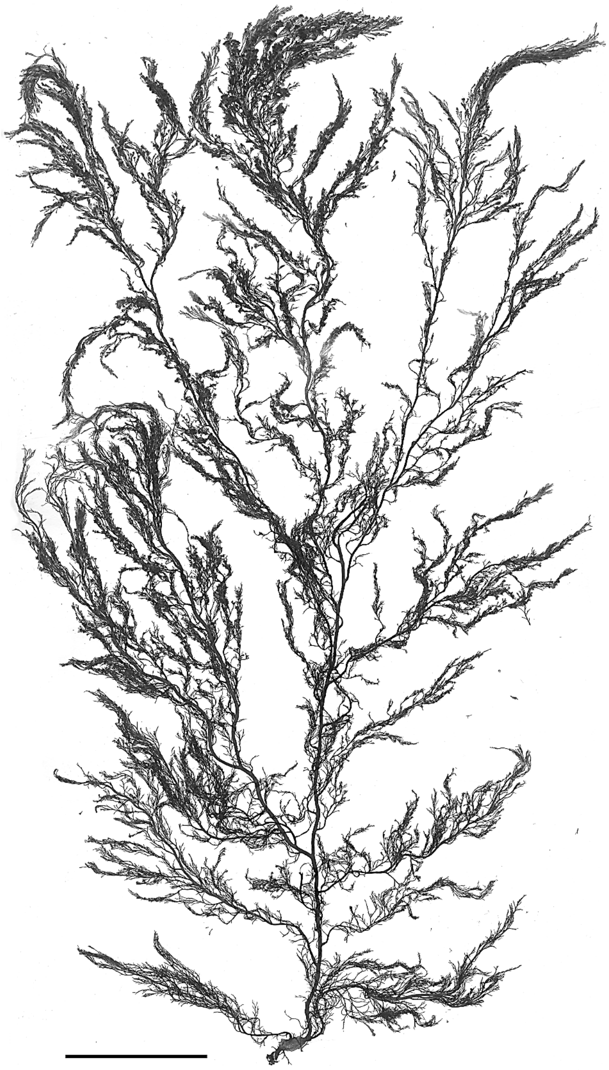

FIG. 162. – *Polysiphonia virgata*. Swakopmund, beach, 8-07-1989, BCF-A 11375. Scale bar = 5 cm.

Habit and vegetative structure: Plant up to 45 cm high, consisting of branched, polysiphonous, completely corticated erect axes, 300-1100 µm in diameter in its median part (up to 1300 µm in the lower part), attached to the substratum by a basal disc. Branching sparse, sometimes dichotomous at base, more or less alternate in the upper part of the plant, with long branches similar to main axes and short branches usually alternately branched, with patent, spine-like branchlets more or less distichously arranged; short branches 380-700 µm in diameter at the base and 200-340 µm in the upper part; last order branchlets 60-140 µm in diameter. Main axes becoming corticated from 1 cm approximately below the apex; cortication restricted to the joints in the subapical zones, becoming quickly denser in basipetal direction, preventing to see the pericentral cells; cortical cells elongate and sinuous, arising from the pericentral cells; segments of the upper part of the plant 0.8-1.6 times longer than broad, with 6-7 pericentral cells in surface view. Trichoblasts

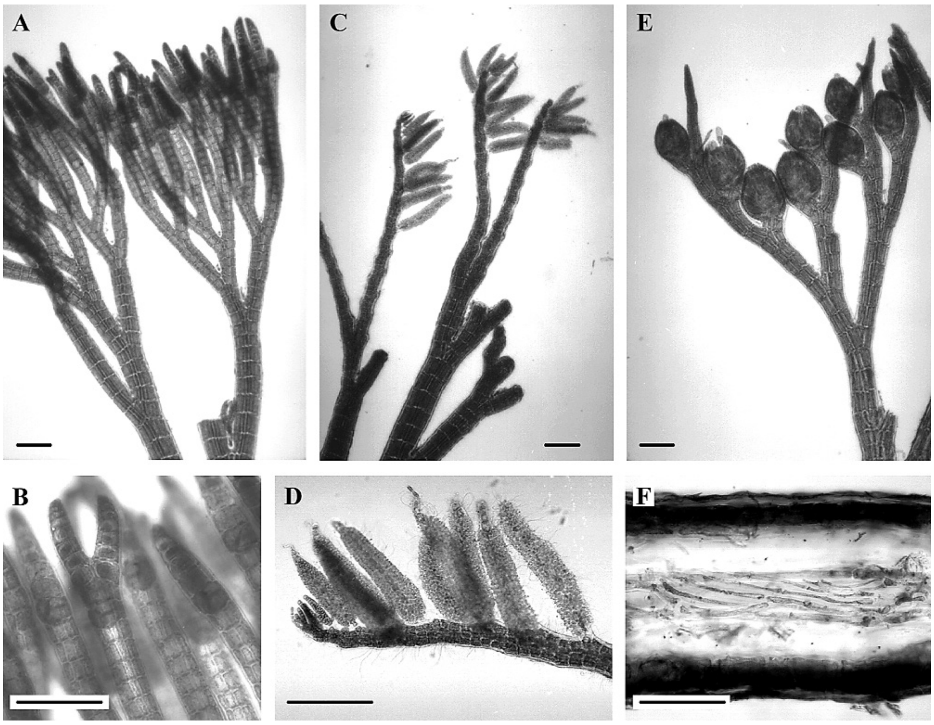

FIG. 163. – *Polysiphonia virgata*. A-B. Branches with tetrasporangia. C. Branches with spermatangial stichidia. D. Detail of a branch apex with spermatangial stichidia. E. Branches with cystocarps. F. Longitudinal section of an axis showing the corticate axial filament. Scale bar = 200 µm.

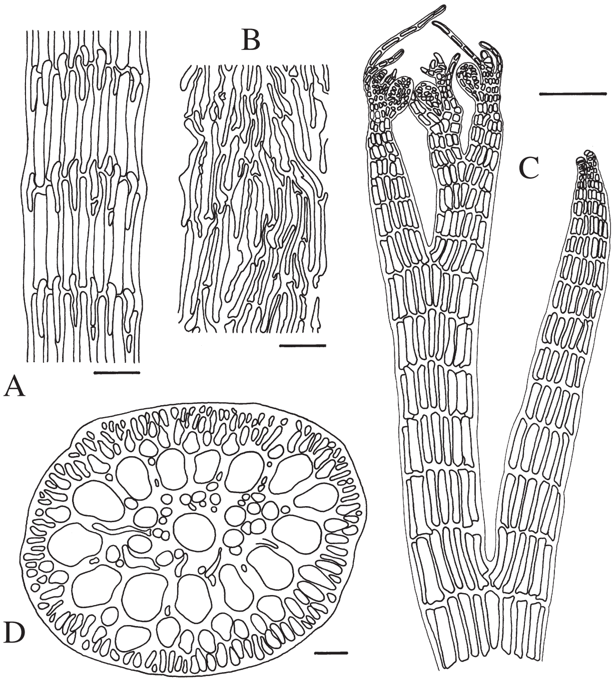

FIG. 164. – *Polysiphonia virgata*. A. Sub-apical portion of an axis showing the cortication. B. Cortication at median part of the plant. C. Apical zone of the plant (female gametophyte). D. Cross section of an axis at median part of the plant. Scale bar = 100 µm.

occurring only in fertile specimens. In cross section, axes composed of an axial cell 88-134 x 68-103 µm surrounded by a more or less wide layer of inner cortical cells, 13-14 pericentral cells and a layer of outer cortical cells; inner cortical cells little defined, 24-64 x 20-48 µm; pericentral cells 80-190 x 72-142 µm; outer cortical cells radially elongated, 36-120 x 16-52 µm. In longitudinal section, inner cortical cells elongate, forming cortical filaments surrounding the axial cells.

Reproduction: Tetrasporophyte and gametophytes often sharing the same basal disc. Tetrasporangia tetrahedrally divided, spherical, 52-72 x 36-72 µm, immersed, placed in the upper part of the branches, one per segment. Plant dioecious. Cystocarps more or less ovoid or ellipsoid, 280-400 x 220-320 µm, with ostiole; carposporangia club-shaped, 64-112 x 20-36 µm. Spermatangial stichidia conical or cylindro-conical, 182-371 x 47-79 µm, at first bearing a basal trichoblast; stichidia more or less arranged in two unilateral rows along the apical zones of branches, leaving clear scars when they fall off.

Habitat: Growing on mollusc shells, in drift material.

Namibian distribution: Elizabeth Bay, Grossebucht, Swakopmund (Lawson *et al.*, 1990) (Map 83).

World distribution: Atlantic Ocean: Argentina (Pujals, 1977); Uruguay (Coll and Oliveira, 1999); Brazil (Wynne, 1998); South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: This taxon was initially described as *Hutchinsia virgata* by C. Agardh (1824) and subsequently it has been assigned to different genera, like *Polysiphonia* Greville (Sprengel, 1827; Wynne, 1986; Stegenga *et al.*, 1997), *Tayloriella* Kylin (Papenfuss, 1940b; Seagrief, 1984), *Carradoria* Martius (Kylin, 1956; Simons, 1976) and *Carradoriella* P. Silva (Silva *et al.*, 1996). After an extensive nomenclatural discussion, Silva (in Silva *et al.*, 1996) proposed the genus *Carradoriella* for this species. However, Wynne (1986) had earlier shown a number of taxonomical reasons to include it in the genus *Polysiphonia*.

According to the available literature, the distribution of *Polysiphonia virgata* is restricted to the south Atlantic, except for a single record from the South African Indian coast. This is an old citation of Krauss (1846) based upon material which is lost (Silva *et al.*, 1996). *P. virgata* had also been recorded from Australia, but Womersley (1979) considered the citation as an error and rejected this species from the Australian flora.

One of the main distinctive traits of *P. virgata* is the presence of an inner cortication surrounding the axial cells. This feature is shared by *Polysiphonia brodiaei* (Dillwyn) Greville, a species occurring in the northern hemisphere, Australia and New Zealand (Maggs and Hommersand, 1993). Unlike *P. virgata*, in which the axes consist of 12-16 pericentral cells (Falkenberg, 1901; Wynne, 1986; Stegenga *et al.*, 1997), *P. brodiaei* has only 6-8 pericentral cells.

Genus *Pterosiphonia* Falkenberg in Schmitz and Falkenberg (1897)

Key to species of *Pterosiphonia*:

1. Axes 1-2 mm broad, corticate 2
1. Axes less than 0.5 mm broad, ecorticate............. ....*P. cf. dendroidea*

2. Lateral branches coalescing with 2-3 segments of the main axis; ultimate branches with 6 pericentral cells ....*P. cloiophylla**
2. Lateral branches coalescing with 4-6 segments of the main axis; ultimate branches with 5 pericentral cells ....*P. complanata*

* *P. cloiophylla* was not observed. More information about this taxon can be found in Hommersand (1963) and Stegenga *et al.* (1997), as well as in the remark of *P. complanata*.

Pterosiphonia complanata (Clemente y Rubio) Falkenberg (Figs. 165-167; Plate IV)

Fucus complanatus Clemente y Rubio (1807), p. 316.
Pterosiphonia complanata (Clemente y Rubio) Falkenberg (1901), p. 265.

Lectotype: MA-Algae 1464, Clemente, Tarifa (Spain).

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11377, with tetrasporangia and carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11379, with tetrasporangia; Möwe Bay, 5-02-1988, BCF-A 11787, with tetrasporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11788, with tetrasporangia; Möwe Bay, Suider kust, 6-02-1988, BCF-A 11790, with tetrasporangia and carposporangia; Rocky Point, 24-02-1986, BCF-A 11380, with tetrasporangia.

References: Gayral (1966), Norton and Parkes (1972), Casares (1987), Maggs and Hommersand (1993).

Habit and vegetative structure: Plant up to 19 cm high, consisting of branched erect axes arising from less developed prostrate axes attached to the substratum by means of rhizoids or discoidal attachment pads; erect axes cylindrical at base and compressed in the median and upper parts, 1-2 mm broad and 600-700 µm thick. Rhizoids unicellular, with or without discoidal attachment tips. Prostrate axes cylindric or slightly compressed, 500-700 µm in diameter, irregularly branched, bearing short (approximately 1 mm in length), robust, more or less spine-like, pinnate branches. Erect axes alternately

FIG. 165. – *Pterosiphonia complanata*. Möwe Bay, 5-02-1988, BCF-A 11787. Scale bar = 2 cm.

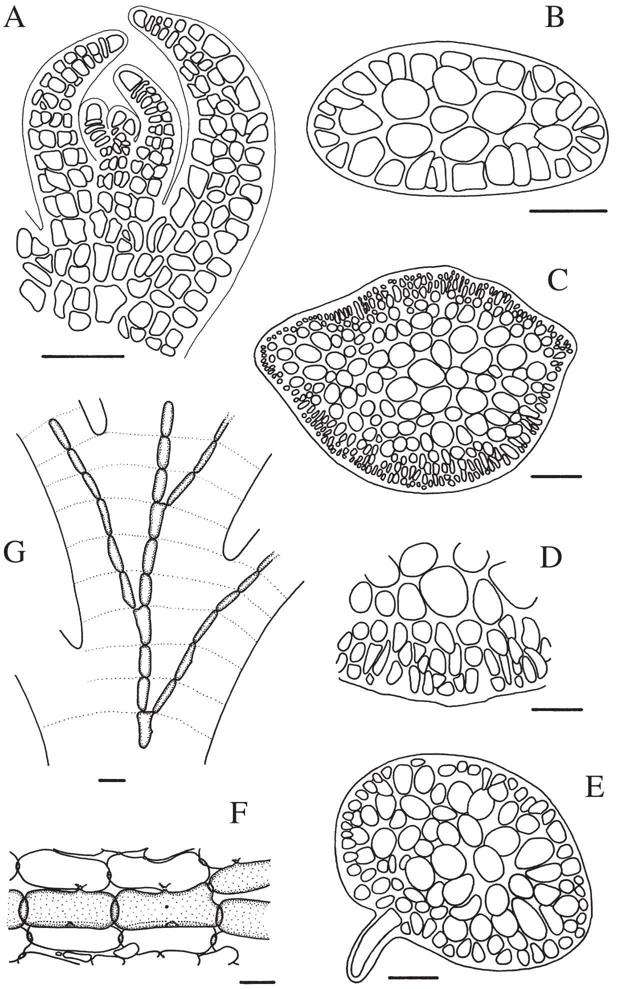

FIG. 166. – *Pterosiphonia complanata*. A. Apical zone of the plant. B. Cross section of a last order branch. C-D. Cross section of an erect axis at median part of the plant. D. Detail of the cortex. E. Cross section of a prostrate axis. F. Axial and periaxial cells of an erect axis in longitudinal section. G. Longitudinal section of an erect axis showing the axial filament. A-B. Scale bar = 50 µm. C, G. Scale bar = 200 µm. D-F. Scale bar = 100 µm.

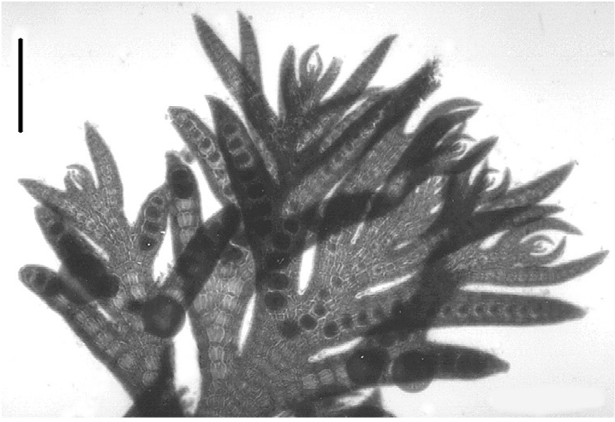

FIG. 167. – *Pterosiphonia complanata*. Apical zone of the plant with tetrasporangia. Scale bar = 400 µm.

branched, distichous, up to 3-4 times pinnate, often devoid of branches in the lower part, where the scars are visible; ultimate branches more or less triangular, 200-260 µm broad, some of them forked; fertile branches terete, thinner, 100-180 µm in diameter. Axes completely corticate; outer cortical cells elongate or more or less isodiametric, angular, irregular in outline or polygonal in surface view, 12-76 x 8-32 µm; pericentral cells only visible in the ultimate branches. Apical cell dome-shaped, 12-16 µm in diameter, overtopped by young laterals; trichoblasts absent. Plastids discoidal. In cross section, polysiphonous structure not much clear in main axes, but more visible in the ultimate branches; main axes composed of a medullar zone and a cortex; medullary cells elliptic or more or less isodiametric, 80-160 x 56-134 µm, smaller towards the cortex, 40-112 x 24-92 µm; outer cortical cells generally elongate, 20-60 x 16-50 µm; ultimate branches composed of an axial cell surrounded by 5 pericentral cells and a layer of cortical cells. In longitudinal section, axial filament visible, branched every three cells; segments 0.2-0.3 times longer than broad; basal zone of lateral branches coalescing with 5 segments of the main axis.

Reproduction: Tetrasporangia tetrahedrally divided, spherical or more or less rectangular, 64-108 x 52-88 µm, immersed, placed one per segment in the ultimate branches. Cystocarps globose, 600-900 µm in diameter, pedicellate, umbilicate, opening to the exterior by a pore 140 µm in diameter; carposporangia club-shaped, 100-176 x 24-40 µm. Spermatangia not seen.

Habitat: Growing among the specimens of *Laminaria pallida* and *Rhodymenia obtusa*, together with *Plocamium rigidum*, in the upper sublittoral zone. Occurring also in drift material.

Namibian distribution: Swakopmund, Möwe Bay, Rocky Point (Map 84).

World distribution: Atlantic Ocean: Namibia; Congo? (Lawson *et al.*, 1995); Mauritania to British Isles (Maggs and Hommersand, 1993). Mediterranean Sea (Athanasiadis, 1987; Giaccone *et al.*, 1985; Ben Maiz *et al.*, 1987; Ballesteros, 1990).

Remarks: Morphologically, our specimens are very similar to the photograph of *Pterosiphonia cloiophylla* (C. Agardh) Falkenberg shown by Wynne (1986), as well as to the iconography of this species which is found in Simons (1969 and 1976), Branch and Branch (1981) and Stegenga *et al.* (1997). This fact initially lead us to identify our specimens as *P. cloiophylla*. However, a more detailed study of this material showed that it was closer to *P. complanata* than to *P. cloiophylla*.

In agreement with Falkenberg (1901), Papenfuss (1943) remarked that *P. cloiophylla* is very similar to *P. complanata*, and that it remains as a different species due only to its different geographical distribution. Moreover, Papenfuss (1943) and Norton and Parkes (1972) pointed out that a comparative study of both species is needed. In this way, Hommersand (1963) carried out a thorough study on *P. cloiophylla*, showing the main differences between this species and *P. complanata*.

According to Hommersand (1963) the main feature which distinguishs *P. cloiophylla* from *P. complanata* is the number of segments of the main axis congenitally fused with a lateral branch. According to this author, and in agreement with Falkenberg (1901), in *P. cloiophylla* the lateral branches fuse with two segments of the main axis, whereas in *P. complanata* they fuse with five or six segments of the main axis [4-4.5 segments according to Maggs and Hommersand (1993)]. Moreover, Hommersand (1963) remarked that in *P. cloiophylla* the axes have five pericentral cells except in the ultimate branchlets and in the tetrasporangial branches, where there are six. In contrast, *P. complanata* has five pericentral cells in all branches (Maggs and Hommersand, 1993).

In our specimens the pericentral cells are difficult to distinguish in a cross section of the main axis, but they are easily observable in the ultimate branches, in which 5 pericentral cells are clearly visible in cross section (Fig. 166B). Moreover, in our specimens the lateral branches fuse with five segments of the main axis (Fig. 166G). These features, as well as other traits and the plant habit, are compatible with the Maggs and Hommersand (1993) description of *P. complanata*, and for this reason we have preferred to assign our material to this species. However, the Namibian specimens are taller and more robust than those of the British Isles, since they can reach up to 19 cm high and consist of axes up to 2 mm broad [3-10 cm high and axes up to 0.9 mm broad in the European specimens, according to Maggs and Hommersand (1993)].

Pterosiphonia complanata is also similar to the Tristan da Cunha species *P. concinna* Baardseth, but unlike *P. complanata*, in this species the axes are only partially corticated, with the cortex never covering the pericentral cells completely (Baardseth, 1941).

Pterosiphonia complanata occurs basically in the northeastern Atlantic and in the Mediterranean Sea (Norton and Parkes, 1972; Lawson *et al.*, 1995). Formerly, Hariot (1895 and 1896) recorded this species from a coastal region nearby the Republic of the Congo, but Lawson and John (1982 and 1987) regarded the record as uncertain since it was based on just two fragments.

Until now, the only species of *Pterosiphonia* recorded from the Namibian coasts was *P. cloiophylla*. This species was described by C. Agardh (1822), as *Rhodomela cloiophylla*, on the basis of material from the Cape of Good Hope, and subsequently it has been recorded from some localities of the east Indian Ocean and the west coast of southern Africa (Silva *et al.*, 1996; Stegenga *et al.*, 1997). In Namibia, *P. cloiophylla* has been recorded from the Lüderitz area, Swakopmund, Terrace Bay and Rocky Point (Lawson *et al.*, 1990). As we have already commented, *P. cloiophylla* and *P. complanata* are very similar species and difficult to distinguish, the reason for which we believe that they could have been mistaken. In this way, it is possible that some of the *P. cloiophylla* records included in Lawson *et al.* (1990), particularly those from Swakopmund and Rocky Point (localities also sampled by us), actually belong to *P. complanata*. However, we hold that a thorough revision of the Namibian material, as well as of the type specimens of both species, should be carried out in order to clarify its taxonomy.

Pterosiphonia cf. dendroidea (Montagne) Falkenberg (Fig. 168)

Polysiphonia dendroidea Montagne (1838), p. 353.
Pterosiphonia dendroidea (Montagne) Falkenberg (1901), p. 268.

Type: PC (Montagne Herb.).

Selected specimens: Möwe Bay, 4-02-1988, BCF-A 11791; Rocky Point, 24-02-1986, BCF-A 11912.

References: Kützing (1863), Falkenberg (1901), Dawson (1963), Dawson *et al.* (1964), Pujals (1967), Abbott and Hollenberg (1976), Santelices (1989).

Habit and vegetative structure: Plant erect, 0.7-1.2 cm high, consisting of a polysiphonous, ecorticate, compressed, branched main axis, 260-340 µm broad in its median part; attachment by means of rhizoids 28-32 µm in diameter. Segments of main axis 0.5-0.7 times longer than broad. Branching alternate, distichous, 2(-3) times pinnate; branches arising from every other segment and coalescing with 2.5 segments of the main axis; ultimate branches tapering towards the apex, straight or slightly divaricate, 80-120 µm in diameter in its median part. Prostrate branches of radial organization occasionally arise from erect axes. Tri-

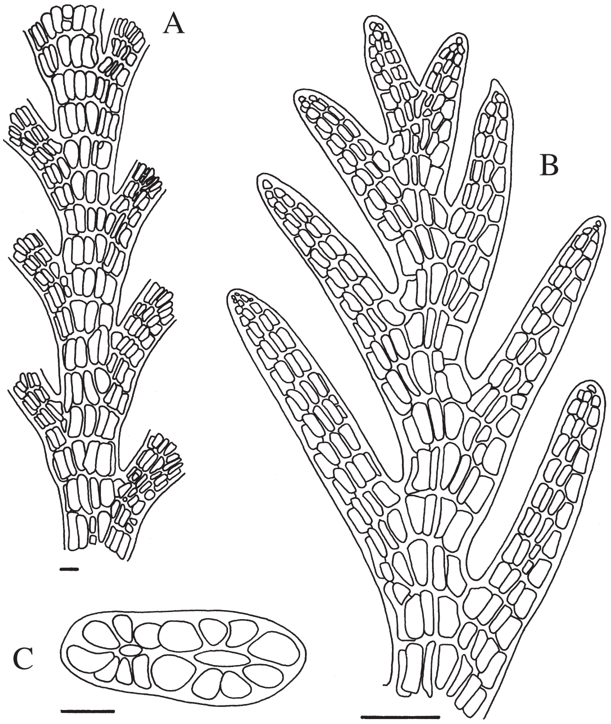

FIG. 168. – *Pterosiphonia cf. dendroidea*. A. Main axis and lower part of branches. B. Last order branches. C. Cross section of the main axis. Scale bar = 100 µm.

choblasts absent. In cross section, main axis 200-220 µm thick, composed of an axial cell 88-120 x 48-68 µm and 8-9 pericentral cells.

Reproduction: Reproductive structures not seen.

Habitat: Epiphytic on *Tayloriella tenebrosa* in the lower eulittoral zone.

Namibian distribution: Möwe Bay, Rocky Point (Map 85).

World distribution: Atlantic Ocean: Argentina (Pujals, 1977); Namibia. Pacific Ocean: Chile, Juan Fernández Islands, Peru, Ecuador (Pujals, 1967); Galapagos Islands, Baja California to Alaska (Scagel *et al.*, 1986).

Remarks: Our material consists of some fragments lacking well developed prostrate axes. However, the morphological and anatomical traits of the erect axes agree quite well with those of *Pterosiphonia dendroidea*. This species was described by Montagne (1838) on the basis of material from Peru, and presently it occurs mainly along the Pacific coasts of America and in Argentina.

P. dendroidea is very similar to *P. parasitica* (Hudson) Falkenberg, *P. pennata* (C. Agardh) Falkenberg and *P. spinifera* (Kützing) Norris and Aken, all of them occurring in the Atlantic ocean. *P. dendroidea* differs from *P. parasitica* mainly in having compressed axes and because the branches fuse with 2-2.5 segments of the main axis [axes cylindrical or subcylindrical and branches fused with 0.7-1.3 segments of the main axis in *P. parasitica*, according to Maggs and Hommersand (1993)]. However, the axes of *P. parasitica* are apparently compressed in a figure of this species shown by Falkenberg (1901). Likewise, according to Casares (1987), *P. parasitica* has compressed erect axes and branches fused with 3 segments of the main axis. On the other hand, Anderson and Stegenga (1989) cited *P. parasitica* from the South African east coast, but stated that the specimens are anomalous, because they have only 5 pericentral cells instead of 6-9 as Ardré (1967) pointed out. This morphological and anatomical variation of *P. parasitica*, as well as the lack of complete specimens, made us doubt when we assigned our material to *P. dendroidea*, in spite of the fact that Maggs and Hommersand (1993) remarked that very few morphological variation occurs in *P. parasitica*.

P. pennata and *P. spinifera* are two very similar species and, according to Maggs and Hommersand (1993), possibly conspecific. Ardré (1967) differentiated the species on the basis of the axis width and the number of pericentral cells [(50-)75-150 (-200) µm in diameter and 6-8 pericentral cells in *P. pennata*, and 250-550 µm in diameter and 10-12 pericentral cells in *P. spinifera*]. Following this criterion, Norris and Aken (1985) cited *P. spinifera* from the coast of Natal, in South Africa, pointing out that a study should be carried out in order to know whether the thickness of axes and the number of pericentral cells actually have, or do not have, a systematical value. Likewise, Stegenga *et al.* (1997) cited *P. spinifera* from the South African west coast, pointing out that the specimens have a number of pericentral cells (8-10) which is intermediate between that of *P. spinifera* and that of *P. pennata*. On the other hand, the Maggs and Hommersand (1993) description of *P. pennata* practically includes the differences between both species mentioned by Ardré (1967). *P. dendroidea* differs from these taxa mainly in the degree of branching, so in *P. dendroidea* the axes are 2-3 times pinnately divided whereas in the other two species they are commonly only once pinnate.

Taking into account the great heterogeneity of the material included in each of this species, we hold that a taxonomical revision of the genus *Pterosiphonia* should be carried out.

Genus *Streblocladia*
Schmitz in Engler and Prantl (1897)

Key to species of *Streblocladia*:

1. Axes with 4 pericentral cells, ecorticate............... ....*S. camptoclada*
1. Axes with 11-14 pericentral cells, partly corticate ....*S. corymbifera*

Streblocladia camptoclada (Montagne) Falkenberg
(Figs. 169-171)

Polysiphonia camptoclada Montagne (1837), p. 352.
Streblocladia camptoclada (Montagne) Falkenberg (1901), p. 345.
Orcasia pulla Simons (1970), p. 8.

Type: PC (Montagne Herbarium); leg. D'Orbigny.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11365, with tetrasporangia; Mile 32, 7-07-1989, BCF-A 11792, with tetrasporangia; Cape Cross, 7-07-1989, BCF-A 11366, with tetrasporangia; Mile 108, 13-07-1989, BCF-A 11367, with tetrasporangia; Terrace Bay, February 1986, BCF-A 11376, with tetrasporangia; Möwe Bay, 4-02-1988, BCF-A 11794; Rocky Point, 24-02-1986, BCF-A 11793, with carposporangia; *ibid*., BCF-A 12238, with tetrasporangia and carposporangia; Cape Frio, 23-02-1986, BCF-A 11368, with tetrasporangia and carposporangia; Angra Fria, 20-02-1986, BCF-A 11369, with tetrasporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11914, with carposporangia.

References: Kützing (1863), Falkenberg (1901), Dawson *et al.* (1964), Simons (1970), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, 2-3(-5) cm high, consisting of cylindrical, polysiphonous, ecorticate, branched axes converging downwards in a more or less spongy base of prostrate axes retaining sediment. Attachment by means of rhizoids, particularly abundant in the prostrate axes but occasionally present in the erect ones, arising from the pericentral cells; rhizoids unicellular, 40-60 µm in diameter, usually ending in a discoidal attachment pad. Prostrate axes 120-200 µm in diameter, branched, with segments 0.4-1.2 times longer than broad. Erect axes (158-)200-280 µm in diameter, with segments 0.4-1.7 times longer than broad, several times branched, often without a differentiated main axis; branching exogenous, sparse or lateral, alternating 2-3(-5) branches on each side; ultimate branches 80-120 µm in diameter, suddenly tapered at apex, often divaricate, fastigiate in fertile specimens. Apical zone apparently sympodial, overtopped by the next lower branch; branches issuing adaxially and unilaterally arranged; apical cell 12-16(-20) x (8-)12-20 µm. Trichoblasts short, branched, occurring only in the specimens bearing procarps. In cross section, both erect and prostrate axes composed of an axial cell 36-56 x 36-48 µm and 4 pericentral cells.

FIG. 169. – *Streblocladia camptoclada*. Langstrand, 6-07-1989, BCF-A 11365. Scale bar = 1 cm.

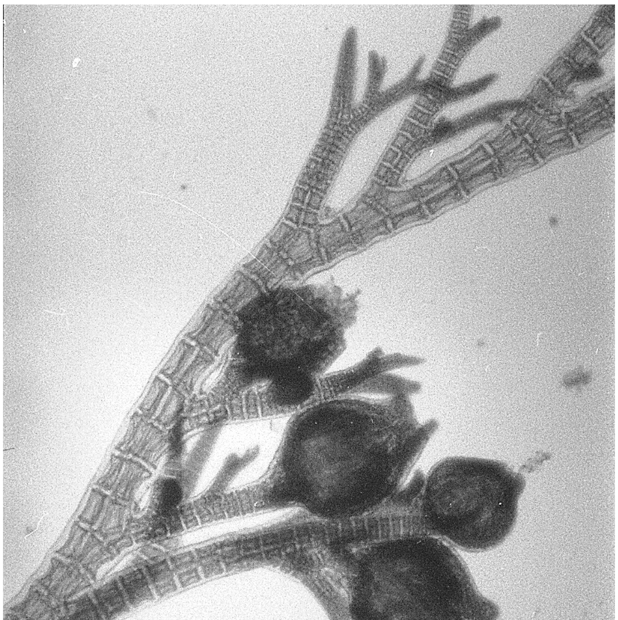

FIG. 170. – *Streblocladia camptoclada*. Cystocarps. Scale bar = 400 µm.

Reproduction: Tetrasporangia tetrahedrally divided, spherical or more or less rectangular, 39-72 x 32-60 µm, immersed in the ultimate branches, one in every segment. Cystocarps elliptic or more or less

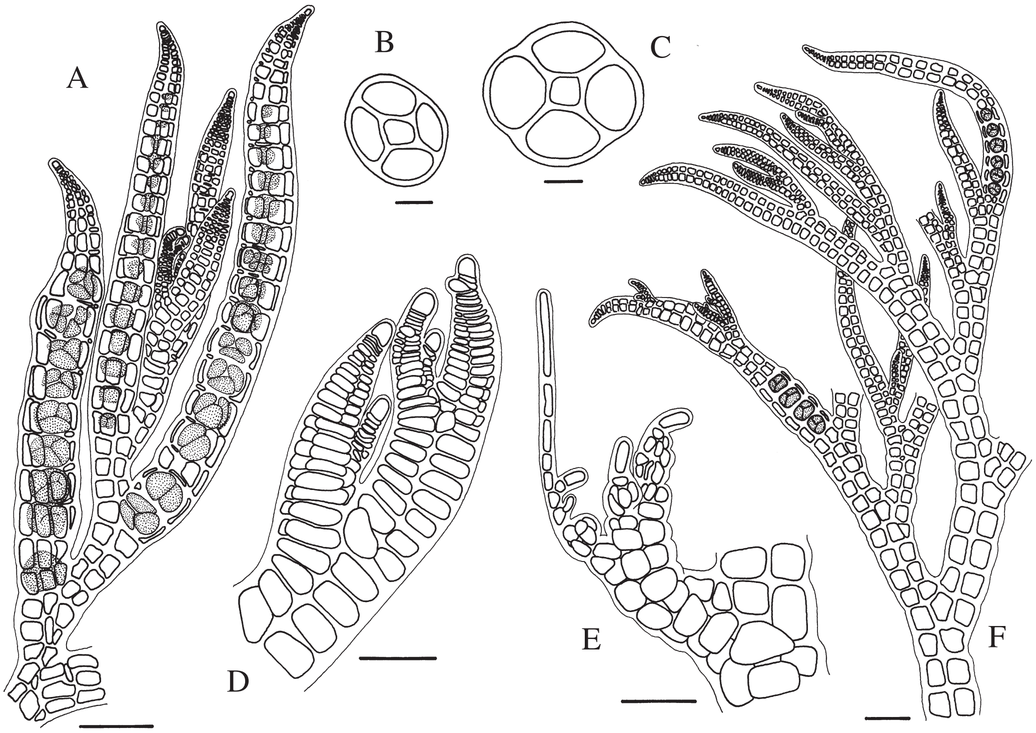

FIG. 171. – *Streblocladia camptoclada*. A. Branches with tetrasporangia. B. Cross section of a prostrate axis. C. Cross section of an erect axis. D. Apical zone of the plant. E. Apical zone with procarps at base of trichoblasts. F. Branches of the upper part of the plant. A, F. Scale bar = 100 µm. B-E. Scale bar = 50 µm.

urceolate, 240-500 x 180-440 µm, with ostiole, arising from the base of trichoblasts; carposporangia club-shaped, 80-100 x 18-28 µm. Spermatangia not seen.

Habitat: Epilithic, growing on mussel shells or epiphytic on several algae, like *Chondria capensis*, *Hypnea spicifera* and *Laminaria pallida* (haptera) among others; occurring also in drift material.

Namibian distribution: Swakopmund, Toscanini, Unjab, Terrace Bay, Möwe Bay, Rocky Point, Cape Frio, Angra Fria, Kunene River (Lawson *et al.*, 1990); Langstrand, Mile 32, Cape Cross, Mile 108, South Kunene (Map 86).

World distribution: Atlantic Ocean: Argentina (?), South Africa, Namibia (Stegenga *et al.*, 1997). Pacific Ocean: Chile, Peru (Wynne, 1986).

Remarks: *Streblocladia camptoclada* was described by Montagne (1837), as *Polysiphonia camptoclada*, on the basis of material from Callao (Peru) and later, Falkenberg (1901) transferred it to the genus *Streblocladia*.

On the other hand, Simons (1970) described *Orcasia pulla* Simons as a new Rhodomelaceae from Namibia. Subsequently, Wynne (1986) stated that *O. pulla* appears indistinguishable from *Streblocladia camptoclada* and that thus, it must be considered as a synonym of this species. Some years later, Stegenga *et al.* (1997) studied the type material of *O. pulla* and corroborated the synonymy proposed by Wynne (1986).

Streblocladia camptoclada occurs in the Pacific coasts of South America and in the Atlantic coasts of southern Africa. Lazo (1982) cited this species from Argentina but Stegenga *et al.* (1997) considered it unlikely that the record corresponded to *S. camptoclada*, since the branches bearing tetrasporangia were different.

In general, our material agrees quite well with the descriptions consulted. However, it is important to point out that our specimens, as well as those from South Africa (Simons, 1970; Stegenga *et al.*, 1997), are much more robust than those described by Dawson *et al.* (1964). Thus, according to these authors, in the specimens from Peru the axes are 65 µm in diameter at the base and 25 µm in diameter in the upper part, whereas in our specimens the axes measure (158-)200-280 µm in diameter in the median part [up to 450 µm according to Simons (1970)] and the ultimate branches 80-120 µm. These differences suggest the possibility that the Atlantic and the Pacific material assigned to *S. camptoclada* could belong to different taxa.

The genus *Streblocladia* is very similar to *Fernandosiphonia* Levring, from which it differs basically in the arrangement of trichoblasts. In *Streblocladia* the trichoblasts are secund and adaxially arranged, whereas in *Fernandosiphonia* they are spirally arranged (Hommersand, 1963; Norris, 1994). Moreover, unlike *Fernandosiphonia*, in *Streblocladia* the first pericentral cell is abaxial, that is to say, it is cut off opposite a lateral branch (Hommersand, 1963; Norris, 1994).

Streblocladia corymbifera (C. Agardh) Kylin
(Figs. 172-174)

Hutchinsia corymbifera C. Agardh (1828), p. 90.
Polysiphonia corymbifera (C. Agardh) Endlicher (1843), p. 45.
Streblocladia corymbifera (C. Agardh) Kylin (1938), p. 20.

Selected specimens: Walvis Bay, Lagoon, 9-07-1989, BCF-A 11795, with tetrasporangia and carposporangia; Langstrand, 6-07-1989, BCF-A 11371, with tetrasporangia, carposporangia and spermatangia; 5 km south of Swakopmund, 7-07-1989, BCF-A 11370, with tetrasporangia, carposporangia and spermatangia; Swakopmund, beach, 8-07-1989, BCF-A 11372, with tetrasporangia, carposporangia and spermatangia; Cape Cross, 7-07-1989, BCF-A 12239, with carposporangia; Rocky Point, 24-02-1986, BCF-A 11373, with tetrasporangia and carposporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11418, with tetrasporangia and spermatangia.

References: Harvey (1847), Kützing (1863), Kylin (1938), Wynne (1986), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, 3-12 cm high, consisting of cylindrical, polysiphonous, branched, corticate axes attached to the substratum by means of both a basal disc and rhizoids occurring usually in the basal part of axes. Rhizoids unicellular, sinuous, 40 µm in diameter, simple or branched, with or without discoidal tips, arising from the cortical cells. Branching dichotomous or polychotomous at base, with wide dichotomic angles, becoming sparse or more or less lateral towards the median part, often with short, branched, patent branchlets that given a rigid aspect to the plant; branching pseudodichotomous or unilateral, fastigiate, in the upper part of axes; apical zone the branches more or less unilaterally arranged, adaxial. Axes 400-840 µm in diameter in the lower part and 200-540 µm in the upper half; segments 0.3-1.3 (-2.9) times longer than broad in the median part of the plant, 0.7-2.3 times longer than broad in the upper part; ultimate branches 60-100(-140) µm in diameter. Cortication abundant in the basal part of axes, usually preventing the segments from being distinguished, decreasing in density upwards remaining limited to few cells placed in the joints between the segments; upper part of axes ecorticate; cortical cells elongate, sinuous in outline, some of them forked, mainly placed between the pericentral cells forming a windowed cortication in the median part of the plant. Trichoblasts occurring in fertile specimens, related with the reproductive structures. Branching exogenous; first pericentral cell abaxial, opposite to the branch initial. In cross section, axes composed of an axial cell 80-180 µm in diameter, 11-14 radially elongated pericentral cells and an outer layer of cortical cells more or less developed depending on the distance to the plant base; cortical cells radially elongated, forming a continuous layer in the basal part of the plant, placed between the pericentral cells in the median part, and lacking in the central part of the upper segments.

FIG. 172. – *Streblocladia corymbifera*. 5 km south of Swakopmund, 7-07-1989, BCF-A 11370. Scale bar = 1 cm.

Reproduction: Tetrasporangia tetrahedrally divided, spherical, 52-100 x 44-100 µm, immersed in the ultimate branches, generally one per segment, distending them. Plant dioecious. Procarps related with the trichoblasts, adaxial, unilaterally arranged in the ultimate branches; cystocarps globose or ellipsoidal, 220-480 µm in diameter, pedicellate, with ostiole; carposporangia club-shaped, 80-126 x 40-55 µm. Spermatangial stichidia conical, 136-277 x 40-79 µm, pedicellate, some of them polysiphonous at base, adaxially arranged every other segment in the

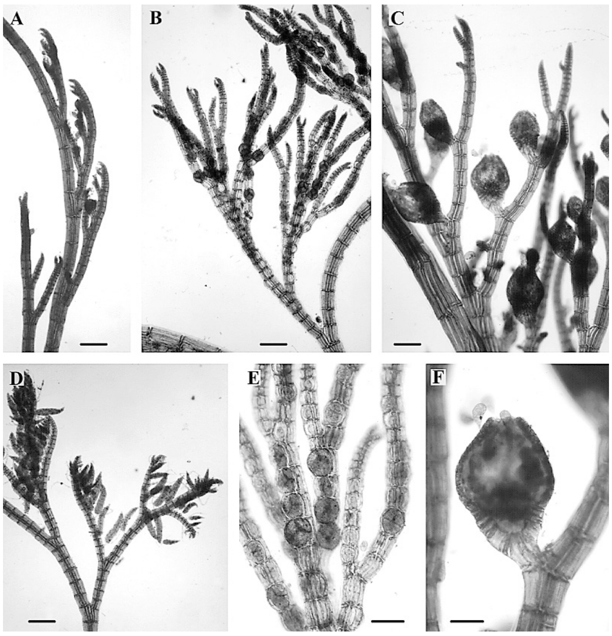

FIG. 173. – *Streblocladia corymbifera*. A. Upper part of the plant. B. Branches with tetrasporangia. C. Branches with cystocarps. D. Branches with spermatangial stichidia. E. Detail of tetrasporangia. F. Detail of a cystocarp. A-D. Scale bar = 200 µm. E-F. Scale bar = 100 µm.

ultimate branches, replacing one of the two branches of the trichoblasts.

Habitat: In the lower eulittoral zone and in tide pools. Epiphytic on several algae, especially on *Codium spp*., on which it attached by means of rhizoids penetrating among the utricles; also growing on mussel shells.

Namibian distribution: Swakopmund, Rocky Point (Lawson *et al.*, 1990); Walvis Bay, Langstrand, Cape Cross, South Kunene (Map 87).

World distribution: Atlantic Ocean: Argentina (Pujals, 1963); Brazil (Wynne, 1998); South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa, Mozambique (Silva *et al.*, 1996).

Remarks: *Streblocladia corymbifera* was initially described by C. Agardh (1828), as *Hutchinsia corymbifera*, on the basis of material from the Cape of Good Hope, and later Kylin (1938) transferred it to the genus *Streblocladia*.

Our material agrees quite well with the *Streblocladia corymbifera* descriptions consulted. However, the morphology of the Langstrand specimens is slightly different from that of our specimens collected in other localities. In the Langstrand specimens the segments of the central part of axes often are barrel shaped, 2-3 times longer than broad, and its pericentral cells are usually spirally twisted. On the contrary, the specimens from other localities have cylindrical segments, up to 1.3 times longer than broad, and with straight pericentral cells. Moreover, although the Langstrand specimens show the same pattern of cortication than that of the remaining specimens, the latter is not so abundant.

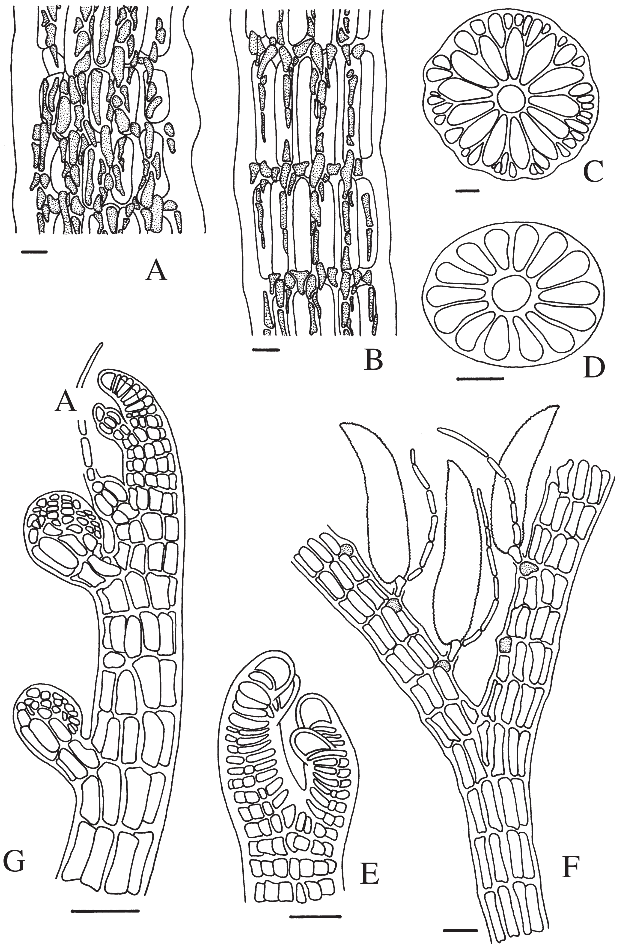

FIG. 174. – *Streblocladia corymbifera*. A-B. Cortication at lower (A) and median (B) parts of the plant. C-D. Cross sections of an axis at lower (C) and upper (D) parts of the plant. E. Apical zone. F. Spermatangial stichidia. G. Apical zone showing several stages in development of cystocarps. A-D. Scale bar = 100 µm. E. Scale bar = 25 µm. F-G. Scale bar = 50 µm.

Streblocladia corymbifera is morphologically similar to *Polysiphonia urbana* Harvey (a southern African endemic species) and to *P. virgata* (C. Agardh) Sprengel, but it differs from these species in the organization type of the apical region: dorsiventral in *S. corymbifera* and radial or bilateral in the other two taxa (Kylin, 1956). Another characteristic trait of the genus *Streblocladia* is the fact that the first pericentral cell is formed opposite a lateral branch (Hommersand, 1963). On the other hand, *P. urbana* has vegetative trichoblasts, whereas these structures are lacking in *S. corymbifera* and *P. virgata*. Likewise, the presence of an inner cortex surrounding the axial filament distinguishes *P. virgata* from *S. corymbifera* and *P. urbana*.

Genus *Tayloriella* Kylin (1938)

Tayloriella tenebrosa (Harvey) Kylin (Figs. 175-176)

Polysiphonia tenebrosa Harvey (1847), p. 55.
Tayloriella tenebrosa (Harvey) Kylin (1938), p. 18.
Streblocladia fasciculifera (Kützing) Falkenberg (1901), p. 353.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11359, with tetrasporangia and carposporangia; Swakopmund, beach, 8-07-1989, BCF-A 11360, with tetrasporangia; Mile 108, 13-07-1989, BCF-A 11361, with tetrasporangia; Möwe Bay, 4-02-1988, BCF-A 11796, with tetrasporangia; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11362, with tetrasporangia; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11797, with tetrasporangia; Rocky Point, 24-02-1986, BCF-A 11363, with tetrasporangia and carposporangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11364, with spermatangia.

References: Harvey (1847), Falkenberg (1901), Kylin (1938, 1956), Simons (1969, 1976), Branch and Branch (1981), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant 2-6(-8) cm high, differentiated into prostrate and erect axes; axes cylindrical, 220-419 µm in diameter, polysiphonous, ecorticate, branched. Prostrate axes interwoven, attached to the substratum by unicellular rhizoids 40-80 µm in diameter; rhizoids ending or not in discoidal attachment pads. Erect axes dichotomously or pseudodichotomously branched, bearing simple or compound determinate branchlets, alternate and more or less distichously arranged in the lower half of the plant (every 3-4 segments), and closer (every 2-3 segments) and progressively spirally arranged upwards; branches coalescing with 1-1.5 segments of the main axis; segments 0.4-1.1 times longer than broad; a characteristic, pale pericentral cell usually occurs at the insertion point of branches; ultimate branches 100-160 µm in diameter, those of the apical zone curved. Apical zone overtopped by the next lower branch; apical cell 12-16 x 8-12 µm. Branching exogenous; at first, the branches arising more or less radially, but later they assume an unilateral arrangement, appearing in twos, adaxial; first pericentral cell abaxial. Trichoblasts short, branched, related with the reproductive structures. In cross section, axes composed of an axial cell 92-140 x 68-100 µm surrounded by 12-14 pericentral cells in the prostrate axes, and by 14-18 pericentral cells in the erect axes.

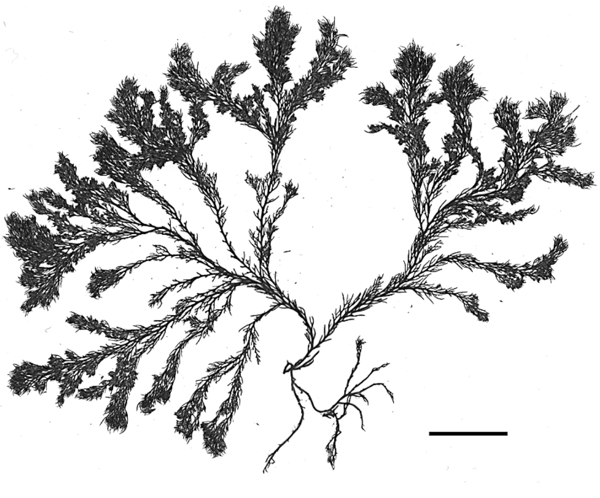

FIG. 175. – *Tayloriella tenebrosa*. Swakopmund, beach, 8-07-1989, BCF-A 11360. Scale bar = 1 cm.

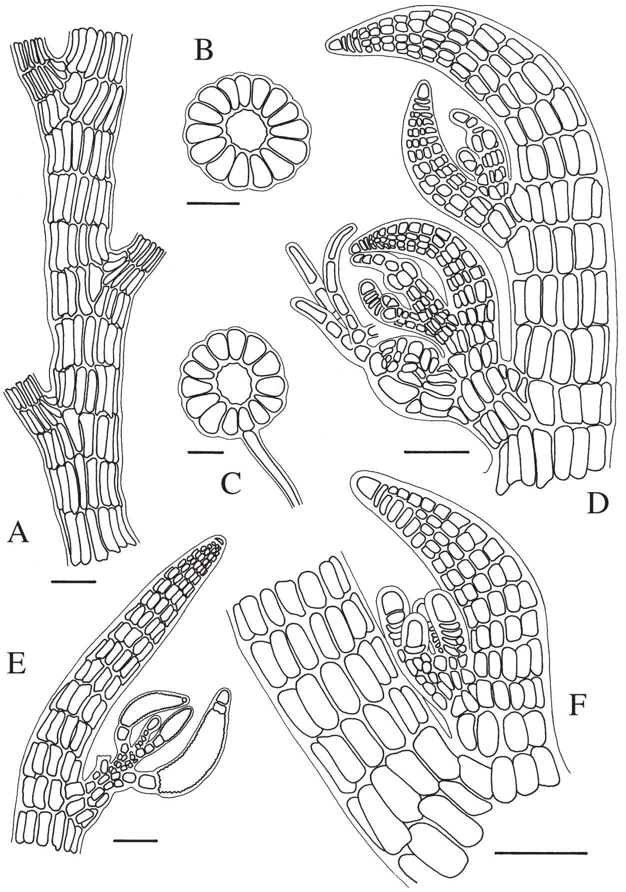

FIG. 176. – *Tayloriella tenebrosa*. A. Median part of an erect axis showing the bases of lateral branches. B. Cross section of an erect axis. C. cross section of a prostrate axis showing the proximal part of a rhizoid. D. Upper part of an erect axis with procarps. E. Spermatangial stichidia. F. Detail of the apical zone of an erect axis. A. Scale bar = 200 µm. B-C. Scale bar = 100 µm. D-F. Scale bar = 50 µm.

Reproduction: Tetrasporangia tetrahedrally divided, spherical, 48-108 x 48-104 µm, immersed in the upper branches, distending them, one in every segment (exceptionally two per segment). Plant dioecious. Procarps issue from the base of trichoblasts; cystocarps globose, 474-700 µm in diameter, with ostiole. Spermatangial stichidia spirally arranged in the apical zone of axes, slightly conical, 120-200 x 40-48 µm, with an unicellular pedicel 20-40 x 16-20 µm and ending in 1-2 sterile apical cells; spermatangia circular in surface view, 4 µm in diameter.

Habitat: In the lower eulittoral and the upper sublittoral zones, epilithic or epiphytic on several algae like *Codium fragile* subsp. *capense* and *Ahnfeltiopsis vermicularis*; also growing on *Acrosorium cincinnatum* in drift material.

Namibian distribution: Swakopmund, Toscanini, Torra Bay, Terrace Bay, Möwe Bay, Rocky Point (Lawson *et al.*, 1990); Mile 108, South Kunene (Map 88).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Tayloriella tenebrosa* was initially described as *Polysiphonia tenebrosa* by Harvey (1847) on the basis of material from Muizenberg (South Africa), and subsequently, Kylin (1938) transferred it to the genus *Tayloriella*, as the type species. According to Kylin (1938), *Tayloriella* includes species which have terete, polysiphonous, ecorticate axes, lack trichoblasts in the sterile specimens, and in which the branches arise radially, every 2-3 segments, but later adopt a bilateral arrangement.

At present, *T. tenebrosa* occurs in both Indian and Atlantic coasts of South Africa and in Namibia, where it is only known from the coasts of the northern half of the country (Lawson *et al.*, 1990).

Concerning the plant habit, our specimens are compatible with the iconography of *T. tenebrosa* shown by Kylin (1938) and Simons (1969 and 1976). Anatomically, our specimens also agree with the *T. tenebrosa* descriptions consulted, although Harvey (1847) and Kylin (1938) recorded 12 pericentral cells in the axes of this species and in our specimens, in agreement with Falkenberg (1901) and Stegenga *et al.* (1997), the pericentral cells are 14-18. Moreover, the distichous arrangement of the branches in the lower half of the axes is sometimes difficult to observe in our specimens, probably because the axes are often twisted.

The genus *Tayloriella* is similar to *Pterosiphonia* Falkenberg and *Pterosiphoniella* Dawson. From the former, it differs mainly in the morphology of the apical region, so in *Tayloriella* the branches arise radially and later they adopt a bilateral arrangement, whereas in *Pterosiphonia* the branches are distichously arranged from their origin (Wynne, 1985c). On the other hand, the genus *Pterosiphoniella*, which occurs on the Pacific coast of Mexico, differs from *Tayloriella* in having trichoblasts in sterile branches (Dawson, 1963), whereas in *Tayloriella* the trichoblasts occur only in fertile specimens (Kylin, 1938).

RHODOPHYCEAE OF UNCERTAIN POSITION
Genus *Aiolocolax* Pocock (1956)

Aiolocolax pulchellus Pocock
(Figs. 177-178)

Aiolocolax pulchellus Pocock (1956), p. 22.

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986; BCF-A 11278, with polysporangia, carposporangia and spermatangia.

References: Pocock (1956), Pérez-Cirera *et al.* (1989b), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant parasitic, consisting of a branched uniseriate filament, 8-12 µm in diameter, running between the axial cell and the pericentral cells of *Polysiphonia scopulorum*, difficult to observe by transparency. Fertile specimens more visible due to the presence of projecting pedicellate reproductive branches up to 300 µm long;

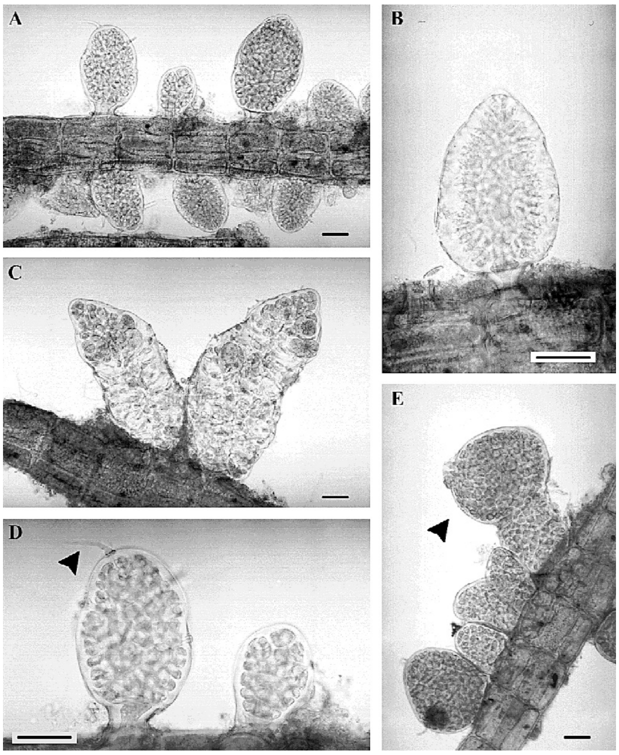

FIG. 177. – *Aiolocolax pulchellus*. 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11278. A. Female and male fertile specimens growing on a filament of *Polysiphonia scopulorum*. B. Fertile branch of a male specimen. C. Branches with polysporangia. D. Fertile branch of a female specimen showing a trichogyne (arrowhead). E. Female fertile branches with a cystocarp (arrowhead). Scale bar = 40 µm.

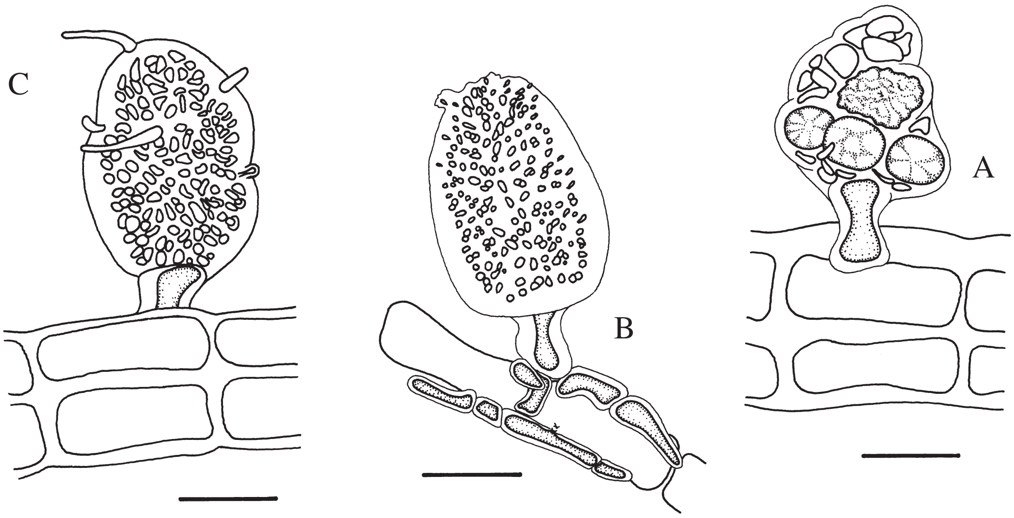

FIG. 178. – *Aiolocolax pulchellus*. A. Branch with polysporangia. B. Male fertile branch and inner filaments growing among the pericentral cells of *Polysiphonia scopulorum*. C. Female fertile branch showing trichogynes. Scale bar = 50 µm.

pedicel unicellular, 46-52 x 20-24 µm, partly sunken in the host structure.

Reproduction: Polysporangia 26-40 x 24-34 µm, placed in conical or cylindroconical branches 92-300 µm long and 68-140 µm broad. Female branches more or less ellipsoid, 110-170 µm long and 70-90 µm broad, containing several procarps easy to recognize due to the presence of exerted trichogynes; trichogynes curved, subulate, 32-40 µm long and 4-6 µm broad; cystocarps globose, 116-136 x 104-124 µm. Spermatangia 2-4 x 2 µm, placed in ellipsoidal or more or less conical branches 110-150 µm long and 70-86 µm broad.

Habitat: Parasite of *Polysiphonia scopulorum*.

Namibian distribution: Mile 4, Mile 8 (Engledow, 1998); South Kunene (Map 89).

World distribution: Atlantic Ocean: South Africa, Northwestern of Iberian Peninsula (Stegenga *et al.*, 1997); Namibia. Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Aiolocolax pulchellus*, the single species of the genus, was described by Pocock (1956), and for more than thirty years, its distribution remained limited to South African coasts, especially to those of the Indian Ocean. Subsequently, Pérez-Cirera *et al.* (1989b) cited this species (and its plant host *Polysiphonia caespitosa* (Pocock) Hollenberg) from Galicia (northwest Iberian peninsula) pointing out that, although it could be an introduced species, more probably it had been overlooked due to its small size and the ecology of its plant host (possibly mistaken for *P. scopulorum* Harvey). For this reason, Pérez-Cirera *et al.* (1989b) stated that *Aiolocolax pulchellus* could have, in fact, a wider distribution. In agreement with these authors, we also think that *A. pulchellus* could be wider distributed.

Aiolocolax pulchellus shows an uncertain systematic position (Pocock, 1956; Goff, 1982; Silva *et al.*, 1996). According to Pocock (1956) this species has certain affinities with the Ceramiales on the one hand, and with the Choreocolaceae on the other.

Division CHROMOPHYTA
Class PHAEOPHYCEAE
Order ECTOCARPALES Setchell and Gardner (1922)
Family ECTOCARPACEAE C. Agardh (1828)

The taxonomy of the family Ectocarpaceae is still not completely clear. On the one hand, the features traditionally used in the distinction of the genera often change with environmental conditions (Price *et al.*, 1978; Lawson and John, 1987). In this way, studies based on the species culture have shown that some genera represent the morphological adaptation of others to the environmental features (Ravanko, 1970; Knoepffler-Péguy, 1977). Like this, according to Knoepffler-Péguy (1977), *Feldmannia* G. Hamel and *Acinetospora* Bornet are not more than morphological variations of a single genus. On the other hand, the study of the life history of some species seems to indicate that certain taxa correspond, in fact, to stages of the life cycle of other taxa (Ravanko, 1970). This would be the case, for example, of *Acinetospora*, which constitutes probably a stage in the life history of some species of *Feldmannia* and *Hincksia* J. Gray (South and Tittley, 1986). In particular, Kornmann (1953), Cardinal (1964), Clayton (1974), among others, hold that *Feldmannia lebelii* (Areschoug ex P. Crouan and H. Crouan) G. Hamel and *F. padinae* (Buffham) G. Hamel, could correspond to the haploid phase of *Acinetospora crinita* (Carmichael ex Harvey) Sauvageau. It seems clear, therefore, that in the taxonomy of this group it is particularly important to know both the reproduction and the life history of the species which constitute it. However, at present, this type of data lack or are insufficient for much of the Ectocarpaceae (Clayton, 1995). It is for this reason that, for the moment, the distinction of genera in this family depends on the criterion of different authors. Whereas some authors hold that the Ectocarpaceae include several genera, and they provide determination keys in order to distinguish them (Cardinal, 1964; Abbott and Hollenberg, 1976; Womersley, 1987; Lawson and John, 1987), other authors such as Russell and Garbary (1978), hold that all taxa should be collected in the genus *Ectocarpus* Lyngbye.

In agreement with Clayton (1974), we hold that the family Ectocarpaceae needs a thorough revision based on the species culture, taking into account both the influence of the environmental factors on its morphology and the study of its life histories. With this approach, the taxonomical features used could either be validated or rejected, and new features could be discovered, thus clarifying the taxonomy of much genera. Likewise, we hold that the use of modern molecular techniques would be of great interest in the taxonomy of this family.

Genus *Ectocarpus* Lyngbye (1819) *nom. cons.*

The genus *Ectocarpus* shows great tolerance to environmental changes, and it undergoes a high phenotypic plasticity which makes the taxonomical characterization of the species difficult (Stache-Crain *et al.*, 1997). This fact is revealed in the high number of species and infraspecific taxa described. However, following Russell (1966), nowadays there is the tendency to consider that it is represented by only two species: *E. fasciculatus* Harvey and *E. siliculosus* (Dillwyn) Lyngbye (Müller and Eichenberger, 1995; Stache-Crain *et al.*, 1997). Cross-fertilization experiments between these two taxa (Müller and Gassmann, 1980), as well as studies based on molecular techniques, suggest that *E. fasciculatus* and *E. siliculosus* are actually two separate species and, moreover, that the latter includes genetically distinct geographical races (Stache-Crain *et al.*, 1997).

Key to species of *Ectocarpus*:

1. Plants without fascicles of branches; plurilocular sporangia usually not in series ......*E. siliculosus**
1. Plants with fascicles of branches; plurilocular sporangia usually in series ....*E. fasciculatus*

* *E. siliculosus* was not observed. More information about this taxon can be found in Womersley (1987) and Stegenga *et al.* (1997).

Ectocarpus fasciculatus Harvey
(Figs. 179-180)

Ectocarpus fasciculatus Harvey (1841), p. 40.

Selected specimens: Swakopmund, beach, 8-07-1989, BCF-A 12043, with plurilocular sporangia; Mile 108, 13-07-1989, BCF-A 12044, with plurilocular sporangia; Rocky Point, 24-02-1986, BCF-A 12042, with plurilocular sporangia; Cape Frio, 23-02-1986, BCF-A 12045, with plurilocular sporangia; Angra Fria, 20-02-1986, BCF-A 12041, with plurilocular sporangia.

FIG. 179. – *Ectocarpus fasciculatus*. Swakopmund, beach, 8-07-1989, BCF-A 12043. – Upper part of the plant. Scale bar = 200 µm.

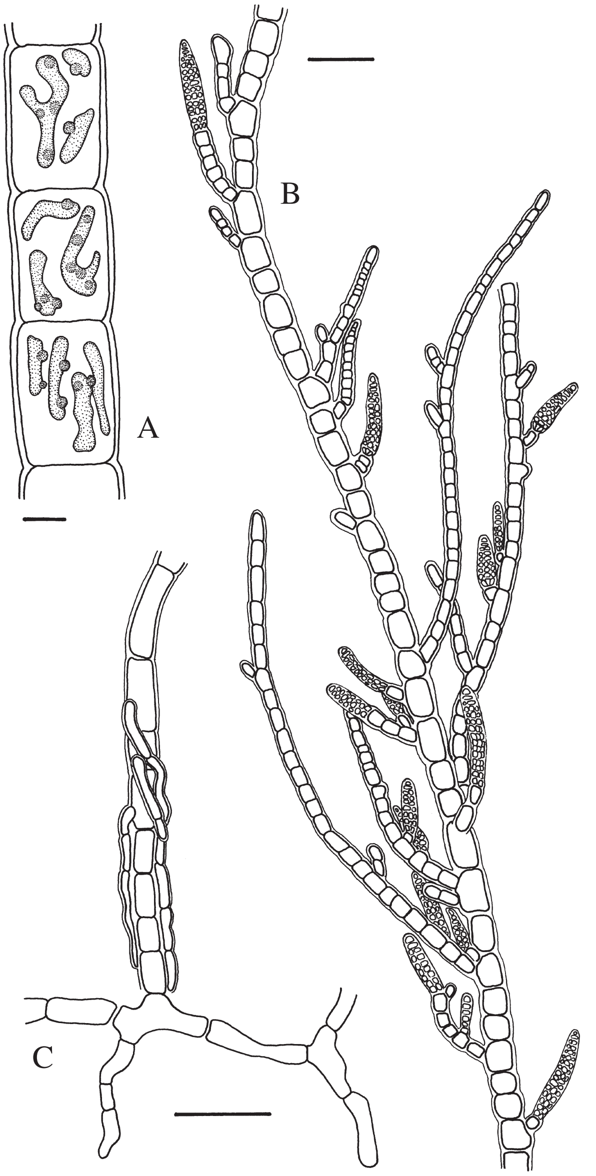

FIG. 180. – *Ectocarpus fasciculatus*. A. Plastids. B. Upper part of an erect filament with plurilocular sporangia. C. Basal part of an erect filament with rhizoids. A. Scale bar = 10 µm. B-C. Scale bar = 50 µm.

References: Taylor (1957), Russell (1966), Kapraun (1984), Womersley (1987), Coppejans (1995), Müller and Eichenberger (1995), Stache-Crain *et al.* (1997), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, erect, up to 10 mm high, growing solitary or forming turfs on other algae. Erect filaments uniseriate, (12-)16-40 µm in diameter at middle part, branched, converging in a rhizoidal base by which means the plant attachs to the substratum. Branching more or less abundant, irregular, often with alternate series of branches that bear branchlets or plurilocular sporangia adaxially arranged; sometimes, filaments not much branched, bearing only short branchlets or plurilocular sporangia irregularly arranged or more or less secund; all branches tapering gradually towards the apex; lower part of filaments usually devoid of branches; hairs absent. Growth diffuse. Cells of lower part of filaments cylindrical, 1.7-2.6 times longer than broad, 52-84 x 20-36 µm, occasionally giving rise to downward rhizoidal filaments; cells of middle part of filaments cylindrical or slightly barrel-shaped, 0.8-2.3 times longer than broad, 18-60 x (12-)16-32 µm; apical cell rounded at apex, 1-2.3 times longer than broad, 10-30 x 8-14 µm. Plastids ribbon-shaped or reticulate, with several pyrenoids.

Reproduction: Plurilocular sporangia conical or cylindro-conical, sometimes more or less elliptic, 50-188 x 14-32 µm, terminal or lateral on axes and branches, irregularly arranged or placed in adaxial series, pedicellate; occasionally more than one sporangia on the same pedicel. Other reproductive structures not seen.

Habitat: Epiphyte on other algae as *Laminaria pallida*, *Ahnfeltiopsis vermicularis* and *Mazzaella capensis*, in the lower eulittoral and upper sublittoral.

Namibian distribution: Swakopmund, Mile 108, Rocky Point, Cape Frio, Angra Fria (Map 90).

World distribution: Widespread in temperate and colder waters. (Womersley, 1987).

Remarks: Our specimens are compatible with those of the South African west coast (Stegenga *et al.*, 1997), although they have slightly thinner erect filaments and longer plurilocular sporangia.

Ectocarpus fasciculatus is very similar to *E. siliculosus* (Dillwyn) Lyngbye, the other species accepted at present in this genus. In spite of genetic and molecular differences (Stache-Crain *et al.*, 1997), these species only differ in habit and ramification type. The former has main axes with secondary branches in lateral series, while the latter has subdichotomous ramification (Womersley, 1987; Müller and Eichenberger, 1995).

Ectocarpus fasciculatus has not been recorded from Namibia. Lawson *et al.* (1990) reported, as *Ectocarpus spp*, without any description or comment, material from Rocky Point and Swakopmund that could belong to this species.

Genus *Feldmannia* G. Hamel (1939a)

Feldmannia irregularis (Kützing) G. Hamel
(Fig. 181)

Ectocarpus irregularis Kützing (1845), p. 234.
Feldmannia irregularis (Kützing) G. Hamel (1939a), p. xvii

Selected specimens: Rocky Point, 24-02-1986, BCF-A 12046, with plurilocular sporangia.

References: Hamel (1931b), Cardinal (1964), Abbott and Hollenberg (1976), Womersley (1987), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous, erect, forming turfs of 1-1.5 mm high on *Laminaria pallida* haptera. Erect filaments 20-24 µm in diameter at middle part, slightly thinner at base, unbranched or sparingly branched at lower part, arising from branched prostrate filaments 12-16 µm in diameter; erect filaments commonly truncate and with plurilocular sporangia irregularly placed on middle part. Rhizoids often present, arising from the basal cells of erect filaments. Cells of erect filaments cylindrical, 2.5-4 times longer than broad at lower part of filaments, 40-64 x 16-20 µm, and 1-2 times longer than broad at upper zone, 20-40 x 20-24 µm. Plastids discoidal, numerous, thickly packed in the cells of middle part of filaments and forming a lax network in the cells of the lower part. Growth zones at upper half of filaments, above plurilocular sporangia.

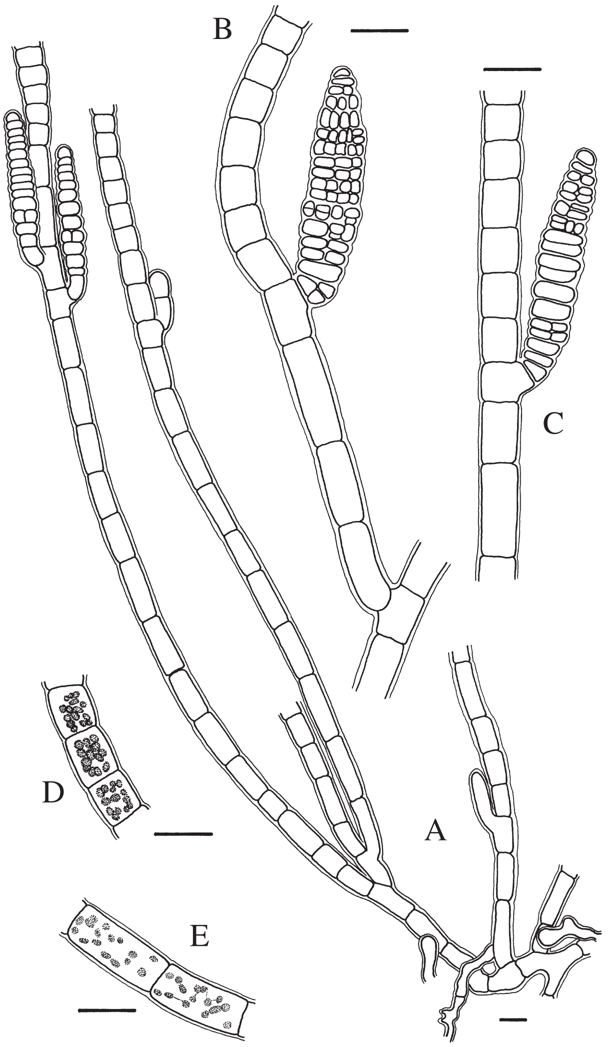

FIG. 181. – *Feldmannia irregularis*. A. Prostrate part of the plant with rhizoids and some erect filaments with two plurilocular sporangia. B-C. Plurilocular sporangia. D-E. Detail of plastids in cells of the upper (D) and lower (E) parts of the plant. Scale bar = 25 µm.

Reproduction: Plurilocular sporangia cylindro-conical, elliptic or more or less cylindric, 128-160 x 24-28 µm, sessile, irregularly arranged at middle part of erect filaments, below the growth zone, often appressed to the filament. Other reproductive structures not seen.

Habitat: Epiphyte on *Laminaria pallida* haptera in the upper sublittoral zone.

Namibian distribution: Rocky Point (Map 91).

World distribution: Widespread in temperate waters (Womersley, 1987).

Remarks: Our specimens are compatible with the *Feldmannia irregularis* descriptions consulted, although they are smaller (up to 1.5 mm high in comparison with up to 15 mm reported in most references) and have fewer ramifications. Accordingly, the material from Namibia agrees quite well with the descriptions and iconography of *Ectocarpus nanus* Levring (Levring, 1938). This species, considered at present as a synonym of *F. irregularis* (Silva *et al.*, 1996), was described by Levring (1938) on the basis of material from Isipingo (east coast of South-Africa). According to Levring, this small species, up to 3 mm high, is an endophyte of *Codium* and its erect axes are branched only at the base. On the other hand, Cardinal (1964) pointed out that in specimens of *F. irregularis* from Roscoff (Britanny coast of France) the branches are scarce. Likewise, Womersley (1967) held that the Australian specimens, although in concordance with the European material, show great variation in the degree of ramification.

Genus *Hincksia* J. Gray (1864)

Hincksia granulosa (J.E. Smith) P. Silva in P. Silva, Meñez and Moe (Fig. 182)

Conferva granulosa J. E. Smith (1811), pl. 2351.
Giffordia granulosa (J. E. Smith) G. Hamel (1939a), p. xv.
Hincksia granulosa (J.E. Smith) P. Silva in P. Silva, Meñez and Moe (1987), p. 130.

Selected specimens: 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11855, with plurilocular sporangia.

References: Newton (1931), Baardseth (1941), Taylor (1957), Cardinal (1964), Chamberlain (1965), Abbott and Hollenberg (1976), Womersley (1987), Santelices (1989), Begum and Khatoon (1992), Adams (1994), Coppejans (1995), Stegenga *et al.* (1997).

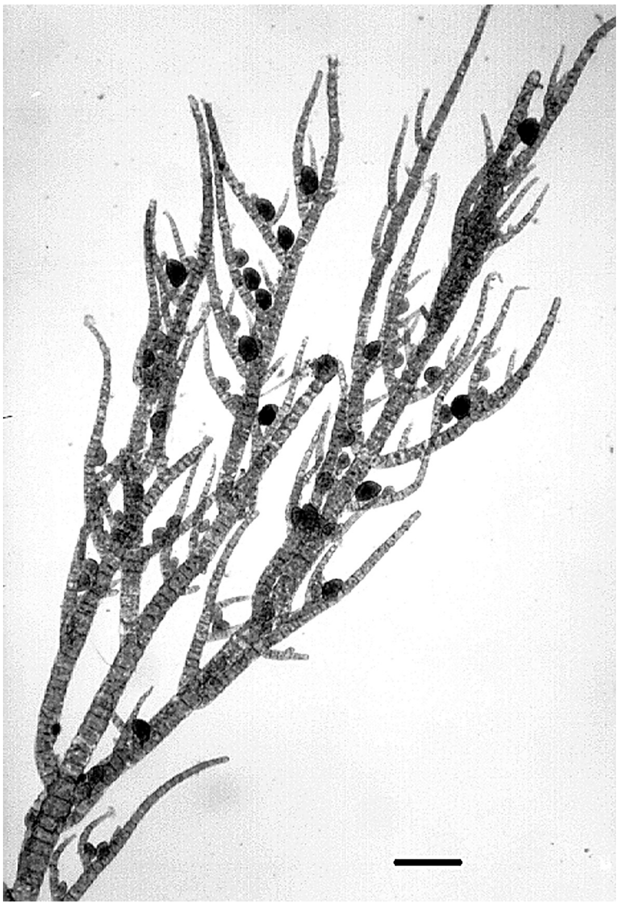

FIG. 182. – *Hincksia granulosa*. 29 km south of Kunene river mouth, 22-02-1989, BCF-A 11855. Scale bar = 200 µm.

Habit and vegetative structure: Plant filamentous, erect, 6-8 mm high, consisting of uniseriate, branched filaments 68-80 µm in diameter, attached to the substratum by means of rhizoids; branching sparse or opossite; branches usually tappering towards the apex, 24-44 µm in diameter in its median part and 12-20 µm in diameter in the apical zone; rhizoids multicellular, branched, 8-12 µm in diameter, arising from the lower cells of filaments and descending downwards forming a rhizoidal cortex. Growth intercalar, diffuse. Cells of the main filaments slightly barrel-shaped, 0.5-1.1 times longer than broad, 28-76 x 56-80 µm; cells of the median part of branches 20-40 x 16-28 µm; apical cell rounded at apex, 20-36(-48) x 12-20(-32) µm. Plastids numerous, discoidal or elliptic, 4-6 µm in greater diameter.

Reproduction: Plurilocular sporangia asymmetrically conical or hemispherical, 68-88 x 44-60 µm, sessile or exceptionally with an unicellular pedicel, lateral, occurring singly or in adaxial series of 2-3 sporangia developed in no consecutive cells of the filaments. Other reproductive structures not seen.

Habitat: Growing on a bryozoan in the upper sublittoral zone.

Namibian distribution: Swakopmund (Wynne, 1986); South Kunene (Map 92).

World distribution: Widespread in temperate waters (Womersley, 1987).

Family PILAYELLACEAE Pedersen (1984)

Following the same criterion used by Silva *et al.* (1996) in the catalogue of the benthic marine algae of the Indian ocean, we consider Pilayellaceae and Ectocarpaceae as different families in the order Ectocarpales.

Genus *Bachelotia* (Bornet) Kuckuck ex G. Hamel (1939b)

Bachelotia antillarum (Grunow) Gerloff (Fig. 183)

Ectocarpus antillarum Grunow (1867), p. 46.
Pilayella antillarum (Grunow) De Toni (1895), p. 535.
Bachelotia antillarum (Grunow) Gerloff (1959), p. 38.
Pilayella fulvescens Bornet (1889), p. 8.
Bachelotia fulvescens (Bornet) Kuckuck in G. Hamel (1939b), p, 66.

Selected specimens: Rocky Point, 24-02-1986, BCF-A 11856, with unilocular sporangia.

References: Taylor (1960), Cardinal (1964), Gayral (1966), Earle (1969), Womersley and Bailey (1970), Magne (1976), Schnetter and Bula-Meyer (1982), Kapraun (1984), Lawson and John (1987), Womersley (1987), Adams (1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant filamentous up to 5 mm high, consisting of both prostrate and erect uniseriate filaments. Prostrate filaments 28-36 µm in diameter, branched, with cylindrical cells, 68-140 x 28-36 µm. Erect filaments 32-44 µm in diameter, simple or branched, sometimes with rhizoidal filaments at lower part; branching irregular, with branches usually arising from the central zone of cells and often spread out at right angles; cells of erect filaments cylindrical, 1.5-3.4 times longer than broad at lower part of filaments, 48-108 x 28-36 µm, and 0.8-1.6 times longer than broad at upper half, 28-52 x 32-40 µm; apical cell cylindrical with a rounded apex, 32-60 x 20-40 µm, sometimes more or less conical. Growth zone located at middle part of erect filaments, with cells 0.4-0.7 times longer than broad, 16-24 x 28-44 µm. Plastids concentrate on one or two more or less stellate clusters, especially in the cells of lower part of filaments.

Reproduction: Unilocular sporangia in intercalary series in erect filaments, some barrel-shaped,

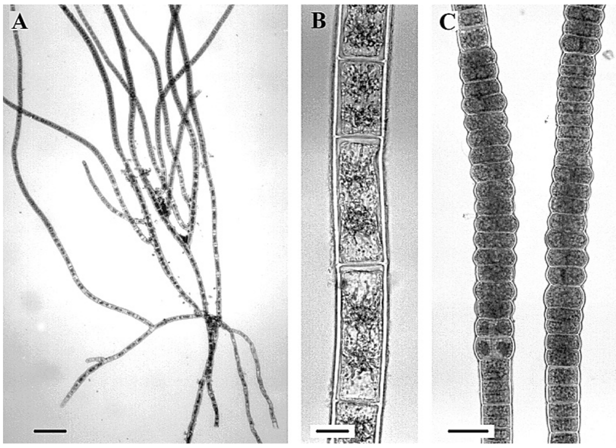

FIG. 183. – *Bachelotia antillarum*. Rocky Point, 24-02-1986, BCF-A 11856. A. Habit. B. Fragment of an erect filament showing the arrangement of plastids. C. Unilocular sporangia. A. Scale bar = 200 µm. B. Scale bar = 20 µm. C. Scale bar = 50 µm.

more broad than long, 16-26 x 42-48 µm, and others longitudinally divided into two more or less isodiametric sporangia, 18-26 x 24-34 µm. Other reproductive structures not observed.

Habitat: Epilithic, forming sand-binding turf together with *Polysiphonia scopulorum* in the lower eulittoral zone.

Namibian distribution: Rocky Point (Map 93).

World distribution: Widespread in temperate and tropical seas (Lawson and John, 1987; Womersley, 1987).

Remarks: Although Silva *et al.* (1996) considered *Bachelotia antillarum* and *B. fulvescens* as two different taxa, most authors (Blomquist, 1958; Cardinal, 1964; Gayral, 1966; Earle, 1969; Price *et al.*, 1978; Seagrief, 1984; Womersley, 1987; Wynne, 1998) regard the two taxa as synonyms.

Bachelotia antillarum was also reported from the east and south coasts of South Africa (Stegenga *et al.*, 1997) and it is one of the few species of the Agulhas marine province lacking in the west coasts of South Africa but occurring in Namibia (Stegenga *et al.*, 1997). Our specimens agree quite well with the South African ones, although they are shorter (up to 5 mm high in comparison with 1-2 cm).

Bachelotia antillarum is similar to species of the genus *Asteronema* Delépine and Asensi as to the morphology and the arrangement of plastids, but it is different with respect to the diameter of the filaments (larger in *Bachelotia*), the intercalary sporangia and because its growth zone is more localized (Delépine and Asensi, 1975). Moreover, Delépine *et al.* (1976) held that the arrangement of plastids in a stellate manner in both genera indicates converging evolution because these taxa have little phylogenetic affinities. This opinion has been recently supported by molecular studies (Reviers and Rousseau, 1999; Rousseau *et al.*, 2001).

Family RALFSIACEAE Farlow (1881)
Genus *Hapalospongidion* D. Saunders (1899)

Hapalospongidion sp.
(Figs. 184-185)

Selected specimens: Möwe Bay, 25-02-1986, BCF-A 12047, with unilocular sporangia; Rocky Point, 24-02-1986, BCF-A 12048, with unilocular sporangia; Cape Frio, 23-02-1986, BCF-A 11853, with unilocular sporangia.

Habit and vegetative structure: Plant crustose, gelatinous, forming brown patches up to approximately 4 cm^2 of surface and 500-1200 µm thick, firmly adhered to the substratum. Plant consisting of compactly joined prostrate filaments from which erect filaments progressively arise. Cells of prostrate filaments irregular in shape, usually elongate, 16-36 x 6-12 µm. Erect filaments simple or slight

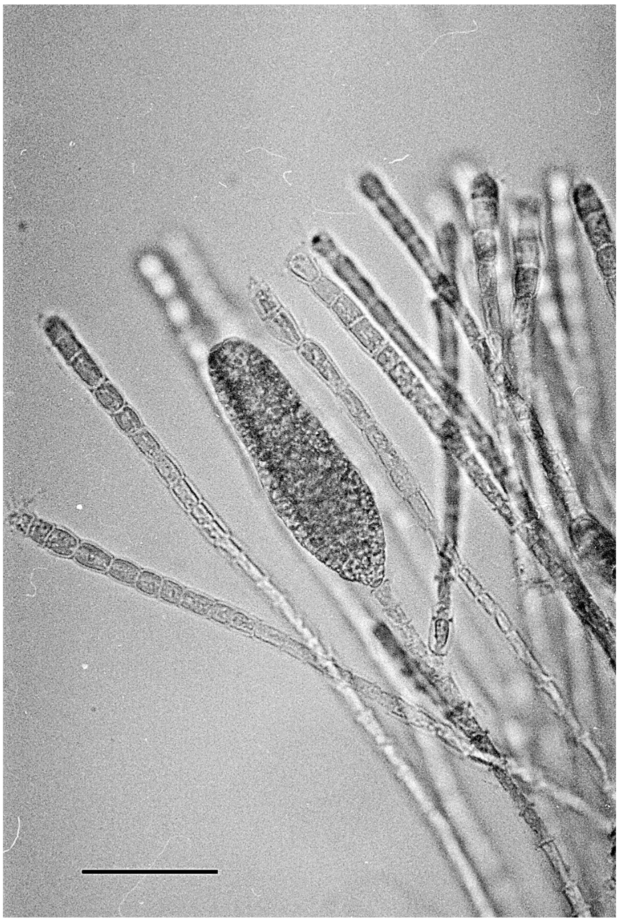

FIG. 184. – *Hapalospongidion sp.* Cape Frio, 23-02-1986, BCF-A 11853. Erect filaments with an unilocular sporangia. Scale bar = 40 µm.

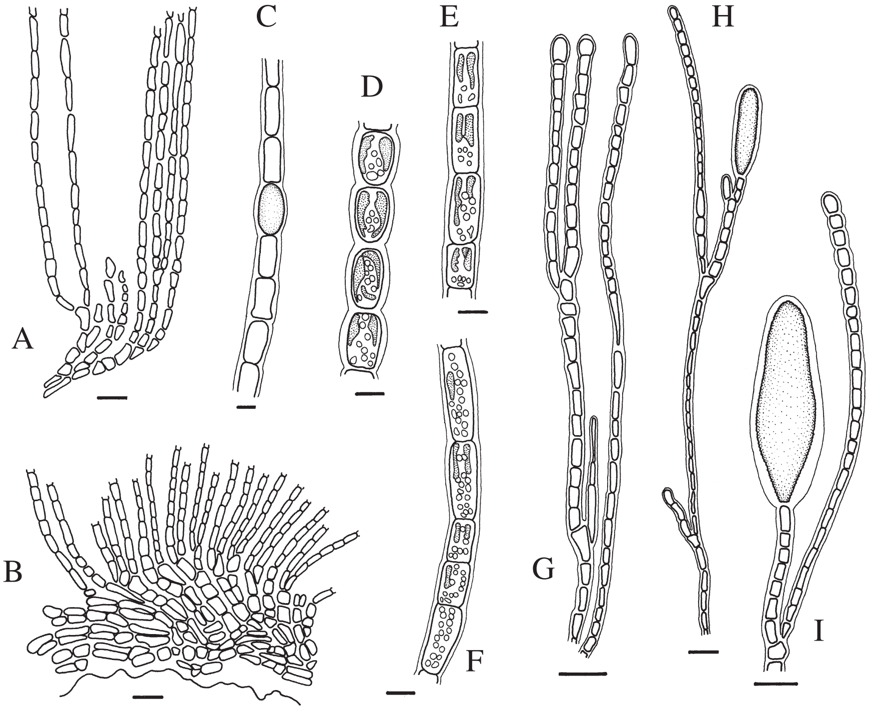

FIG. 185. – *Hapalospongidion* sp. A. Lower part of erect filaments. B. Basal zone of the plant showing prostrate filaments and the lower part of erect ones. C. Portion of an erect filament with one refringent cell. D-F. Cells of the upper (D), median (E) and lower (F) parts of an erect filament, showing plastids and physodes. G-H. Upper part of erect filaments with one unilocular sporangia (H). I. Detail of an unilocular sporangia. A-B, G-I. Scale bar = 20 µm. C-F. Scale bar = 5 µm.

branched, curved at the base, 20-30(-80) cells long and 5-10 µm in diameter, weakly joined with each other and therefore easily separated under slight pressure; cells of erect filaments cylindrical or slightly barrel-shaped, 1-4.8 times longer than broad, 8-38 x 6-8 µm, those of upper part of filaments shorter than those of the middle part; apex of apical cell rounded, 6-10 x 6-8 µm; elongate refringent cells of 8-24 x 6-8 µm commonly present in erect filaments, intercalarly. Cells with 1-2 parietal plastids, seemingly without pyrenoids, especially visible in the cells of the upper part of erect filaments, less apparent towards the base of filaments where the cells contain numerous physodes.

Reproduction: Unilocular sporangia clavate or more or less ovoidal, 40-148 x 14-40 µm, pedicellate, laterally arranged at upper half of erect filaments, remaining within plant structure; pedicel 2-27 cells long, similar to erect filaments. Other reproductive structures not seen.

Habitat: Epilithic, among the specimens of *Nothogenia erinacea* in the lower eulittoral zone.

Namibian distribution: Möwe Bay, Rocky Point, Cape Frio (Map 94).

Remarks: According to the literature consulted, our specimens agree quite well with the descriptions of *Mesospora* Weber van Bosse, *Hapalospongidion* Saunders and *Basispora* John and Lawson. These genera, which are morphologically and anatomically very similar, have been scarcely studied and have a taxonomy which is much confused. The three genera consist of crustose plants with a base of prostrate filaments from which slightly joined erect filaments arise. In the three genera the plurilocular sporangia are intercalary and the unilocular sporangia are terminal in the erect filaments or in more or less long pedicels.

The genus *Mesospora* was created by Weber van Bosse (1911) on the basis of specimens from Indonesia which were described as *M. schmidtii* by that author as the type species. Subsequently, Børgesen (1924) described *M. van-bosseae* from the Isle of Pascua, and later Feldmann (1937) described *M. mediterranea* from Banyuls-sur-Mer (France). Feldmann (1937) remarked that the specimens of *Ralfsia macrocarpa* previously described by him from Algeria (Feldmann, 1931) belong, in fact, to specimens of *Mesospora* epiphytic on *R. verrucosa*. Feldmann (1937) also pointed out that the Algerian specimens differed from the Banyuls specimens in the size of the unilocular sporangia, but he did not state whether they corresponded or not to *M. mediterranea*. Some years later, Hartog (1968) transferred *R. macrocarpa* to the genus *Mesospora*, pointing out the possibility that this species and *M. mediterranea* were conspecific. More recently, in agreement with Hartog (1968), Tanaka and Chihara (1982) treated *M. mediterranea* as a synonym of *M. macrocarpa* (Feldmann) Hartog. Likewise, Tanaka and Chihara (1982) transferred the species from Samoa *R. pangoensis* Setchell, as well as its variety *galapaguensis* Setchell et Gardner, to the genus *Mesospora*, pointing out that it has vegetative and reproductive features very similar, if not the same, to those of *M. schmidtii*. On the basis of the available descriptions, our material differs from the species of *Mesospora* in forming more robust patches (up to 1200 µm thick) and because it has curved-at-base erect filaments which are usually composed of longer cells (up to 4.8 times longer than broad). In having the unilocular sporangia placed among the erect filaments in median part of the crust, our specimens are similar to *M. macrocarpa*. However, the pedicell length (up to 27 cells long) and the absence of both hairs and rhizoids, as well as the features above mentioned, distinguish the Namibian specimens from this species.

The genus *Hapalospongidion* was created by D. Saunders (1899), who described *H. gelatinosum* on the basis of material from California as the type species. Subsequently, Lindauer (1949) added two new species to the genus, *H. saxigenus* and *H. durvilleae*, but later John and Lawson (1974) transferred them to the genus *Basispora*. More recently, Womersley (1987) described *H. capitatum* from the west coast of Australia. Our specimens differed from species of *Hapalospongidion* mainly in the arrangement of the unilocular sporangia, since they are placed laterally on the erect axes, at the tip of more or less long pedicels, whereas in *Hapalospongidion* they are terminal on vegetative filaments (Abbott and Hollenberg, 1976). In spite of this, our specimens agree quite well with Womersley's (1987) description of *H. capitatum*, but in this species the apical cells are 10-12 µm in diameter (6-8 µm in our specimens) and the plurilocular sporangia are the only reproductive structures observed (structures not found in Namibian material).

The genus *Basispora* was established by John and Lawson (1974) on the basis of specimens from the coasts of Ghana previously assigned by them to the genus *Mesospora* and *Hapalospongidion*. John and Lawson (1974) described *B. africana* as the type species, and they transferred *Hapalospongidion saxigenus* and *H. durvilleae* to the genus *Basispora*, pointing out that the latter differs from the other two species in being a parasite taxa. At the same time, South (1974) created the genus *Herpodiscus* on the basis of *Hapalospongidion durvilleae*. *Basispora* differs from the genus *Hapalospongidion* and *Mesospora*, as well as from our specimens, mainly in having several discoidal plastids per cell instead of one or few blade-like plastids.

Womersley (1987) remarked that *Mesospora* and *Basispora* should be regarded as synonyms of *Hapalospongidion*, and that *Herpodiscus* is a genus unrelated to the Ralfsiaceae. This author also remarked that the number of plastids in *Mesospora* and *Hapalospongidion* probably depends on size and age of the cells. In our specimens we have observed the following: that the upper cells of the erect filaments have a single laminar plastid, parietal, clearly visible; that the cells of the median part of erect filaments have 2-3 plastids less conspicuous due to the increase of the number of physodes; and that the cells of the lower part of erect filaments seemingly do not have plastids, but they are completely full of physodes. In agreement with Womersley (1987), it is possible that the two or three plastids observed in the median part of erect filaments come from the fragmentation of a single plastid. Nevertheless, we hold that this situation is very different to that of *Basispora*, in which the cells have several discoidal plastids (John and Lawson, 1974). In this way, it is important to point out, however, the possibility that these authors had taken the physodes for plastids in describing *Basispora*, since the former are very common in the cells of the Phaeophyceae (Clayton, 1995) and they are easy to mistake with the latter. As Womersley (1987) does not appear to have studied the type material of *Basispora* to consider it as a synonym of *Hapalospongidion* (he apparently based the synonymy on bibliographical data), and since in our opinion the number and morphology of plastids could be an important feature in the taxonomy of this group, we hold that the genus *Basispora* should be regarded independently until accurate studies have been carried out in order to prove the contrary. In contrast, we agree with Womersley (1987) in considering *Mesospora* as a synonym of *Hapalospongidion*.

Following Womersley (1987), Silva (in Silva *et al.*, 1996) transferred *Mesospora schmidtii* Weber van Bosse, the type species of the genus *Mesospora*, to *Hapalospongidion*. Likewise, this author proposed the name *H. pangoense* (Setchell) P. Silva for *M. pangoensis* (Setchell) Chihara and Tanaka, although this combination had already been made previously by Hollenberg (1942). More recently, Wynne (1998) transferred *M. macrocarpa* to the genus *Hapalospongidion*. Only *M. van-bosseae*, the species from Isle of Pascua, remained. For this reason, and although we are aware that a thorough taxonomical revision of this group of phaeophyceae should be carried out, we propose the following combination:

Hapalospongidion van-bosseae (Børgesen) Rull Lluch, comb. nov.

Basionym: *Mesospora van-bossae* Børgesen in Skottsberg, *Nat. Hist. Juan Fernandez and Easter Is.*, Vol. 2, p. 258. 1924.

Our material also is more or less consistent with the description by Sartoni and Boddi (1989) of the Mediterranean species *Acrospongium ralfsioides* Schiffner and with the descriptions of *Microspongium gelatinosum* Reinke by Fletcher (1987) and Fletcher *et al.* (1988). However, unlike our specimens, *A. ralfsioides* forms thinner patches (up to 300 µm thick), has erect filaments with a lower number of cells (12-16 cells), and has intercalary or terminal unilocular sporangia. Likewise, the Namibian specimens differ from *M. gelatinosum*, which corresponds to the crustose phase in the life history of *Scytosiphon lomentaria* (Lyngbye) Link (Lund, 1966; McLachlan *et al.*, 1971; Fletcher, 1978), because *M. gelatinosum* has plastids with one pyrenoid and sessile or shortly pedicellate (1-3 cells long) unilocular sporangia. It is important to point out, however, that *S. lomentaria* has been recorded from Namibia (Lawson *et al.*, 1990) and therefore, it is probable that *M. gelatinosum* also was found.

For all the above reasons, and waiting for a thorough taxonomical revision of this group of crustose phaeophyceae, we believe it appropriate to assign our specimens to *Hapalospongidion* without specifying the species. Besides some specimens recorded as *Ralfsia sp.* by Kensley and Penrith (1980), *Ralfsia expansa* (J. Agardh) J. Agardh and *Basispora africana* [recently recorded from Möwe Bay by Engledow (1998)] were the only crustose phaeophyceae recorded from Namibia until now.

Genus *Ralfsia* Berkeley in Smith and Sowerby (1843)

Ralfsia expansa (J. Agardh) J. Agardh

(Figs. 186-187)

Myrionema expansum J. Agardh (1847), p. 7.
Ralfsia expansa (J. Agardh) J. Agardh (1848), p. 63.

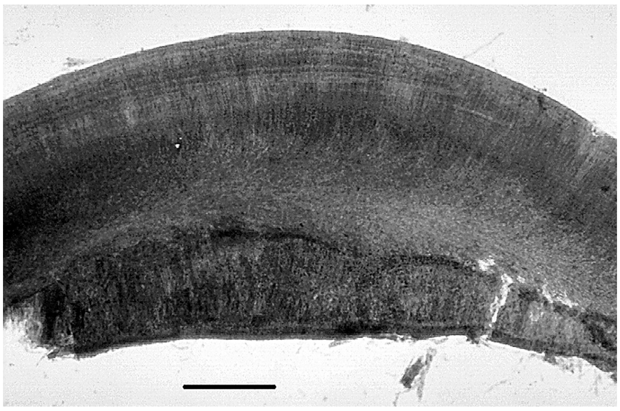

FIG. 186. – *Ralfsia expansa*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11854. Radial vertical section of the plant. Scale bar = 400 µm.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11854, with plurilocular sporangia.

References: Børgesen (1912), Levring (1938), Taylor (1960), Ugadim (1973), Simons (1976), Lawson and John (1987), Sartoni and Boddi (1989), Santelices (1989).

Habit and vegetative structure: Plant crustose of solid texture, fragile, forming dark brown patches completely adherent to the substratum, from which it is easy to remove. In cross radial section, structure compact, up to 1400 µm thick, differentiated into medulla and cortex. Medulla consisting of horizontally arranged and progressively curved upwards branched filaments 10-14(-20) µm in diameter; occasionally, medullary filaments also curved downwards; cells of medullary filaments oblong, squarish or irregular in shape, 28-46 x 10-14 µm, containing numerous physodes; sometimes, lower medullary filaments more or less free and sinuous, like rhizoids. Cortical filaments erect, about 40-50 cells long and 4-8 µm in diameter in the upper half, thicker in the lower part, simple or scarcely branched at base, closely adjacent (not separating under pressure), arising from the medullary filaments; cells of cortical filaments oblong or squarish, 5-24 x 4-13 µm, usually difficult to distinguish because of the great number of physodes that they contain; intercalary gland cells 9-14 x 6-9 µm, occurring often in the cortical filaments. Plastid laminar or reticulate in the upper cells of cortical filaments, not discernible in the lower cells.

Reproduction: Plurilocular sporangia scarcely developed, placed in sori; sporangia linear, 30-40 x 2-3 µm, uniseriate, exceptionally pluriseriate, composed of 7-9 loculi and one sterile apical cell 6-8 x 2-4 µm. Other reproductive structures not seen.

Habitat: Growing on rocky substratum and mussel shells in the lower eulittoral zone.

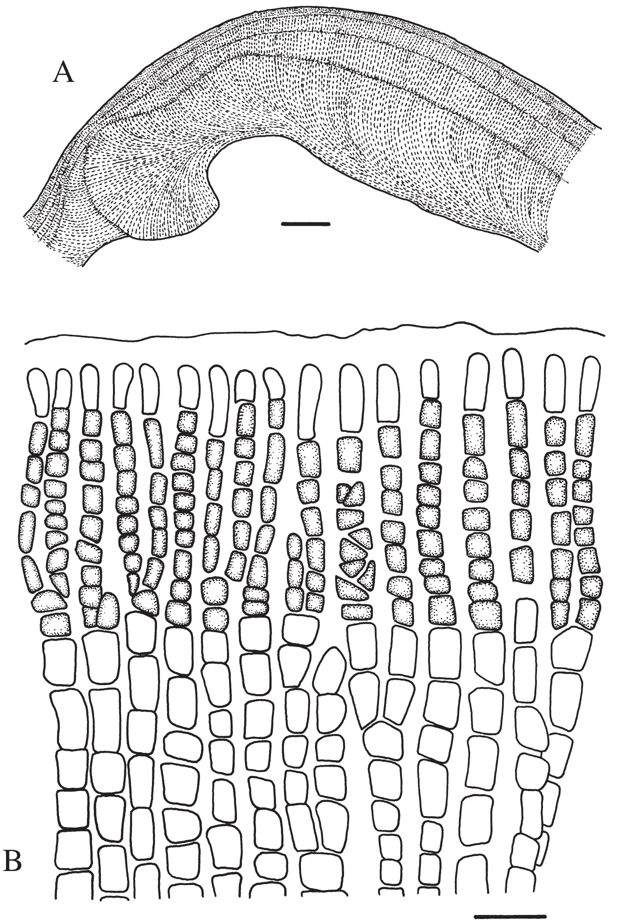

FIG. 187. – *Ralfsia expansa*. A. Schematic radial vertical section of the plant. B. Upper part of erect filaments with plurilocular sporangia. A. Scale bar = 200 µm. B. Scale bar = 10 µm.

Namibian distribution: Elizabeth Bay, Swakopmund, Cape Frio (Lawson *et al.*, 1990) (Map 95).

World distribution: Probably widespread in warm temperate and tropical seas (Lawson and John, 1987).

Remarks: *Ralfsia expansa* was initially described by J. Agardh (1847), as *Myrionema expansum*, on the basis of material from Veracruz (Mexico) and presently its distribution includes the warm temperate and tropical seas, particularly in the Atlantic Ocean.

Our specimens agree quite well with *R. expansa* descriptions and iconography consulted. In this way, cortex and medulla are clearly differentiated in the Namibian specimens, in agreement with Sartoni and Boddi (1989), who considered this fact as a distinctive trait of *R. expansa*. However, our specimens differed from those described by Sartoni and Boddi (1989) in having a thicker cortex (up to 300 µm thick in comparison with 40-120 µm thick). Likewise, the plurilocular sporangia are generally uniseriate in Namibian material, whereas they usually are partially biseriate in this species according to Børgesen (1912), Lawson and John (1987) and Sartoni and Boddi (1989). Moreover, in our specimens the plurilocular sporangia are smaller [30-40 µm long in comparison with 40-80 µm according to Sartoni and Boddi (1989)] and they are formed by a lower number of loculi (7-9 loculi in comparison with 10-20 reported in the literature). Although these are significant differences, those concerning the plurilocular sporangia could be explained if these structures were not completely developed in the Namibian material.

Ralfsia expansa is very similar to *R. verrucosa* (Areschoug) J. Agardh. Børgesen (1912) stated that *R. expansa* differed from *R. verrucosa* in having longer and pedicellate unilocular sporangia. This author, who assigned his material to *R. expansa*, also remarked that it could be considered as a variety of *R. verrucosa*. On the other hand, Sartoni and Boddi (1989) pointed out that the presence or absence of pedicels in the unilocular sporangia is a variable feature, and therefore without taxonomical value. In contrast, concerning the length of the unilocular sporangia, these authors agreed with Børgesen (1912) when they stated that in *R. expansa* these structures are longer than in *R. verrucosa*. Moreover, according to Sartoni and Boddi (1989), *R. expansa* differs from *R. verrucosa* in having partially biseriate plurilocular sporangia and in showing a multiaxial growing region in the marginal zone.

As we have already mentioned, the only reproductive structures found in our specimens are the plurilocular sporangia, and it is possible that they were not completely developed. For this reason, we cannot assign them definitely to any species. However, the vegetative structure of the plant, together with the fact that *R. expansa* is a widespread species on west African coasts (Lawson and John, 1987), led us to assign our specimens tentatively to this taxon.

Genus *Stragularia* Strömfelt (1886)

Stragularia clavata (Harvey in Hooker) Hamel (Fig. 188)

Myrionema clavata Harvey in Hooker (1833), p. 391.
Ralfsia clavata (Harvey in Hooker) P. Crouan and H. Crouan (1852), no. 56.
Stragularia clavata (Harvey in Hooker) Hamel (1939a), p. XXXI.
Ralfsia bornetii Kuckuck (1894), p. 245.

Selected specimens: Swakopmund, 8-07-1989, BCF-A 12049, with unilocular sporangia.

References: Taylor (1957), Ardré (1970), Yoneshigue (1985), Fletcher (1987).

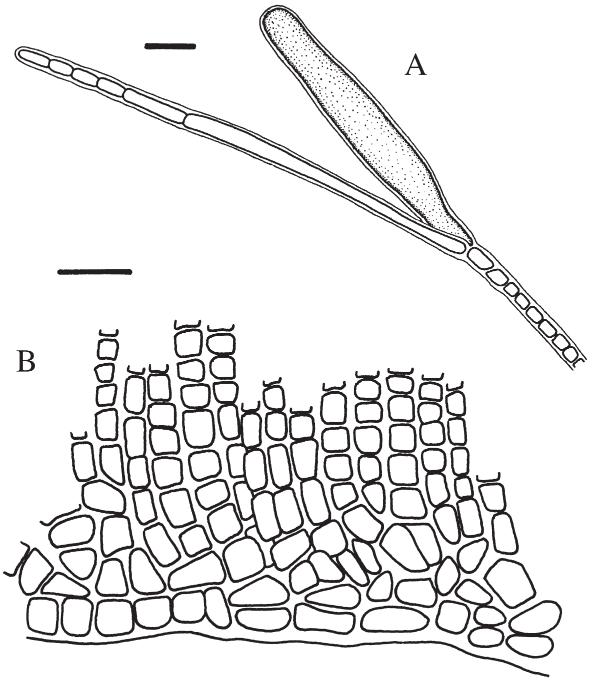

FIG. 188. – *Stragularia clavata*. A. Basal part of the plant in cross section. B. Unilocular sporangia. Scale bar = 20 µm.

Habit and vegetative structure: Plant crustose forming dark brown patches 500-580 µm thick firmly adherent to the substratum. In cross section, structure consisting of 1-2 basal layers of cells and erect filaments closely adjacent but separating somewhat under pressure. Cells of basal layers square or horizontally elongated, 10-18 x 8-10(-14) µm. Erect filaments 300-320 µm long and 6-8(-10) µm in diameter, straight or slightly curved at base, consisting of about 40 cells 0.7-2.3 times longer than broad, 4-14 x 6-9 µm. Plastids laminar or more or less reticulate, easily visible in the cells of the upper part of erect filaments but less apparent in the lower cells, with one pyrenoid often invisible.

Reproduction: Unilocular sporangia in superficial gelatinous sori, between paraphyses weakly joined and so separating under pressure; sporangia clavate, 124-192 x 20-28 µm, placed at base of paraphyses, generally sessile, sometimes with an unicellular pedicel; paraphyses slightly clavate, 200-260 µm long, 4 µm in diameter at base and (6-)8 µm in diameter at apical zone, consisting of 5-7 cylindrical cells, the basal considerably longer than the others. Other reproductive structures not observed.

Habitat: Growing on mussel shells together with *Polysiphonia virgata* in drift material.

Namibian distribution: Swakopmund (Map 96).

World distribution: Atlantic Ocean: Namibia; Selvagens Islands (Price *et al.*, 1978); Portugal (Ardré, 1970); France (Hamel, 1935); British Isles (Fletcher, 1987); Netherlands (Stegenga *et al.*, 1997); Brazil (Yoneshigue, 1985); New Jersey to St. Lawrence (Taylor, 1957); Canada (South, 1984). Mediterranean Sea (Ribera *et al.*, 1992). Pacific Ocean: Alaska (Setchell and Gardner, 1925).

Remarks: *Stragularia clavata* was described as *Myrionema clavata* by Harvey in Hooker (1833) on the basis of material from the west coast of Scotland. This species is similar to *Ralfsia bornetii* Kuckuck, although it has shorter paraphysis and unilocular sporangia (Fletcher, 1987). Nevertheless, after revision of the British Islands material, this author held that it is difficult to maintain the two taxa as different species, and pending further studies, he considered *R. bornetii* a synonym of *S. clavata*. This opinion, formerly expressed by Newton (1931) and Hamel (1935), was shared by Ribera *et al.* (1992). In contrast, Edelstein *et al.* (1970) considered that some of the features that distinguish the two taxa are persistent in culture and, together with other authors (Taylor, 1957; South, 1984; Yoneshigue, 1985), regarded them as different species.

Our specimens, by having long paraphyses and long unilocular sporangia may be more closely related to *R. bornetii* than *S. clavata*. However, in the absence of a global taxonomic study of the Ralfsiaceae, we prefer to follow Fletcher and assign them to *Stragularia clavata*.

The only Ralfsiaceae recorded from Namibia so far are *R. expansa* (J. Agardh) J. Agardh (Lawson *et al.*, 1990) and *Basispora africana* John and Lawson (Engledow, 1998). *Stragularia clavata* differs from *R. expansa* by forming thinner crusts and by having straight or only slightly curved-at-base erect filaments separating somewhat under pressure. Likewise, *S. clavata* differs from *Basispora africana* by having a more compact texture and laminar or more or less reticulate plastids instead of numerous discoidal plastids as in *B. africana* (John and Lawson, 1974). Moreover, *S. clavata* has the unilocular sporangia placed at the base of the paraphyses, whereas they are terminal in *B. africana*.

Order CHORDARIALES Setchell and Gardner (1925)
Family CHORDARIOPSIDACEAE Kylin (1940)
Genus *Chordariopsis* Kylin (1940)

Chordariopsis capensis (C. Agardh) Kylin
(Figs. 189-191)

Chordaria flagelliformis (O.F. Müller) C. Agardh var. *capensis* C. Agardh (1824), p. 257.
Chordariopsis capensis (C. Agardh) Kylin (1940), p. 54.
Chorda capensis Kützing (1843), p. 334.
Chordaria capensis (Kützing) Areschoug (1851), p. 22.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11753, with unilocular sporangia; Swakopmund, beach, 8-07-1989, BCF-A 11754, with unilocular sporangia; Terrace Bay, February 1986, BCF-A 11755, with unilocular sporangia; Möwe Bay, 4-02-1988, BCF-A 12040.

References: Kylin (1940), Simons (1969, 1976), Branch and Branch (1981), Adams (1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, up to 39 cm high, consisting of several terete, much branched main axes arising from the same discoidal attachment base; main axes 400-600 µm in diameter in its median part. Branches of varying lengths, usually simple, 260-680 µm in diameter in its median part, constricted at base and progressively tapering upwards, irregularly arranged around the main axes, the basal ones often reflexed; short branches patent, some of them forked; long branches occasionally branched like the main axes. Outer cortical cells elliptic or isodiametric in surface view, 6-10 x 5-8 µm; apical zone multicellular. In cross section, axes differentiated into medulla and cortex; medullary cells colourless, more or less isodiametric, 7-20 x 6-14 µm, the inner ones larger and thick-walled, 13-36 x 13-32 µm; central medulla sometimes hollow; cortical and subcortical cells pigmented; cortex composed of radiating filaments 2-3 cells long; the lower cells of cortical filaments squarish or rectangular, 6-8 x 6-7 µm, and the apical one longer and with rounded apex, 8-18 x 6-8 µm. In longitudinal section, inner medullary cells cylindric, very long, 400-700 x 12-18 µm, decreasing in length towards the cortex; outer medullary cells 42-110 x 10-22 µm.

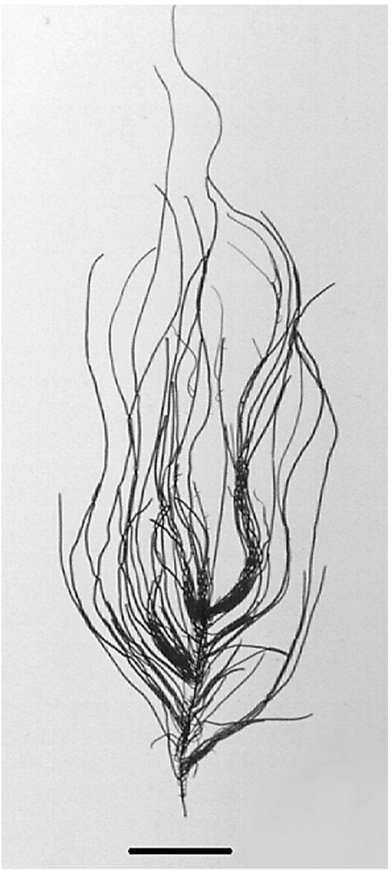

FIG. 189. – *Chordariopsis capensis*. Swakopmund, beach, 8-07-1989, BCF-A 11754. Scale bar = 2 cm.

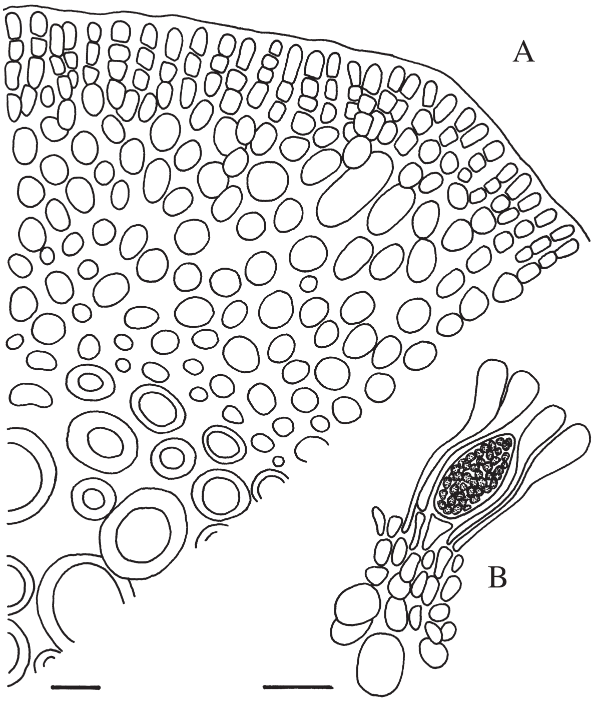

FIG. 190. – *Chordariopsis capensis*. A. Portion of the cross section of an axis. B. Unilocular sporangia and paraphyses. Scale bar = 15 µm.

Reproduction: Unilocular sporangia elliptic, spindle-shaped or more or less clavate, 20-34 x (4-) 10-13 µm, developed among paraphyses in the cortical zone of axes and branches; paraphyses club-shaped, usually unicellular, 50 x 6-8 µm. Other reproductive structures not seen.

Habitat: Epilithic, in the lower eulittoral zone and in tide pools.

Namibian distribution: Elizabeth Bay, Lüderitz, Swakopmund, Torra Bay, Rocky Point, Cape Frio (Lawson *et al.*, 1990); Terrace Bay, Möwe Bay (Map 97).

World distribution: Atlantic Ocean: Tierra del Fuego, Falkland Islands, South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996); Kerguelen Islands (Stegenga *et al.*, 1997). Pacific Ocean: Macquarie Island, Auck-

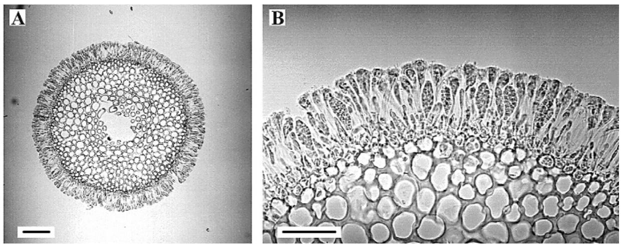

FIG. 191. – *Chordariopsis capensis*. A. Cross section of a fertile axis. B. Detail of the cross section of an axis with unilocular sporangia. A. Scale bar = 80 µm. B. Scale bar = 40 µm.

land Islands, Chile (Stegenga *et al.*, 1997).

Remarks: *Chordariopsis capensis* was initially described by C. Agardh (1824), as a variety of *Chordaria flagelliformis* (O. F. Müller) C. Agardh, on the basis of material from the Cape of Good Hope. Subsequently, Kylin (1940) created the genus *Chordariopsis* and the family Chordariopsidaceae for this taxon. At present, this family includes only the genus *Chordariopsis*, which is monospecific and presents a circumpolar distribution limited to the southern hemisphere (Clayton, 1995).

Morphologically, *Chordariopsis capensis* is very similar to *Chordaria flagelliformis*, a north Atlantic species formerly recorded from Namibia by Dinter (1919). Subsequently, Price *et al.* (1978) and Lawson *et al.* (1990) included this record in their catalogues, pointing out that it probably refers to *Chordariopsis capensis*. This species differs from *C. flagelliformis* in having a uniaxial structure [a feature difficult to observe according to Ricker (1987)], a compact cortex (consisting of assimilatory filaments in *C. flagelliformis*) and commonly unicellular paraphyses (pluricellular in *C. flagelliformis*).

Order SCYTOSIPHONALES Feldmann (1949)
Family SCYTOSIPHONACEAE Farlow (1881)
Genus *Petalonia* Derbès and Solier (1850) *nom. cons.*

Petalonia fascia (O. F. Müller) Kuntze
(Figs. 192-193)

Fucus fascia O. F. Müller (1778), p. 7.
Ilea fascia (O. F. Müller) Fries (1835), p. 321.
Phyllitis fascia (O. F. Müller) Kützing (1843), p. 342.
Petalonia fascia (O. F. Müller) Kuntze (1898), p. 419.
Petalonia debilis (C. Agardh) Derbès and Solier (1850), p. 265.

Selected specimens: Langstrand, 6-07-1989, BCF-A 12058, with plurilocular sporangia.

References: Earle (1969), Ugadim (1973), Abbott and Hollenberg (1976), Simons (1976), Tseng (1984), Kapraun (1984), Womersley (1987), Noda (1987), Fletcher (1987), Santelices (1989), Adams (1994), Coppejans (1995), Stegenga *et al.* (1997).

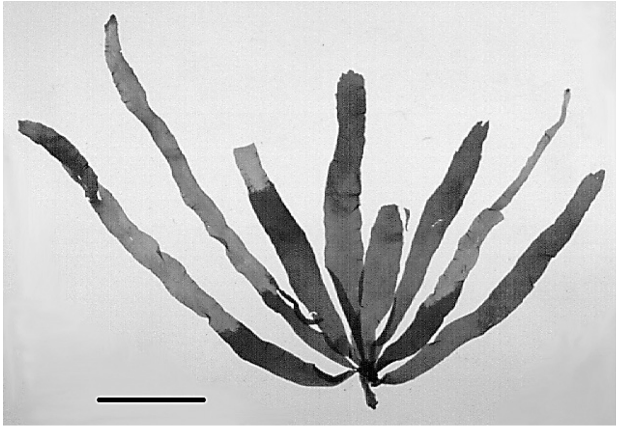

FIG. 192. – *Petalonia fascia*. Langstrand, 6-07-1989, BCF-A 12058. Scale bar = 5 cm.

Habit and vegetative structure: Plant foliaceous, up to 20 cm high, consisting of several lanceolate blades 1-2.5 cm broad attached to the substratum by a basal disc; blades undivided, shortly stipitate, with entire margin and smooth surface. Outer cortical cells polygonal, elongate or more or less isodiametric in surface view, 4-6 x 3-5 µm. In cross section, blade 120-132 µm thick, differentiated into cortex and medulla. Cortex composed of 2-3 layers of pigmented cells, the outer ones squarish or rectangular, 4-6 x 3-8 µm, and the inner ones elliptic or more or less isodiametric, 8-10 x 6-10 µm. Medulla composed of rounded or elliptic colourless cells 20-52 x 16-40 µm loosely arranged. In longitudinal section, medullary cells generally long, 20-200 x 14-32 µm, often with not much defined tips. In a section parallel to the blade surface, medullary cells very long, sinuous, with lateral protuberances, joined between them forming a loose network. Hairs 4 µm in diameter, occurring in scattered tuft over the blade. Plastid laminar with 1(2) clearly visible pyrenoids.

Reproduction: Plurilocular sporangia cylindrical, uniseriate or biseriate, 31-34 µm high, placed in extensive sori on both sides of the blade; loculi squarish or rectangular, 4-8 x 2-4 µm. The non simultaneous liberation of spores produce pale areas in the blade surface devoid of sporangia. Other reproductive structures not seen.

Habitat: In the eulittoral zone, in a place with numerous mussels and anemones.

Namibian distribution: Elizabeth Bay, Swakopmund (Lawson *et al.*, 1990); Langstrand (Map 98).

World distribution: Widely distributed in cold and temperate waters (Womersley, 1987; Kapraun, 1984).

Remarks: According to Lawson *et al.* (1990) the genus *Petalonia* is represented in Namibia by *P.*

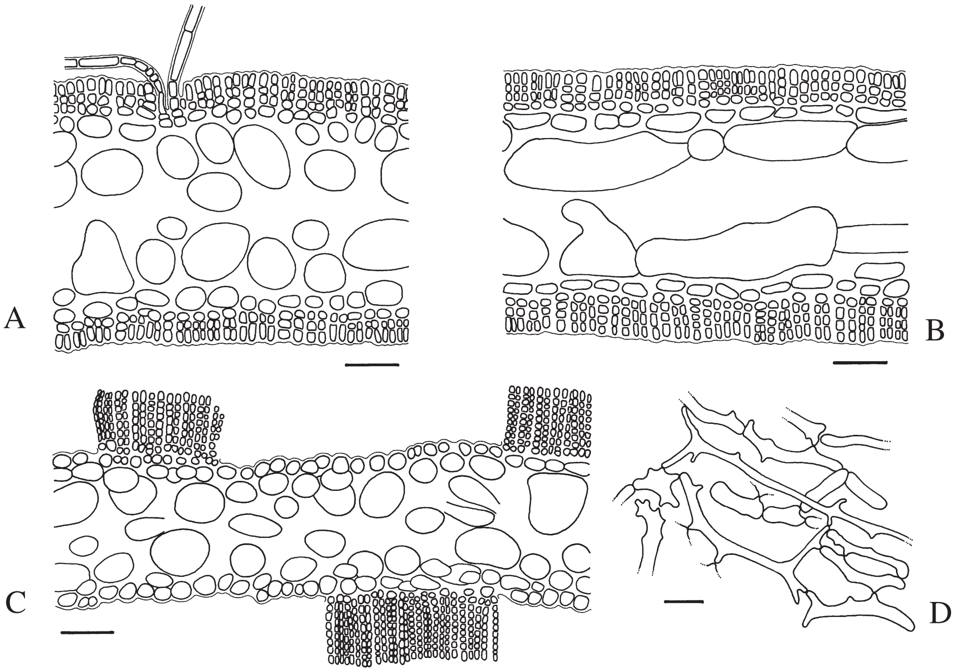

FIG. 193. – *Petalonia fascia*. A. Cross section of the blade. B. Longitudinal section of the blade. C. Cross section of the blade through a fertile area, showing the discontinuous arrangement of plurilocular sporangia. D. Medullary cells in a section parallel to the blade surface. A-C. Scale bar = 25 µm. D. Scale bar = 100 µm.

debilis (O. F. Müller) Kuntze, which has been recorded from Elizabeth Bay and Swakopmund. According to Santelices (1989) *P. debilis* differs from *P. fascia* by the size and by the blade width. Like this, the small specimens (3-4 cm high) consisting of narrow blades (up to 0.5 cm broad) would belong to *P. debilis*, whereas the larger specimens (up to 10 cm high and 1 cm broad) would belong to *P. fascia*. In agreement with Wynne (1969), Price *et al.* (1978) and Fletcher (1987), we hold that these differences are not important enough to distinguish species and, therefore, we consider *P. debilis* as a synonym of *P. fascia*. Silva *et al.* (1996), in contrast, preferred to consider *P. debilis* as a variety of *P. fascia*.

Petalonia fascia is morphologically very similar to *Endarachne binghamiae* J. Agardh, a taxon recorded from Namibia by Lawson *et al.* (1990) and the distribution of which also includes the south of California, Baja California, Japan, Chile (Santelices, 1989), New Zealand (Adams, 1994), China (Tseng, 1984), Korea (Kang, 1966), Brazil (Wynne, 1998) and South Africa (Silva *et al.*, 1996; Stegenga *et al.*, 1997). The main feature distinguishing *Endarachne* from *Petalonia* refers to the structure of the medulla. According to Wynne and Banaimoon (1990), the medulla consists of branched and compactly interwoven filaments in *Endarachne*, whereas it is cellular in *Petalonia*. Setchell and Gardner (1925) remarked that in *Ilea* (*Petalonia*) the inner medullary cells may be more or less elongate, although they do not form a filamentous structure as in *Endarachne*. Vinogradova (1973) also observed filaments in the medulla of *Petalonia zosterifolia* (Reinke) Kuntze and, on the basis of this, he synonymized *Endarachne* and *Petalonia*, transferring *E. binghamiae* to the latter genus. Some authors, like Kitayama *et al.* (1995), followed the same criterion, whereas Silva *et al.* (1996) preferred to maintain both genera as different entities awaiting future studies.

In a longitudinal section of the blade, our specimens have elongate medullary cells with ill-defined tips. These cells are especially visible in a section parallel to the blade surface, appearing as sinuous elongate cells with lateral protuberances, which join together forming a loose network. This structure could be reminiscent of *Endarachne binghamiae*, but according to the iconography of this species found in Setchell and Gardner (1925), Wynne and Banaimoon (1990) and Stegenga *et al.* (1997), we hold that it is more characteristic of *P. fascia* than of *E. binghamiae*.

Order LAMINARIALES Kylin (1917)
Family LAMINARIACEAE Bory de Saint-Vincent (1827)
Genus *Laminaria* Lamouroux (1813) *nom. cons.*

In addition to *Laminaria pallida*, the only species treated in this work, *L. digitata* f. *ensifolia* and *L. ochroleuca* have been also reported from Namibia. Both taxa had only been recorded formerly from Walvis Bay [Dinter (1922c) and Barton (1896), respectively] and it is probable that the cites refer to *L. pallida*. In this way, Izquierdo (1993) pointed out that *L. pallida* has been often mistaken for *L. ochroleuca* by European authors. See notes 69 and 70 of the check list (page 30).

Laminaria pallida Greville in J. Agardh
(Figs. 194-195)

Laminaria pallida Greville in J. Agardh (1848), p. 134.
Laminaria schinzii Foslie (1893), p. 91.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11851; Rocky Point, 24-02-1986, BCF-A 11852, with unilocular sporangia.

References: Foslie (1893), Papenfuss (1942), Simons (1969, 1976), Anderson *et al.* (1989), Molloy (1990), Molloy and Bolton (1996a), Stegenga *et al.* (1997).

Habit and vegetative structure: Sporophyte up to 2.5 m high, differentiated into blade, stipe and haptera. Blade 150-175 cm long, cuneate at base, dissected into several segments 2-6.5 cm broad at base and 9.5-11.5 cm broad in the median part, palmate, eroded at apex and with smooth surface; margin of the segments (approximately 1 cm wide) often paler than the central zone. Stipe darker than the blade, terete, 23-75 cm long and 1.7-2 cm in diameter, the basal part thinner than the upper; transitional zone between stipe and blade compressed and more or less spatulate. Haptera branched and interwoven forming a compact attachment base. In surface view, meristodermic cells of the blade rounded, 4-7 µm in diameter, loosely arranged. In cross section, stipe solid in the lower part and hollow in the upper one; structure differentiated into medulla, cortex and meristoderm; medulla composed of branched filaments 4-20 µm in diameter, often enlarged at join zones between the cells (16-34 µm); medullary filaments arranged in all directions; cortical cells colourless, polygonal, ovate or more or less isodiametric, 40-100 x 36-68 µm, thick-walled (6-8 µm), the outer ones relatively smaller and pigmented, 28-52 x 16-32 µm; meristodermic cells anticlinally elongate, pigmented; mucilage conducts 47-63 x 32-40 µm, localized in the outer cortex. Blade approximately 1 mm thick, with similar structure to that of the stipe; medulla 300 µm thick, consisting of filaments 6-14 µm in diameter, in general longitudinally or obliquely arranged; cortical zone 360-380 µm thick, consisting of colourless, polygonal, elongate or more or less isodiametric cells 24-92 x 16-52 µm, the outer ones pigmented; cell-wall thick except in the sieve plates; transitional zone between medulla and cortex compact, composed of cells relatively smaller; mucilage conducts 40-100 x 40-80 µm, localized in the outer cortex. In longitudinal section, inner cortical cells of stipe more or less rectangular with rounded apices, 52-140 x 24-52 µm, connected to the medullary filaments.

FIG. 194. – *Laminaria pallida*. 5 km south of Swakopmund, 6-07-1989. Scale bar = 10 cm.

Reproduction: Unilocular sporangia club-shaped or elliptic, 40-54 x 8-10 µm, placed among paraphyses in extensive gelatinous sori localized in the central part of the blade segments; paraphyses clavate, 54-70 µm long and 4 µm broad in the upper part. Other reproductive structures not seen.

Habitat: Epilithic, in the sublittoral zone.

Namibian distribution: Elizabeth Bay, Lüderitz, Walvis Bay, Swakopmund, Terrace Bay, Möwe Bay, Rocky Point (Lawson *et al.*, 1990) (Map 99).

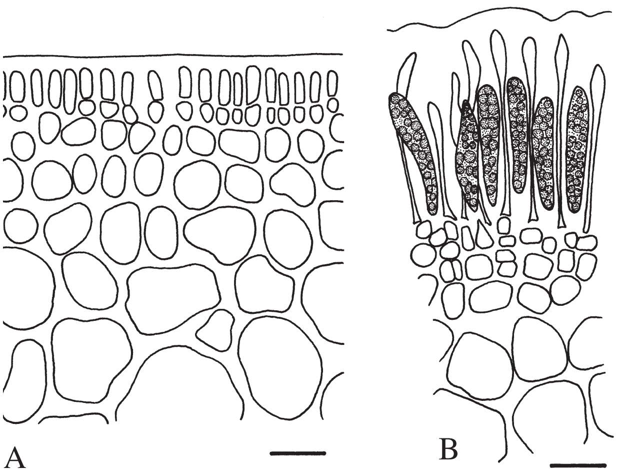

FIG. 195. – *Laminaria pallida*. A. Outer cortical zone of the blade in cross section. B. Unilocular sporangia and paraphyses. Scale bar = 20 µm.

World distribution: Atlantic Ocean: Gough Island, Tristan da Cunha, South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: St. Paul Island, Amsterdam Island, South Africa (Silva *et al.*, 1996).

Remarks: *Laminaria pallida* was described by Greville (in J. Agardh, 1848) on the basis of material from Table Bay (South African Atlantic coast). Some years later, Foslie (1893) described *Laminaria schinzii*, a species very similar to *L. pallida*, on the basis of some specimens from Walvis Bay (Namibia). The main difference between the species lies in the stipe, which is hollow in *L. schinzii* and solid, shorter and conical in *L. pallida* (Molloy and Bolton, 1996a). Moreover, according to Papenfuss (1942), *L. pallida* would have a more meridional distribution than *L. schinzii*, which would be restricted to the rocky shores between Cape Columbine (Atlantic coast of South Africa) and Rocky Point, in northern Namibia (Anderson *et al.*, 1989). Both species would coexist in the boundary of their distributions.

Wynne (1986) cited *L. schinzii* from Swakopmund and remarked on the possibility that it was merely a form of *L. pallida*. Both species have been recently considered conspecific by Stegenga *et al.* (1997), who held that the distinction between them appears not to be clear, and that the hollow and solid stiped specimens are interfertile, as has been shown by Dieck and Oliveira (1993). In contrast, other authors, such as Molloy and Bolton (1996a) and Molloy (1998), preferred to consider both species as separate entities.

Division CHLOROPHYTA
Class ULVOPHYCEAE
Order ULVALES Blackman and Tansley (1902)
Family CHAETOPHORACEAE Greville (1824)

Genus *Entocladia* Reinke (1879)

Key to species of *Entocladia*:

1. Filaments 3-6 µm in diameter............*E. viridis**
1. Filaments thicker (5-12 µm in diameter)..........2

2. Lenticular cells present.....................*E. vagans**
2. Lenticular cells absent.................*E. leptochaete*

* *E. viridis* and *E. vagans* were not observed. More information about these taxa can be found in Burrows (1991) and/or Lawson and John (1987).

Entocladia leptochaete (Huber) Burrows (Fig. 196)

Endoderma leptochaete Huber (1893), p. 319.
Entocladia leptochaete (Huber) Burrows (1991), p. 108.

Lectotype: original illustration [Huber (1893), p. xv, fig. 1-9] in the absence of material. Croisic, Finistère, France.

Selected specimens: Swakopmund, beach, 8-07-1989, BCF-A 12076; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11906.

References: Hamel (1931a), Burrows (1991).

Habit and vegetative structure: Plant microscopic, epiphytic or endophytic, consisting of irregularly grouped cells forming ill-defined prostrate filaments. Cells irregular in shape or more or less polygonal, elongated or almost isodiametric, 8.8-28 x 7.2-12 µm. Plastid parietal, with 1-3 pyrenoids clearly visible.

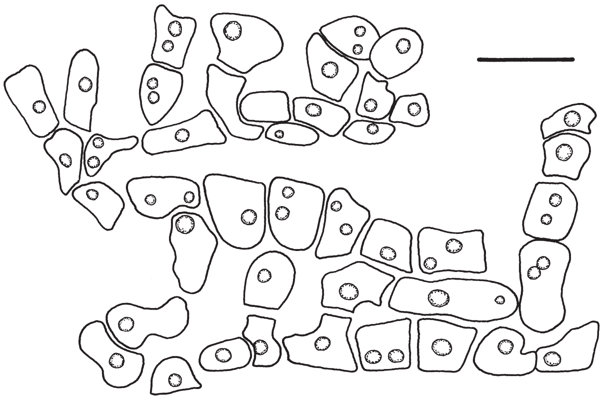

FIG. 196. – *Entocladia leptochaete*. Habit. Scale bar = 20 µm.

Reproduction: Fertile cells like vegetative ones, 15.2-18.4 x 8-9.6 µm, with 4-7 reproductive cells inside.

Habitat: Growing on *Polysiphonia scopulorum* and also in the cell wall of *Tayloriella tenebrosa* pericentral cells.

Namibian distribution: Swakopmund, South Kunene (Map 100).

World distribution: Atlantic Ocean: Namibia; France to Sweden, British Isles (Burrows, 1991); Canada (South and Tittley, 1986). Mediterranean Sea (Gallardo *et al.*, 1993). Indian Ocean: India (Silva *et al.*, 1996).

Remarks: According to the literature, *Entocladia leptochaete* has not been recorded from the Southern hemisphere. This species is very similar to *E. viridis* Reinke, a species of wider distribution (Lawson and John, 1987; Burrows, 1991) and also reported from Namibia by Engledow (1998). *E. viridis* has narrower cells than *E. leptochaete* (6 µm of average diameter according to Burrows, 1991) and only one pyrenoid per cell. Although Burrows (1991) considered *E. viridis* and *E. leptochaete* as different entities, he pointed out that the two taxa could be conspecific. *E. leptochaete* is also similar to *E. vagans* Reinke, another species recorded by Engledow (1998) from Namibia, but it differs from *E. vagans* by lacking lenticular cells.

Our material has relatively large cells, 7.2-12 µm in diameter, with 1-3 (usually 2) pyrenoids clearly visible in each cell; for this reason and by the absence of lenticular cells, we have assigned it to *E. leptochaete*. Nevertheless, we think that studies of reproduction and life cycle are needed for the determination of the species of this genus.

On the other hand, Namibian specimens also agree with *Entocladia polysiphoniae* Setchell and Gardner, a species described from the Pacific coasts of Mexico (Setchell and Gardner, 1924) and also reported in Japan (Noda, 1987). However, Setchell and Gardner (1924) pointed out the presence of a single pyrenoid per cell in this species.

Genus *Ulvella* P. Crouan and H. Crouan (1859)

Ulvella lens P. Crouan and H. Crouan
(Fig. 197)

Ulvella lens P. Crouan and H. Crouan (1859), p. 288.

Holotype: PC (Herb. Thuret). Rade de Brest (France).

Selected specimens: Langstrand, 6-07-1989, BCF-A 12077; 5 km south of Swakopmund, 6-07-1989, BCF-A 11835; Möwe Bay, 5-02-1988, BCF-A 12078; Cape Frio, 23-02-1986, BCF-A 12079; Angra Fria, 20-02-1986, BCF-A 12080; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 12081.

References: Hamel (1931a), Dangeard (1931), Baardseth (1941), Taylor (1960), Schnetter (1978), Burrows (1991).

Habit and vegetative structure: Plant microscopic, epiphytic, forming more or less discoidal patches, up to 700 µm in diameter, often confluent, consisting of a polystromatic central zone and a monostromatic periphery. Central cells elliptic, ovate or almost isodiametric, 4-10 x 4-9 µm, often darker than those of the periphery; peripheral cells elongated, rectangular or more or less sinuous in outline, 6-30 x 2-6 µm, arranged in more or less branched radial filaments; marginal cells often forked. In radial cross section, central zone of the disc usually distromatic; basal cells square or rectangular, 6-12 µm broad and 5-8 µm high; upper cells cylindrical with a rounded apex, 10-22 x 5-12 µm, anticlinally arranged; peripheral zone monostromatic, with cells 10-13 µm broad and 2-3 µm high. Plastid parietal with one pyrenoid.

Reproduction: Reproductive structures not seen.

Habitat: Epiphytic on other algae, like *Rhodymenia obtusa*, *Streblocladia camptoclada*, *Chondria capensis* and *Ceramium spp*.

Namibian distribution: Langstrand, Swakopmund, Möwe Bay, Cape Frio, Angra Fria, South Kunene (Map 101).

World distribution: Atlantic Ocean: Tristan da Cunha (Baardseth, 1941); Namibia; Angola (Law-

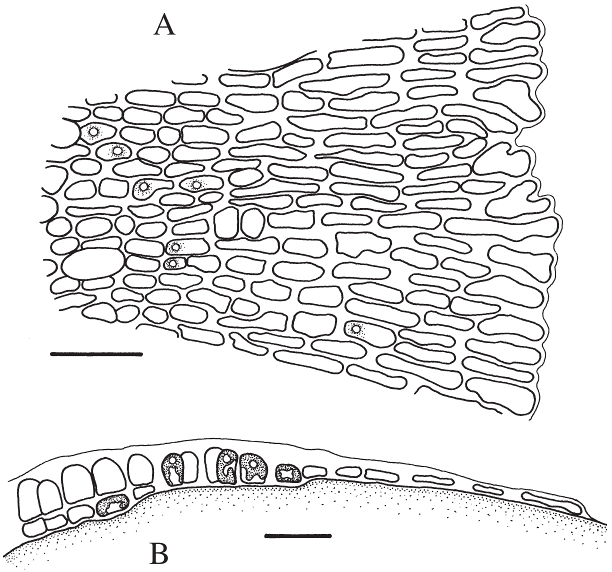

FIG. 197. – *Ulvella lens*. A. Portion of a disc in surface view. B. Radial cross section of a disc. Plastids and pyrenoids only apparent in some cells. Scale bar = 20 µm.

son *et al.*, 1975); north of Iberian Peninsula to Norway, Azores, England (South and Tittley, 1986); Trinidade Island (Pedrini *et al.*, 1989); Florida, North Carolina (Taylor, 1960); Massachusetts, West Greenland (South and Tittley, 1986). Caribbean Sea (Taylor, 1960; Schnetter, 1978). Mediterranean Sea (Gallardo *et al.*, 1993). Pacific Ocean: Japan (Burrows, 1991). Indian Ocean: Maldives, India, Pakistan (Silva *et al.*, 1996).

Remarks: *Ulvella lens* is similar to *Ulvella setchellii*, a species described by Dangeard (1931) from material from Le Croisic and Roscoff (France). According to this author, the main difference between *U. lens* and *U. setchellii* is the length of the marginal cells, shorter in the former (5-10 µm) than in the latter (10-50 µm). However, several authors, like Baardseth (1941), Taylor (1960) and Schnetter (1978), did not consider this difference and Baardseth (1941) pointed out that the length of marginal cells may depend on the type of substratum or other environmental factors. In contrast, Nielsen (1977) pointed out that the differences between the two species are constant in the same conditions of culture.

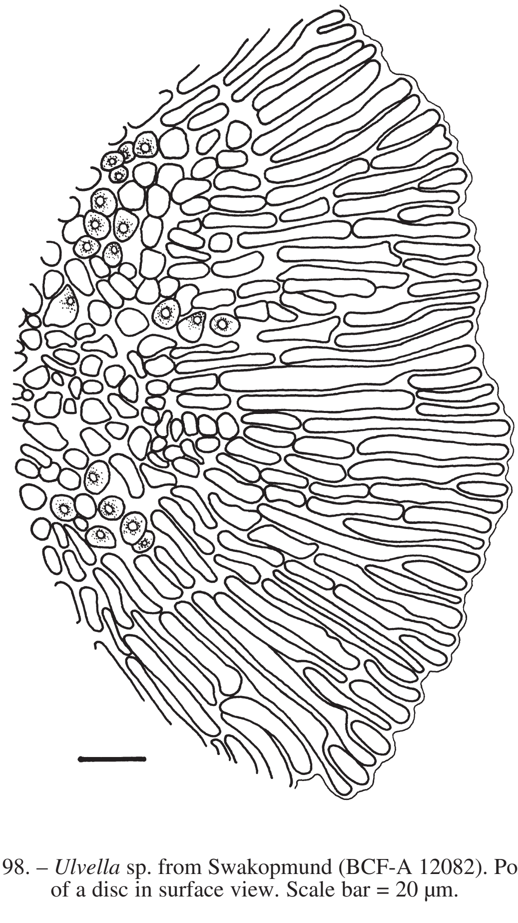

FIG. 198. – *Ulvella* sp. from Swakopmund (BCF-A 12082). Portion of a disc in surface view. Scale bar = 20 µm.

Among our material of *Ulvella*, there are specimens with marginal cells of different length (6-30 µm) which we have identified as *U. lens*, and other specimens, from Swakopmund (beach, 8-07-1989, BCF-A 12082, growing on *Rhodymenia obtusa*), in which most marginal cells are 40-80 µm long (Fig. 198). The Swakopmund specimens could be identified as *U. setchellii* according to Nielsen (1977), although they agree quite well with the iconography, description and habit of an indeterminate species of *Ulvella* from the west coast of South Africa described by Stegenga *et al.* (1997).

Family ULVACEAE Lamouroux ex Dumortier (1822)
Genus *Enteromorpha* Link in Nees (1820) *nom. cons.*

This genus requires taxonomical revision, at least in this geographical area.

Key to species of *Enteromorpha*:

1. In surface view, cells irregularly arranged along the whole of the plant; plastid with 1 pyrenoid .. ..*E. intestinalis*
1. In surface view, cells arranged in longitudinal rows and usually also in transverse rows; plastid with 1-3 pyrenoids...2

2. Cells with (1-)2-3 pyrenoids.............*E. flexuosa*
2. Cells with 1 pyrenoid 3

3. Axes compressed, only tubular at base and in the margin 4
3. Axes cylindrical or slightly compressed, always tubular ....*E. prolifera**

4. Laminar zone (2 cell layers) 70 µm thick in the median part of the plant; in cross section, cells 3-5 times longer than broad............*E. atroviridis**
4. Laminar zone (2 cell layers) 50 µm in the median part of the plant; in cross section, cells 2 or less times longer than broad...................*E. linza*

* In addition to the species referred to in this key, *E. bulbosa* (Suhr) Montagne was also recorded from Namibia, however, we do not include it in the key because of the scarcity of information that we have about this taxon. *E. prolifera* and *E. atroviridis* were not observed. More information about these taxa can be found in Burrows (1991) and Stegenga *et al.* (1997).

Enteromorpha flexuosa (Wulfen) J. Agardh

(Figs. 199-200)

Conferva flexuosa Roth (1800), p. 188, *nom. illeg.*
Ulva flexuosa Wulfen (1803), p. 1.
Enteromorpha flexuosa (Wulfen) J. Agardh (1883), p. 126.
Enteromorpha tubulosa (Kützing) Kützing (1856), p. 11.

Holotype: WU (No. 23 in Wulfen's Herbarium, as *Ulva flexuosa*). Duino, near Trieste; Adriatic.

Selected specimens: Mile 108, 13-07-1989, BCF-A 12084.

References: Anand (1940), Taylor (1960), Bliding (1963), Ugadim (1973), Abbott and Hollenberg (1976), Schnetter and Bula Meyer (1982), Teo and Wee (1983), Koeman and Hoek (1984), Womersley (1984), Lawson and John (1987), Burrows (1991), Adams (1994), Stegenga *et al.* (1997).

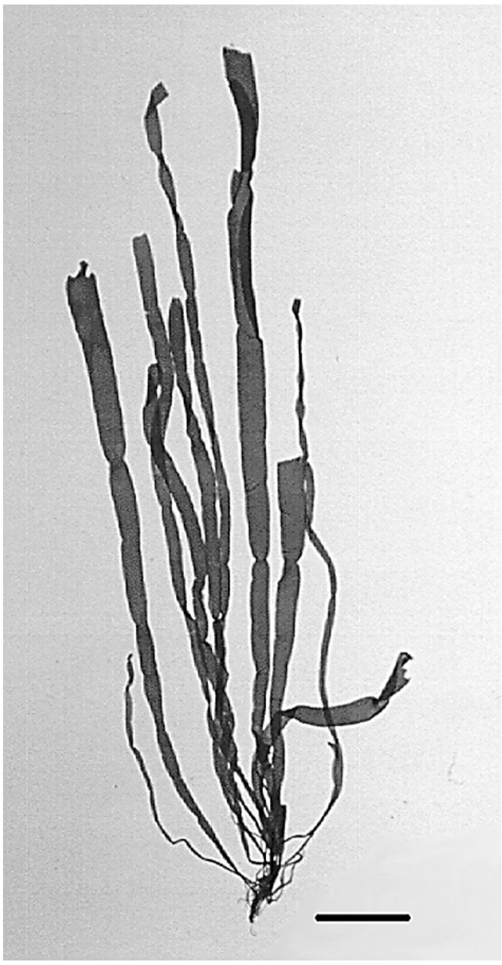

FIG. 199. – *Enteromorpha flexuosa*. Mile 108, 13-07-1989, BCF-A 12084. Scale bar = 1 cm.

Habit and vegetative structure: Plant up to 11 cm high, consisting of either terete and tubular axes up to 1 mm in diameter approximately or axes tubular and narrow at base, 260 μm in diameter, and progressively enlarged and flattened upwards, up to 5 mm broad; flattened axes simple or with short proliferations in the lower part; attachment by a basal disc from which several erect axes arise. In surface view, cells of the lower part of the plant rounded, isodiametric or usually elongate, 12-20 x 6-14 μm, with (1-)2(-3) pyrenoids, irregularly arranged or placed in longitudinal rows; basal cells rhizoidal; cells of the median and upper parts of the plant squarish or rectangular, with rounded corners, 9-18 x 6-12 μm, with (1-)2-3 pyrenoids, irregularly arranged or placed in longitudinal and often also horizontal rows. In cross section, axes either tubular

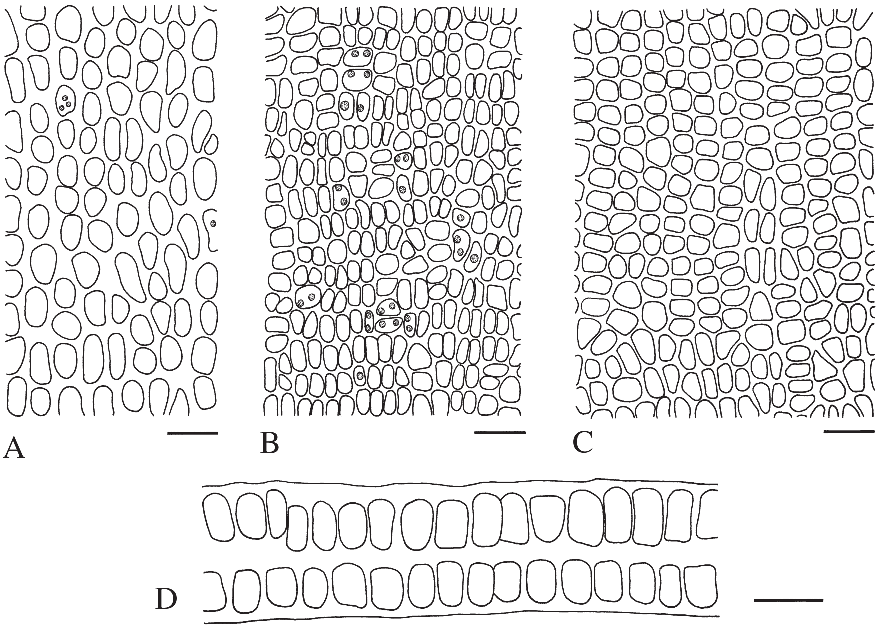

FIG. 200. – *Enteromorpha flexuosa*. A-C. Lower (A), median (B) and upper (C) parts of the plant in surface view; pyrenoids only apparent in some cells. D. Laminar zone of the plant in cross section. Scale bar = 25 μm.

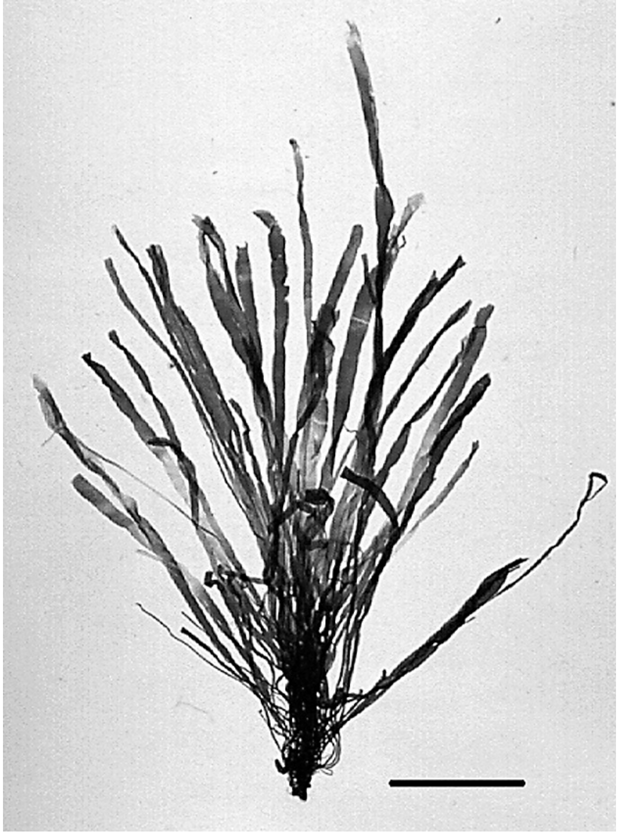

FIG. 201. – *Enteromorpha intestinalis*. Mile 108, 13-07-1989, BCF-A 11750. Scale bar = 2 cm.

or flattened and only hollow at margins; tube-wall 18-22 µm thick; blade (two cell layers) 40-42 µm thick; cells anticlinally elongate, 12-18 x 8-14 µm.

Reproduction: Reproductive cells not seen.

Habitat: Epiphytic on *Chaetomorpha aerea* and *Gracilariopsis longissima* in the eulittoral zone.

Namibian distribution: Rocky Point (Lawson *et al.*, 1990); Mile 108 (Map 102).

World distribution: Cosmopolitan (Lawson and John, 1987).

Enteromorpha intestinalis (Linnaeus) Nees (Figs. 201-202)

Ulva intestinalis Linnaeus (1753), p. 1163.
Enteromorpha intestinalis (Linnaeus) Nees (1820), Index, p. [2].
Enteromorpha compressa (Linnaeus) Nees (1820), Index, p. [2].

Selected specimens: Cape Cross, 7-07-1989, BCF-A 11834; Mile 108, 13-07-1989, BCF-A 11749, 11750.

References: Taylor (1960), Bliding (1963), Dawson *et al.* (1964), Rizzi-Longo and Giaccone (1974), Abbott and Hollenberg (1976), Womersley (1984), Noda (1987), Lawson and John (1987), Burrows (1991), Adams (1994), Coppejans (1995), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 17 cm high, consisting of one to several erect axes either wholly cylindrical, 80-220 µm in diameter, or cylindrical below, 80-200 µm in diameter, and gradually enlarged and flattened upwards up to 5 mm broad; axes simple or with proliferations or branches only in the lower part; attachment by a caespitose basal disc. In surface view, cells of the lower part of axes polygonal with rounded corners, 8-30 x 6-20 µm, with 1 pyrenoid, irregularly arranged; cells next to the base of axes and proliferations rhizoidal; cells of the median part of axes polygonal, 6-14 x 5-12 µm, irregularly arranged, with 1(-2) pyrenoids clearly visible; cells of the upper part of the plant polygonal or polygonal with rounded corners, 6-15 x 6-12 µm, in general irregularly arranged, with 1 pyrenoid;

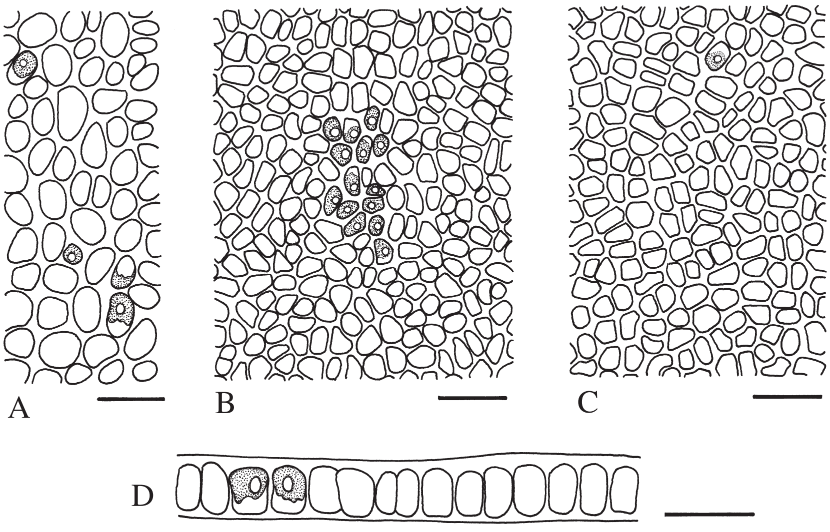

FIG. 202. – *Enteromorpha intestinalis*. A-C. Lower (A), median (B) and upper (C) parts of the plant in surface view; plastid and pyrenoids only apparent in some cells. D. Portion of the cross section of an axis. Scale bar = 25 µm.

plastid hood-shaped in the cells of the lower and median part of axes. In cross section, axes either tubular, with cavity 120- x 70-80 µm, or compressed and wholly hollow or only hollow at margins; tube-wall 18-26 µm thick; cells anticlinally elongate 12-22 x 7-14 µm.

Reproduction: Reproductive cells not seen.

Habitat: Epiphytic on *Tayloriella tenebrosa* and *Gracilariopsis longissima* in the eulittoral zone.

Namibian distribution: Swakopmund (Lawson *et al.*, 1990); Cape Cross, Mile 108 (Map 103).

World distribution: Cosmopolitan (Lawson and John, 1987).

Remarks: Among our material there are specimens which consist of unbranched axes and others with axes branched at the base. According to some authors, such as Womersley (1984) and Coppejans (1995), the unbranched specimens would belong to *E. intestinalis* whereas the branched ones would belong to *E. compressa*. Burrows (1991), in contrast, pointed out that there seems no basis, either morphological or genetic, for distinguishing both species, and that in any case, they can be treated taxonomically as two subspecies. However, since it is usually difficult to decide whether or not a plant is branched when the expression of branching is slight, this author considers it more appropriate not to distinguish the subspecies, but to treat the taxon as a whole, as *E. intestinalis*, until future genetic studies have been carried out. Following Burrows (1991), we treated *E. intestinalis* in a wide sense, without distinguishing between branched and unbranched specimens. On the other hand, some of our specimens (BCF-A 11749) consist of very narrow axes (about 200 µm in diameter), but as they have the cells irregularly arranged and usually with a hood-shaped plastid bearing a single pyrenoid, we have assigned them also to *E. intestinalis*. It is important to point out that Lawson *et al.* (1990) referred to this taxon with the name *E. compressa* in their work on the marine flora of Namibia.

According to the descriptions available, *E. intestinalis* is very similar to *E. bulbosa*, a taxon the distribution of which is basically limited to the subantarctic region (Chamberlain, 1965) but also recorded from Namibia (Lawson et al, 1990). The available data about this taxon do not allow us to distinguish both species and, therefore, we have preferred to assign our specimens tentatively to *E. intestinalis* waiting for future studies to clarify the taxonomy of this genus.

Enteromorpha linza (Linnaeus) J. Agardh (Figs. 203-205)

Ulva linza Linnaeus (1753), p. 1163.
Enteromorpha linza (Linnaeus) J. Agardh (1883), p. 134.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11713.

References: Taylor (1957), Dawson *et al.* (1964), Ugadim (1973), Abbott and Hollenberg (1976), Schnetter (1978), Womersley (1984), Tseng (1984), Noda (1987), Lawson and John (1987), Santelices (1989), Burrows (1991), Adams (1994), Coppejans (1995), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant 8-17 cm high, consisting of simple or only branched at base erect axes attached to the substratum by a caespitose basal disc; axes cylindrical in the lower part, 220 µm

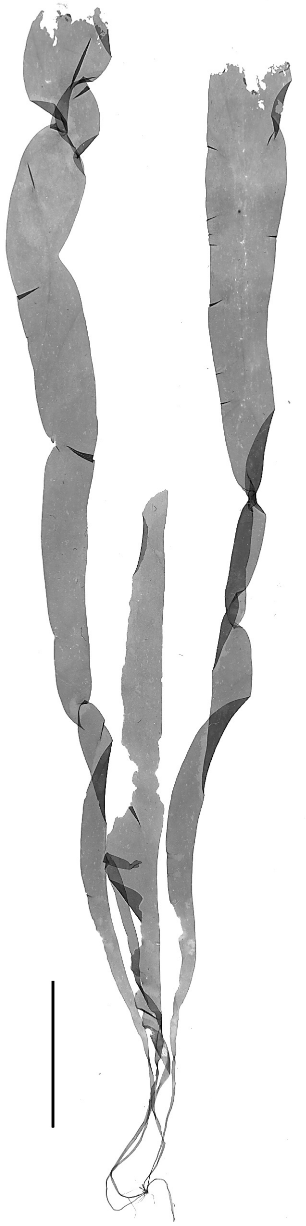

FIG. 203. – *Enteromorpha linza*. Langstrand, 6-07-1989, BCF-A 11713. Scale bar = 2 cm.

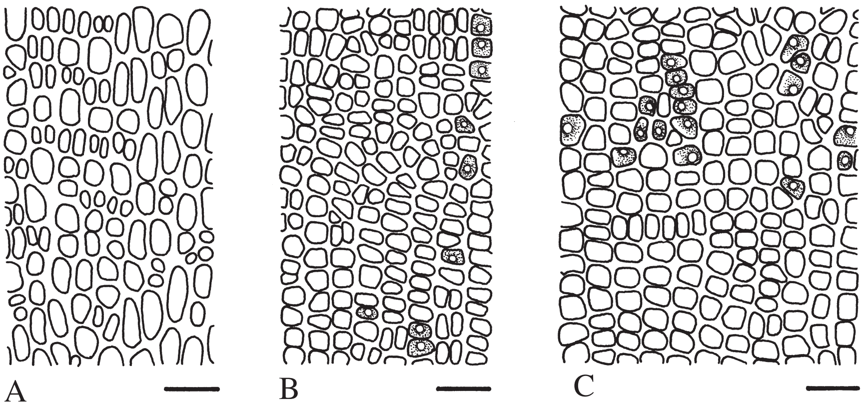

FIG. 204. – *Enteromorpha linza*. A-C. Lower (A), median (B) and upper (C) parts of the plant in surface view; plastid and pyrenoids only apparent in some cells. Scale bar = 25 µm.

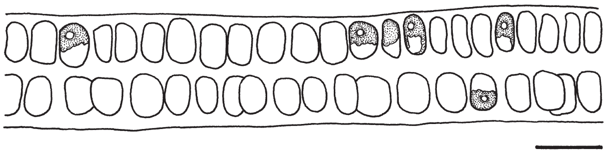

FIG. 205. – *Enteromorpha linza*. Central portion of the cross section of an axis (median part of the plant); plastid and pyrenoids only apparent in some cells. Scale bar = 25 µm.

in diameter, gradually enlarged and flattened upwards, up to 5-13 mm broad. In surface view, cells polygonal, squarish or rectangular, with rounded corners, more or less arranged in longitudinal and often also horizontal rows along the whole of the plant; cells of the basal part of axes usually elongate, 8-30 x 5-14 µm, and those of the median and upper parts squarish or rectangular, 8-14 x 6-12 µm; plastid parietal with one pyrenoid clearly visible. In cross section, median part of axes mainly laminar, composed of two cell layers that separate in the marginal zones leaving a small cavity; blade 42-46 µm thick, with cells elliptic or more or less rectangular, 14-16 x 6-14 µm, anticlinally arranged; plastid parietal, usually localized in the outer half of the cell, with 1 pyrenoid clearly visible.

Reproduction: Reproductive cells 6-8 µm in diameter, formed inside the cells of the upper part of axes.

Habitat: Epilithic or epiphytic on *Mazzaella capensis* in the eulittoral zone.

Namibian distribution: Lüderitz, Swakopmund (Lawson *et al.*, 1990); Langstrand (Map 104).

World distribution: Widespread from boreal-antiboreal to tropical seas (Lawson and John, 1987).

Remarks: *Enteromorpha linza* is very similar to *E. atroviridis* (Levring) Wynne, a species the distribution of which is restricted to the Atlantic coasts of South Africa and Namibia (Stegenga *et al.*, 1997). According to Wynne (1986) *E. atroviridis* differs from *E. linza* by its darker green colour and its weak attachment to paper on pressing. Likewise, according to Levring (1938) and Stegenga *et al.* (1997), the blades are 70-120 µm thick and consist of cells 3-5 times longer than broad in cross section in *E. atroviridis*, whereas they are 50 µm thick and consist of cells up to two times longer than broad in *E. linza*.

Genus *Ulva* Linnaeus (1753) *nom. cons.*

Key to species of *Ulva*:

1. Blade elongate, usually twisted, with a pale midrib clearly visible; in cross section, central part of the blade thicker than the marginal zones ....*U. fasciata*
1. Blade orbicular or more or less elongate, without a differentiated midrib; in cross section, blade thickness more or less uniform 2

2. Blade margin entire or with minute teeth near the base ....*U. rigida*
2. Blade margin dentate or with short spine-like proliferations...3

3. In cross section, cells of the median part of the blade conical, 42-62 µm high ....*U. capensis*
3. In cross section, cells of the median part of the blade cylindrical, 15-35 µm high...*U. rhacodes**

* In addition to the species referred to in this key, *U. nematoidea* Bory de Saint Vincent, was also recorded from Namibia. In our opinion this taxon seems not to differ significantly from *U. fasciata* (see the remark in this species). *U. rhacodes* was not observed. More information about this taxon can be found in Stegenga *et al.* (1997).

Ulva capensis Areschoug
(Figs. 206-207)

Ulva capensis Areschoug (1851), p. 15.

Selected specimens: Möwe Bay, 25-02-1986, BCF-A 11715; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11839; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11840; Rocky Point, 24-02-1986, BCF-A 11716.

References: Areschoug (1851), Simons (1976), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliaceous of papery texture, rigid, orbicular or elliptic in shape, up to 20 cm long and 3-9 cm broad, often divided into more or less narrow segments, attached to the substratum by a basal disc; blade surface smooth, often perforated; margin of the blade and perforations usually dentate or with small spine-like proliferations, sometimes irregularly two-lipped. In surface view, cells commonly of little defined outline, rectangular or squarish, with rounded corners, 6-18 x 4-14 µm, more or less arranged in groups; cells with 1-2(-3) pyrenoids. In cross section, blade 100-181 µm thick, composed of two cell layers; cells of the median part of the blade conical, 42-62 µm high per 6-16 µm of maximum broad, anticlinally arranged, with the narrow tip towards the exterior; plastid parietal, with 1-4 pyrenoids.

Reproduction: Reproductive cells not seen.

Habitat: Usually epiphytic on other algae, like *Caulacanthus ustulatus*, *Corallina sp.* and *Ahnfeltiopsis glomerata*, in the lower eulittoral zone and in tide pools.

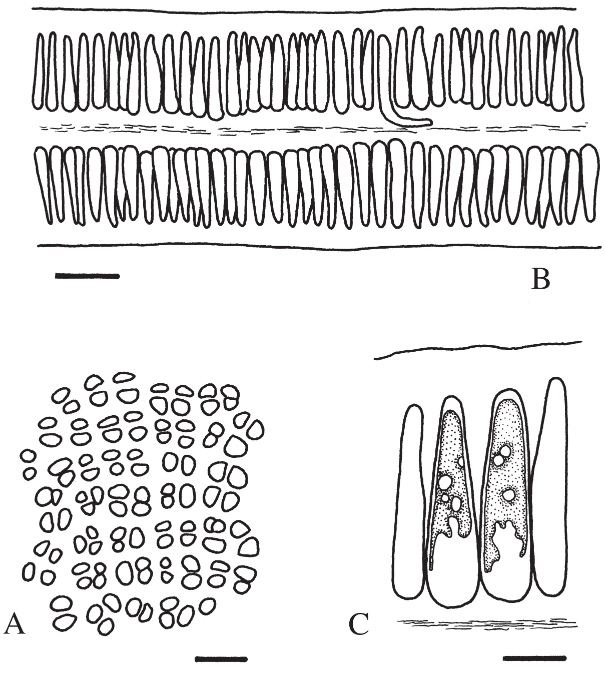

FIG. 206. – *Ulva capensis*. A. Blade cells in surface view. B. Portion of a cross section of the blade. C. Detail of cells in cross section. A, C. Scale bar = 20 µm. B. Scale bar = 50 µm.

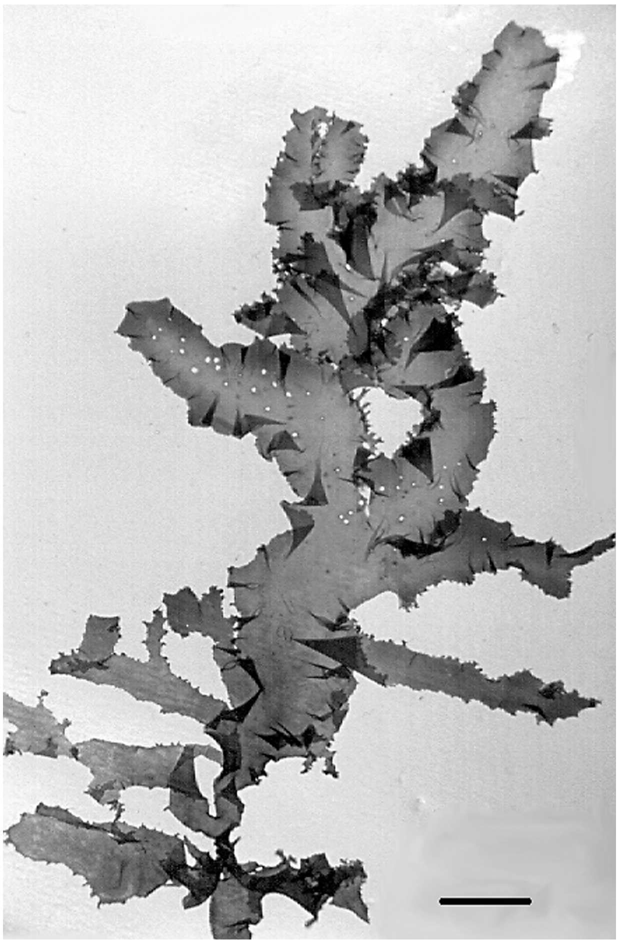

FIG. 207. – *Ulva capensis*. Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11839. Scale bar = 2 cm.

Namibian distribution: Lüderitz, Swakopmund, Möwe Bay (Lawson *et al.*, 1990); Rocky Point (Map 105).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Possibly southern Australia and New Zealad (Stegenga *et al.*, 1997).

Remarks: *Ulva capensis* was described by Areschoug (1851) on the basis of material from the south of South Africa (between Table Bay and Algoa Bay). Some years before, Kützing (1849) described *Phycoseris uncialis* on the basis of some specimens collected by Drège in Table Bay, and later Montagne (1850) transferred it to the genus *Ulva*. In describing *U. capensis*, Areschoug (1851) remarked that the Drège material corresponded to young specimens of this species. Likewise, Papenfuss (1940b) regarded the possibility of that the Drège material could be identical to *U. capensis*, but he stated that the type material of Kützing's species should be studied in order to confirm it. Taking all this into account, and after a nomenclatural analysis of this taxon, Silva *et al.* (1996) pointed out that *U. capensis* must be considered as a illegitimate name, being *U. uncialis* the correct name for this taxon. However, following Joska (1992), Stegenga *et al.* (1997) distinguished *U. capensis* from *U. uncialis*, considering the latter as a synonym of *U. rigida* C. Agardh.

Ulva capensis is morphologically and anatomically very similar to *U. laetevirens* Areschoug, a species occurring in Europe, south California, south Australia and New Zealand (Phillips, 1988). Seemingly, the sole difference between both species lies in the cell size in surface view [8-15 µm in diameter in *U. capensis* according to Stegenga *et al.* (1997), and 10-33 x 6-26 µm in *U. laetevirens* according to Phillips (1988)].

Since *U. capensis* and *U. rigida* (as *U. uncialis*) had been formerly mistaken, its distribution should be taken with caution until a critical revision of the material assigned to these species had not been carried out.

Ulva fasciata Delile
(Figs. 208-209)

Ulva fasciata Delile (1813), p. 297.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11717; 5 km south of Swakopmund, 6-07-1989, BCF-A 11718; Swakopmund, beach, 8-07-1989, BCF-A 11719; Mile 32, 7-07-1989, BCF-A 11837; Mile 108, 13-07-1989, BCF-A 11720; Rocky Point, 24-02-1986, BCF-A 11836; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 11721.

References: Hamel (1931a), Nasr (1940), Anand (1940), Srinivasan (1973), Jaasund (1976), Schnetter (1978), Gallardo (1984), Lawson and John (1987), Phillips (1988), Trono (1997), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant up to 27 cm high, consisting of an elongate blade, occasionally more or less orbicular at base, sessile or shortly stipitate, 0.5-3(-6) cm broad, divided, usually twisted, attached to the substratum by a basal disc; blade surface smooth, with wavy margins and sometimes with some perforation, longitudinally crossed by a pale midrib 0.5-2 mm broad, especially visible in the upper half of the plant; margin of blade and perforations entire or minutely dentate. Cells elongate, ovate or more or less isodiametric in surface view, 9-18 x 6-12 µm, those of the midrib larger, 14-34 x 10-22 µm; cells with (1-)2-5(-6) pyrenoids. In cross section, blade (88-)100-180 µm thick in the midrib and (60-)80-100 µm thick at the marginal zones, composed of two cell layers; cells cylindrical, those

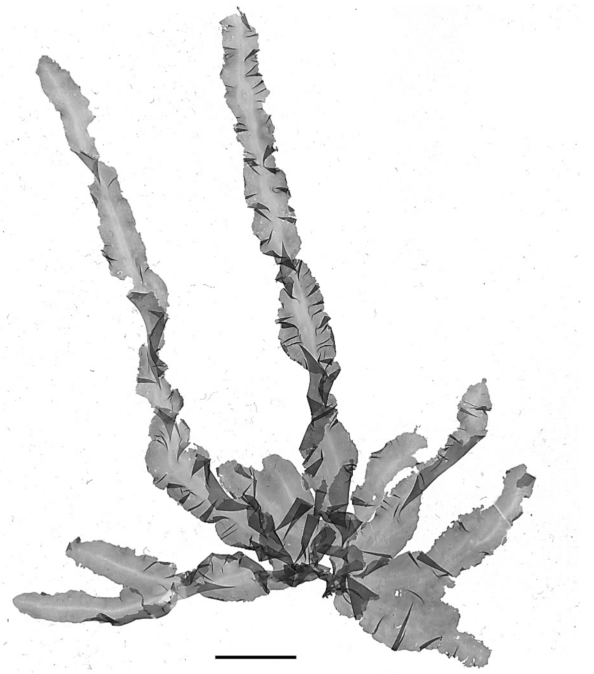

FIG. 208. – *Ulva fasciata*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11718. Scale bar = 2 cm.

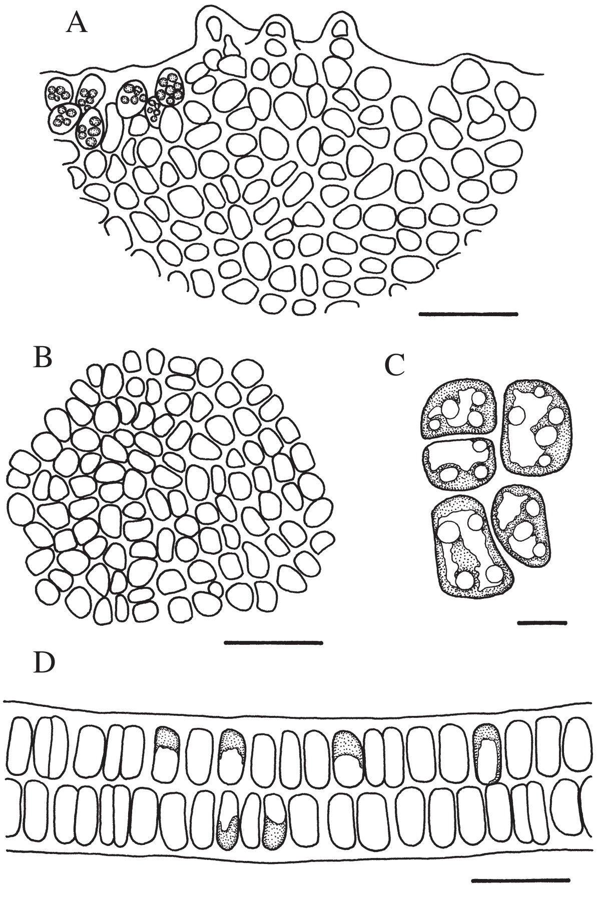

FIG. 209. – *Ulva fasciata*. A. Blade margin in surface view showing some fertile cells. B. Cells of the median part of the blade in surface view. C. Detail of cells in surface view. D. Portion of a cross section of the blade. A-B, D. Scale bar = 50 µm. C. Scale bar = 10 µm.

of the marginal zones 26-42 x 8-22 µm and those of the midrib larger, 32-60 x 12-26 µm; plastid hood shaped, localized in the outer tip of the cells.

Reproduction: Reproductive cells formed into fertile blade cells localized in a discontinuous, narrow marginal band and liberated to the exterior through a pore.

Habitat: In the eulittoral and the upper sublittoral zones, epilithic, growing on mollusca or epiphytic on several algae like *Ahnfeltiopsis vermicularis*, *Chondria capensis*, *Laminaria pallida*, *Rhodymenia obtusa*, *Tayloriella tenebrosa* and *Codium spp.*; occurring also in tide pools and in drift material.

Namibian distribution: Swakopmund (Lawson *et al.*, 1990); Langstrand, Mile 32, Mile 108, Rocky Point, South Kunene (Map 106).

World distribution: Pantropical (Lawson and John, 1987).

Remarks: *Ulva fasciata* was described by Delile (1813) on the basis of material from Alexandria (eastern Mediterranean) and now is considered as a pantropical species (Lawson and John, 1987).

All the references consulted coincide with the fact that *U. fasciata* has a blade divided into narrow ribbons (1-3 cm broad). Moreover, according to some authors, like Hamel (1931a), Anand (1940), Srinivasan (1973), Schnetter (1978) and Stegenga *et al.* (1997), the blade has undulating margins and is longitudinally crossed by a midrib, with the central portion of the blade thicker (70-150 µm) than the margins (50-95 µm). In contrast, other authors (Nasr, 1940; Jaasund, 1976; Gallardo, 1984; Lawson and John, 1987; Phillips, 1988; Trono, 1997) do not mention this last feature, and sometimes, the undulating margins are not showed in the illustrations either.

Regarding the plant habit, *U. fasciata* is very similar to *U. costata* (Howe) Hollenberg, *U. taeniata* (Setchell) Setchell and Gardner and *U. nematoidea* Bory de Saint Vincent. Levring (1941) treated the Californian species *U. costata* (as *U. fasciata* var. *costata* Howe) as a synonym of *U. nematoidea*, and Wynne (1986), who cited *U. nematoidea* from Swakopmund, suggested the possibility that *U. taeniata*, another taxon from California, also was a synonym of this species. However, Abbott and Hollenberg (1976) cited *U. costata* and *U. taeniata* but they do not make any reference to *U. nematoidea*. Also in this way, Silva *et al.* (1996) cited *U. taeniata* from the Indian ocean without mention of *U. nematoidea*. Likewise, Santelices (1989) remarked that *U. costata* has also been recorded in the Chilean coasts as *U. nematoidea*.

According to the available literature, *U. nematoidea*, *U. costata* and *U. taeniata* are morphologically and anatomically very similar. The two former species show a differentiated midrib, whereas in *U. taeniata* this structure seems to be lacking, although in this species the blade is thicker in the central part than in the margins. According to this, and following Wynne (1986) and Levring (1941), we hold that *U. nematoidea*, *U. costata* and *U. taeniata* could be conspecific.

In general, our material is compatible with the Stegenga *et al.* (1997) description of *U. fasciata* and with both the photograph and description of *U. nematoidea* showed by Wynne (1986). It is surprising that this author, who cited *U. nematoidea* from Africa for the first time, did not make any reference to *U. fasciata*, especially when the latter occurs in Angola (Lawson and Price, 1969; Lawson *et al.*, 1975) and South Africa (Seagrief, 1984).

Although it is probable that our specimens represent the same taxon as those of Wynne (1986), we have preferred to assign them tentatively to *U. fasciata*, since this species has been previously recorded in Namibia (Lawson *et al.*, 1990) and it is widespread in tropical regions. However, we think that a thorough revision of these morphologically similar species is required in order to clarify its taxonomy.

Ulva rigida C. Agardh
(Figs. 210-211)

Ulva rigida C. Agardh (1823), p. 410.
Ulva uncialis (Kützing) Montagne (1850), p. 248.

Lectotype: LD (Agardh Herbarium no. 14294); Cadiz, Spain.

Selected specimens: Walvis Bay, Lagoon, 9-07-1989, BCF-A 12111; Langstrand, 6-07-1989, BCF-A 11723; 5 km south of Swakopmund, 6-07-1989, BCF-A 11724; Swakopmund, beach, 8-07-1989, BCF-A 11725.

References: Levring (1938), Baardseth (1941), Abbott and Hollenberg (1976), Kapraun (1984), Lawson and John (1987), Santelices (1989), Adams (1994), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant foliose, elongate or more or less orbicular, up to 20 cm high and up to 16(-25) cm broad, usually dissected into elongate, irregular segments 3-10 cm broad; attachment by a basal disc; blade surface smooth, with numerous perforations irregular in shape and variable in size; the perforations possibly causing the split of the blade; margin of the blade and perforations irregular, eroded, exceptionally minutely dentate in some places. In surface view, cells polygonal with the corners more or less rounded, elongate, triangular or almost isodiametric, 6-20 x 4-14 µm, with

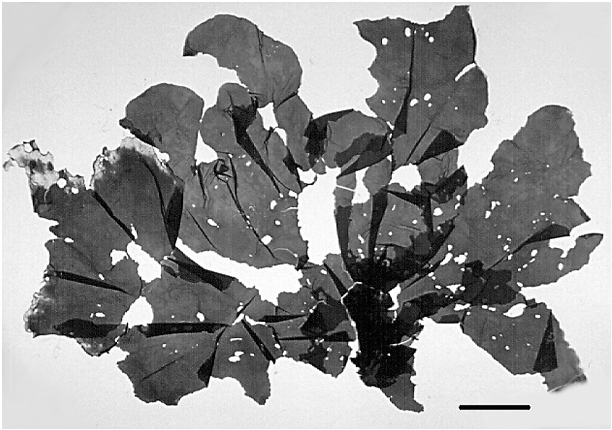

FIG. 210. – *Ulva rigida*. 5 km south of Swakopmund, 6-07-1989, BCF-A 11724. Scale bar = 3 cm.

1-2(-4) pyrenoids. In cross section, blade 52-100 µm thick, composed of two cell layers; cells cylindrical, 1.3-4.3 times higher than broad, 20-34 x 8-18 µm, anticlinally arranged; plastid hood shaped, with 2-3 pyrenoids.

Reproduction: Reproductive cells formed into marginal fertile blade cells and liberated to the exterior through a pore 4 µm in diameter, causing a discontinuous, irregular, translucent marginal band in the blade.

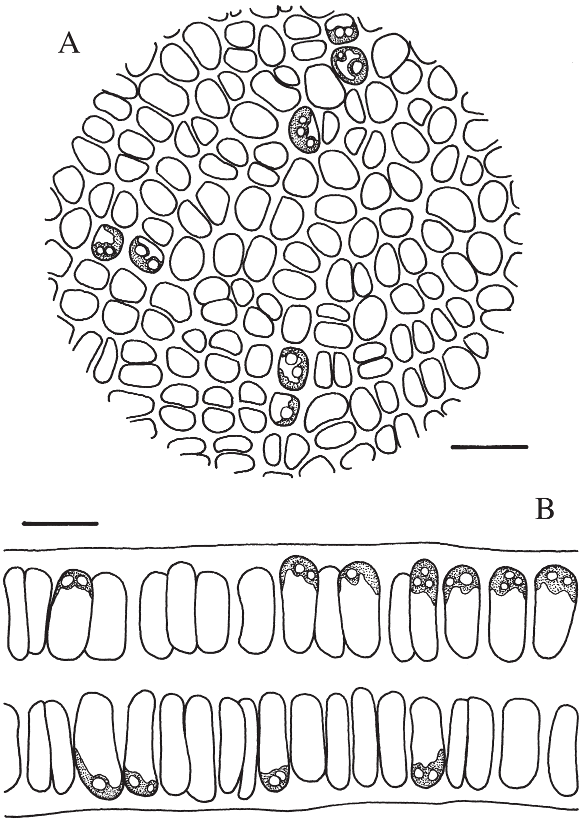

FIG. 211. – *Ulva rigida*. A. Blade cells in surface view. B. Portion of a cross section of the blade; plastid and pyrenoids only apparent in some cells. Scale bar = 25 µm.

Habitat: In the eulittoral and the upper sublittoral zones, epilithic, growing on mollusca or epiphytic on other algae like *Rhodymenia capensis*, *Chondria capensis* and *Laminaria pallida* (haptera); occurring also in tide pools and in drift material.

Namibian distribution: Lüderitz, Möwe Bay (Lawson *et al.*, 1990); Walvis Bay, Langstrand, Swakopmund (Map 107).

World distribution: Cosmopolitan in temperate and tropical seas (Huisman and Walker, 1990).

Remarks: *Ulva rigida* was described by C. Agardh (1823) on the basis of material from Cádiz (south Iberian peninsula). Subsequently, J. Agardh (1883) modified the original description by adding that, in cross section, the cells of the lower part of the blade are rectangular and 2-3 times longer than broad, this being one of the main distinctive traits of this species. Later, Bliding (1968) made a detailed description of *U. rigida* pointing out that one of the more typical features of this species is the fact that, in cross section, the cells of the upper part of the blade are more or less isodiametric, whereas those of the lower part are very high and tapering at the top. More recently, Phillips (1988) remarked that the material described by Bliding (1968) as *U. rigida* did not agree with the type material of this species, since in the latter the cells were not conical, but rectangular in cross section, as had been previously stated by J. Agardh (1883) and Papenfuss (1960). In this way, Phillips (1988) pointed out that the Bliding (1968) material of *U. rigida* was compatible with the type material of *U. laetevirens* Areschoug, and therefore, must be considered as representative of this species. According to Phillips (1988), the main feature which distinguished *U. rigida* from *U. laetevirens* is the shape of the cells in lower part of the blade in cross section: in *U. rigida* these cells are rectangular and palisade like, whereas in *U. laetevirens* they are conical. However, according to the literature consulted, the criterion of Phillips (1988) has not been followed, at least in Europe, since most of the subsequent papers refer to *U. rigida* in the sense of Bliding (1968), instead of to *U. laetevirens* (Ballesteros, 1990; Burrows, 1991; Gallardo *et al.*, 1993; Rindi and Cinelli, 1995; Aysel and Erdugan, 1995; Guiry, 1997). Among the few authors following Phillips (1988), it is important to point out Cormaci *et al.* (1997) who stated that the *U. rigida* citations of Malta must refer to *U. laetevirens*.

Our material agrees quite well with the descriptions of Phillips (1988) and Stegenga *et al.* (1997) of *U. rigida*, the reason for which we have assigned our specimens to this species. However, it is important to point out that the specimens from the Lagoon of Walvis Bay have relatively thinner blades (52 µm thick) and shorter cells in cross section (1.3-2.4 times longer than broad), features more typical of *Ulva lactuca* Linnaeus. In contrast, the number of pyrenoids (2-4) are more characteristic of *U. rigida*.

Class CLADOPHOROPHYCEAE
Order CLADOPHORALES Haeckel (1894)
Family CLADOPHORACEAE Wille in Warming (1884)
Genus *Chaetomorpha* Kützing (1845) *nom. cons.*

Key to species of *Chaetomorpha*:

1. Filaments less than 1 mm in diameter in the upper part; basal cell up to 2 mm long..*C. aerea*
1. Filaments 1-1.8 mm in diameter in the upper part; basal cell 5-12 mm long............*C. robusta*

In addition to the species referred to in this key, *C. linum* (O. F. Müller) Kützing was also recorded from Namibia. In our opinion this taxon should be excluded from the Namibian flora. See the 77 note of the check list (page 30).

Chaetomorpha aerea (Dillwyn) Kützing
(Fig. 212)

Conferva aerea Dillwyn (1806), pl. 80.
Chaetomorpha aerea (Dillwyn) Kützing (1849), p. 379.

Type: BM (ex K), Cromer, England.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11734; 5 km south of Swakopmund, 6-07-1989, BCF-A 11735; Swakopmund, beach, 8-07-1989, BCF-A 11736; Mile 108, 13-07-1989, BCF-A 11737; Rocky Point, 24-02-1986, BCF-A 12061.

References: Setchell and Gardner (1920), Taylor (1957, 1960), Dawson *et al.* (1964), Simons (1976), Islam (1976), Humm (1979), Womersley (1984), Noda (1987), Adams (1994), Coppejans (1995), Stegenga *et al.* (1997).

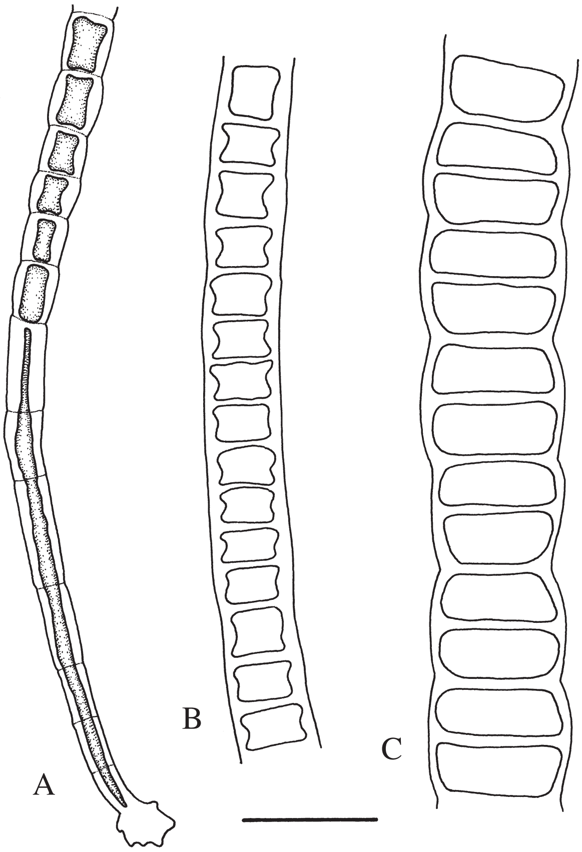

FIG. 212. – *Chaetomorpha aerea*. Basal (A), median (B) and upper (C) parts of a filament. Scale bar = 500 µm.

Habit and vegetative structure: Plant forming tufts up to 21 cm high, consisting of several unbranched filaments basally joined in a caespitose discoidal base; filaments uniseriate, (80-)120-240 µm in diameter at base, gradually increasing up to 280-680 µm in the upper part; occasionally, filaments entangled and twisted forming a sort of rope. Basal cell (340-)700-1840 x (100-)120-240 µm, resulting from the fusion of 3-7 cells; suprabasal cells cylindric, 0.8-2.1 times longer than broad, 140-460 x 160-240 µm; cells of the upper half of filaments cylindric or somewhat barrel shaped, 0.2-1.1 times longer than broad, (80-)100-340 x (140-)180-600 µm. Cell wall 20-80 µm thick.

Reproduction: Reproductive structures not seen.

Habitat: In tide pools, epilithic or less frequently epiphyte on *Corallina sp*. Also growing among the *Laminaria pallida* haptera in the upper sublittoral zone.

Namibian distribution: Swakopmund (Wynne, 1986); Langstrand, Mile 108, Rocky Point (Map 108).

World distribution: Cosmopolitan (Womersley, 1984; Huisman and Walker, 1990).

Remarks: Several authors, for example Abbott and Hollenberg (1976), Kapraun (1984), Lawson and John (1987), Santelices (1989), Burrows (1991) and Lawson *et al.* (1990), among others, have treated *Chaetomorpha aerea* as a synonym of *C. linum* (O. F. Müller) Kützing. Others, on the contrary, have preferred to maintain both species as different entities (Taylor, 1960; Valet, 1961; Dawson *et al.*, 1964; Womersley, 1984; Wynne, 1986; South and Tittley, 1986; Gallardo *et al.*, 1993; Adams, 1994; Silva *et* *al.*, 1996; Stegenga *et al.*, 1997; etc.). The main difference between both taxa lies in the fact that *C. linum* is a free living species, whereas *C. aerea* grows attached to the substratum by means of a basal disc. Burrows (1991) commented on the different reasons for considering both taxa conspecific, and decided to treat *C. aerea* as a synonym of *C. linum*. In the present work, in contrast, we prefer to follow Silva *et al.* (1996), who considered both taxa as different species as it is suggested by Kornmann (1972) and Blair (1983).

Although *Chaetomorpha aerea* is a cosmopolitan species (Huisman and Walker, 1990), in Namibia it has been recorded only from Swakopmund until now (Lawson *et al.*, 1990). The global distribution of this species is difficult to specify because it is often treated as a synonym of *C. linum*.

Chaetomorpha robusta (Areschoug) Papenfuss (Fig. 213)

Lychaete robusta Areschoug (1851), p. 8.
Chaetomorpha robusta (Areschoug) Papenfuss (1940a), p. 200.
Chaetomorpha clavata Kützing (1849), p. 380, *pro parte* [non *Conferva clavata* C. Agardh (1824), p. 99].

Selected specimens: Möwe Bay, 25-02-1986, BCF-A 12062; *ibid.*, 5-02-1988, BCF-A 11849; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11850.

References: Papenfuss (1940a), Simons (1969, 1976), Branch and Branch (1981), Stegenga *et al.* (1997).

Habit and vegetative structure: plant forming dark green tufts up to 66 cm high composed of several unbranched filaments basally joined in the same discoidal base. Filaments uniseriate, 340-600 µm in diameter at the base, gradually increasing up to 1000-1800 µm in diameter in the upper part. Basal cell more or less club shaped, very long, 5-12 mm in length and 540-800 µm in diameter in the upper tip; cells cylindrical or somewhat barrel shaped, those of the median part of filaments 1-2.8 times longer than broad, 1-2.2 x 0.8-1 mm, and those of the upper part 1-1.7 times longer than broad, 1.2-2.6 x 1.2-1.6 mm.

Reproduction: Reproductive structures not seen.

Habitat: Epilithic or growing on mollusc shells, in the lower eulittoral and the upper sublittoral zones; also in tide pools.

Namibian distribution: Swakopmund, Torra Bay, Terrace Bay, Möwe Bay, Rocky Point (Lawson *et al.*, 1990) (Map 109).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997).

Remarks: *Chaetomorpha robusta* was initially described as *Lychaete robusta* by Areschoug (1851) on the basis of material from the Cape of Good Hope, and its present distribution includes the Atlantic coasts of South Africa and Namibia.

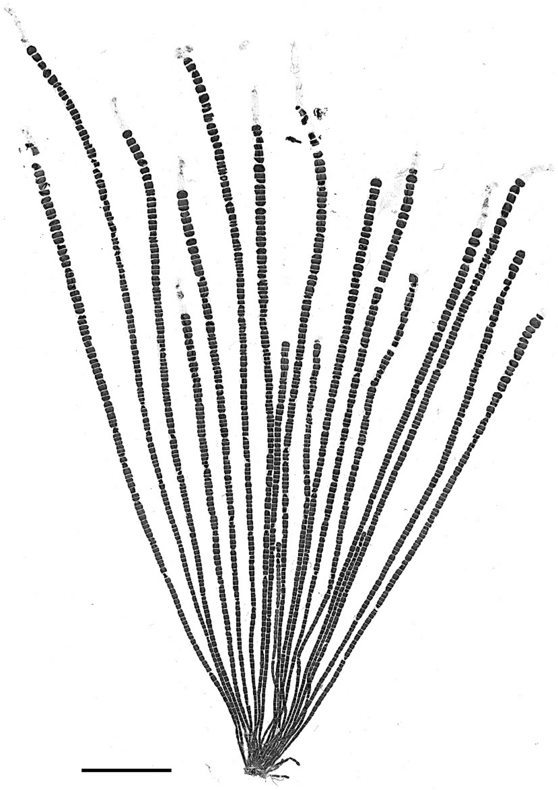

FIG. 213. – *Chaetomorpha robusta*. Möwe Bay, 5-02-1988, BCF-A 11849. Scale bar = 2 cm.

Chaetomorpha robusta had been formerly mistaken for *C. clavata* Kützing, a taxon of probably pantropical distribution (Lawson and John, 1987), but Papenfuss (1940a) studied the type material of this species and he concluded that both taxa are different, restoring the name *robusta* with which the species was initially described. According to Papenfuss (1940a) *C. robusta* can reach up to more than 20 cm high and it consists of filaments 1-1.5 mm in diameter, whereas *C. clavata* is a smaller species composed of thinner filaments (the type measures about 2 cm in length and its filaments about 700 µm in diameter). In contrast, according to Taylor (1960) and Lawson and John (1987), *C. clavata* can reach up to 30-60 cm high and consists of filaments about 1.5 mm in diameter at the distal parts. It seems, therefore, that the confusion continues. In this way, Lawson and Price (1969) pointed out that the differences between both species, but also with *C. antennina* (Bory de Saint-Vincent) Kützing, should be clarified.

Genus *Cladophora* Kützing (1843) *nom. cons.*

Key to species of *Cladophora*:

1. Plant consisting of free filaments basally joined in a more or less compact base; rhizoids, if present, localized in the basal part of filaments..2
1. Plant forming dense masses of entangled, branched filaments bearing numerous rhizoids along them......................................*C. contexta**

2. Filaments 400-500 µm in diameter; cells 3-7 mm in length ....*C. hospita*
2. Filaments narrower and cells less than 3 mm in length 3

3. Attachment by a more or less spongy rhizoidal disc; branching dichotomous, sparse or irregular; swollen cells of granulose contents often present ....*C. capensis*
3. Attachment by a compact disc; branching commonly whorled; swollen cells absent ....*C. flagelliformis*

* *C. contexta* was not observed. More information about this taxon can be found in Stegenga *et al.* (1997).

Cladophora capensis (C. Agardh) De Toni
(Figs. 214-215)

Conferva capensis C. Agardh (1824), p. 118.
Cladophora capensis (C. Agardh) De Toni (1889), p. 354.
Cladophora ecklonii Kützing (1849), p. 395.

Selected specimens: Langstrand, 6-07-1989, BCF-A 11738; 5 km south of Swakopmund, 6-07-1989, BCF-A 11739; Swakopmund, beach, 8-07-1989, BCF-A 11740; Mile 32, 7-07-1989, BCF-A 11848; Möwe Bay, 4-02-1988, BCF-A 11847; Rocky Point, 24-02-1986, BCF-A 11748; Cape Frio, 23-02-1986, BCF-A 11747.

References: Levring (1938), Papenfuss (1940b), Simons (1960b, 1969, 1976), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant forming tufts 2-14 cm high, consisting of several erect filaments attached to the substratum by a more or less spongy rhizoidal disc; filaments uniseriate, branched, 80-240 µm in diameter, often merged at base. Branching dichotomous, sparse or irregular; branches usually merged at base with the main axis, especially in the lower half of the plant, where they seems to arise from any level of the axial cell; apical zone of branches often truncate; young branches paler than the others, arising from the apical zone of the cells; downwards rhizoids occurring exception-

FIG. 214. – *Cladophora capensis*. Langstrand, 6-07-1989, BCF-A 11738. Scale bar = 1 cm.

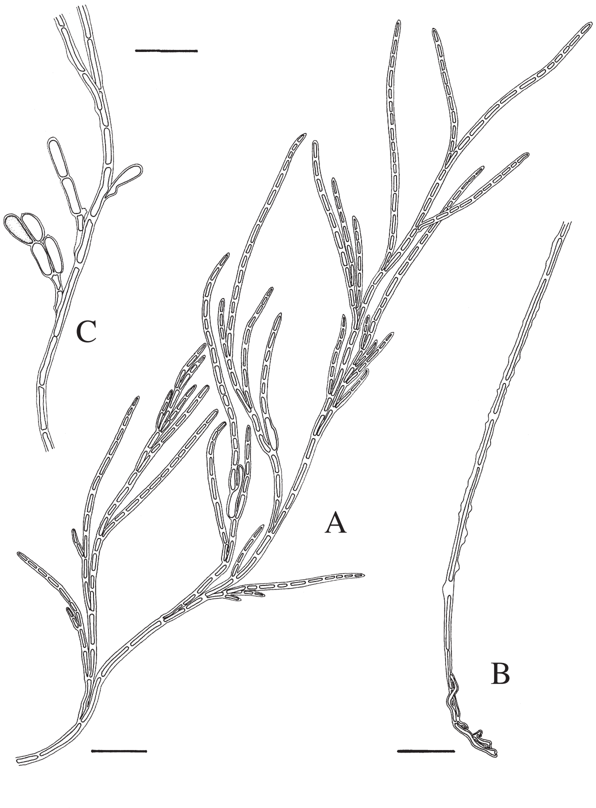

FIG. 215. – *Cladophora capensis*. A. Upper half of a filament. B. Basal part of a filament. C. Portion of a filament showing a group of swollen cells. Scale bar = 1 mm.

ally at base of the plant. Basal cell of axes more or less long, often difficult to distinguish; cells cylindrical, those of the lower half of axes 2.2-13.6(-19) times longer than broad, 395-1900 x 79-200 µm, and those of the upper half 1.2-9.5 times longer than broad, 200-1060 x 71-220 µm; apical cell conical, (142-)200-460 x 50-120 µm, often curved at apex; swollen cells of granulose contents, 220-1260 x 140-340 µm, commonly present, occurring singly or in simple or branched series, intercalary, apical or lateral; apical swollen cells often mucronate. Cell wall 16-60 µm thick.

Reproduction: Reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral zone, growing together with *Chaetomorpha spp*., *Chordariopsis capensis*, *Nothogenia erinacea* and *Streblocladia camptoclada*; also growing in tide pools.

Namibian distribution: Elizabeth Bay, Halifax Bay, Diaz Point, Lüderitz, Swakopmund, Torra Bay, Terrace Bay, Möwe Bay, Rocky Point (Lawson *et al.*, 1990); Langstrand, Mile 32, Cape Frio (Map 110).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

Remarks: *Cladophora capensis* was initially described by C. Agardh (1824), as *Conferva capensis*, on the basis of material from the Cape of Good Hope, and its present distribution is limited to the coasts of South Africa and Namibia.

The presence of swollen cells of granulose contents, although not always constant as was pointed out by Simons (1960b), easily identifies this species.

Cladophora flagelliformis (Suhr) Kützing (Figs. 216-217)

Conferva flagelliformis Suhr (1840), p. 294.
Cladophora flagelliformis (Suhr) Kützing (1849), p. 388.
Lychaete flagelliformis (Suhr) Areschoug (1851), p. 9.
Conferva virgata C. Agardh (1824), p. 119, *nom. illeg.*
Cladophora virgata Kützing (1843), p. 271.

Selected specimens: 5 km south of Swakopmund, 7-07-1989, BCF-A 11741; Swakopmund, beach, 8-07-1989, BCF-A 11742; Mile 30, 7-07-1989, BCF-A 11743; Mile 32, 7-07-1989, BCF-A 11744; Mile 108, 13-07-1989, BCF-A 11745.

References: Levring (1938), Baardseth (1941), Simons (1960b, 1969, 1976), Branch and Branch (1981), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, 1.5-8(-18) cm high, consisting of several branched, uniseriate filaments 140-280 µm in diameter basally joined in a compact and caespitose discoidal base. Branching usually whorled (up to 5-6 branches per whorl) or opposite, occasionally sparse; whorls with short and long branches arising from the apical pole of axial cells; short branches more or less divaricate, given a thorny aspect to the plant; long branches 120-160 µm in diameter at base, increasing gradually upwards up to 160-360 µm, simple or only branched in the lower third, truncate at apex, with the upper cells often devoid of cell contents and the basal cell more or less merged with the axial one. Cells of main filaments cylindrical, those of the basal part 1.9-6.3 times longer than broad, 300-1200 x 140-200 µm, and those of the upper part 0.9-5 times longer than broad, 240-700 x 140-260 µm; cells of the long branches cylindrical, some slightly barrel shaped, the lower ones 1.3-3.6 times longer than broad, 220-520 x 140-180 µm, and the upper ones 0.8-2 times longer than broad, 180-480 x 160-300 µm; apical cell mucronate or rounded at apex.

FIG. 216. – *Cladophora flagelliformis*. 5 km south of Swakopmund, 7-07-1989, BCF-A 11741. Scale bar = 1 cm.

Reproduction: Reproductive structures not seen.

Habitat: Epilithic or epiphytic on several algae, like *Rhodymenia obtusa* and *Plocamium rigidum*, in the lower eulittoral and the upper sublittoral zones, growing together with *Acrosorium cincinnatum*, *Gymnogongrus* sp., *Chaetomorpha aerea*, *Gracilariopsis longissima*, etc. Occurring also on vertical walls of tide pools and in drift material.

Namibian distribution: Elizabeth Bay, Lüderitz, Swakopmund, Torra Bay (Lawson *et al.*, 1990); Mile 30, Mile 32, Mile 108 (Map 111).

World distribution: Atlantic Ocean: Tristan da Cunha (Baardseth, 1941); South Africa, Namibia

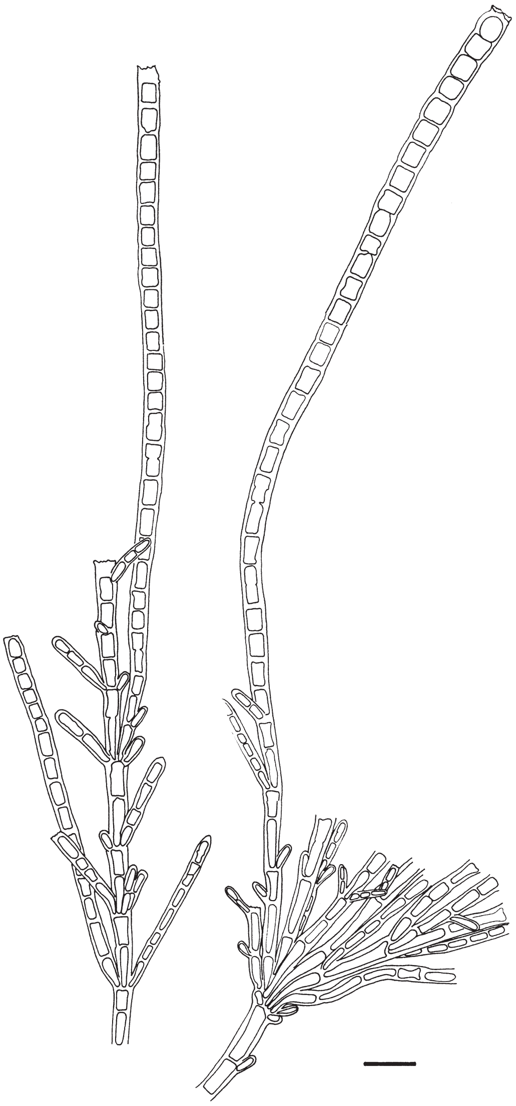

FIG. 217. – *Cladophora flagelliformis*. Detail of filaments. Scale bar = 500 µm.

(Stegenga *et al.*, 1997). Indian Ocean: South Africa, Tanzania (Silva *et al.*, 1996).

Remarks: Silva *et al.* (1996) remarked that *Conferva virgata* C. Agardh is a later homonym of *C. virgata* Roth (1797), and pointed out the possibility that the latter name refers to *Cladophora rupestris* (Linnaeus) Kützing. For this reason, Silva *et al.* (1996) considered *Conferva virgata* C. Agardh as an illegitimate name and treated *Cladophora virgata* Kützing as a new name.

Cladophora hospita (Mertens ex Chamisso) Kützing (Figs. 66 and 218)

Conferva hospita Mertens ex Chamisso (1821), p. 178.
Cladophora hospita (Mertens ex Chamisso) Kützing (1843), p. 271.
Lychaete hospita (Mertens ex Chamisso) Areschoug (1851), p. 11.
Conferva mirabilis C. Agardh (1820), pl. IX., *nom illeg.* (see remark).
Cladophora mirabilis (C. Agardh) Rabenhorst in Hohenacker (1852), n. 53.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 11842; Möwe Bay, 4-02-1988, BCF-A 11846; Möwe Bay, Cala Poste, 7-02-1988, BCF-A 11845; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 11844; Rocky Point, 24-02-1986, BCF-A 11843.

References: Papenfuss (1940b), Simons (1969, 1976), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, dark green in colour, reaching up to 25 cm high, consisting of stiff, branched, uniseriate filaments 400-480 µm in diameter in its median part, attached to the substratum by means of rhizoids. Branching dichotomous, trichotomous, alternate or sparse. Cells cylindrical, usually very long, 3-7 mm in length, and often slightly swollen at transversal cross walls; basal cell up to 2 cm long; apical cell cylindrical with rounded apex, 1.5-4 mm long per 200-360 µm in diameter.

Reproduction: Reproductive structures not seen.

Habitat: Epilithic in the lower eulittoral zone,

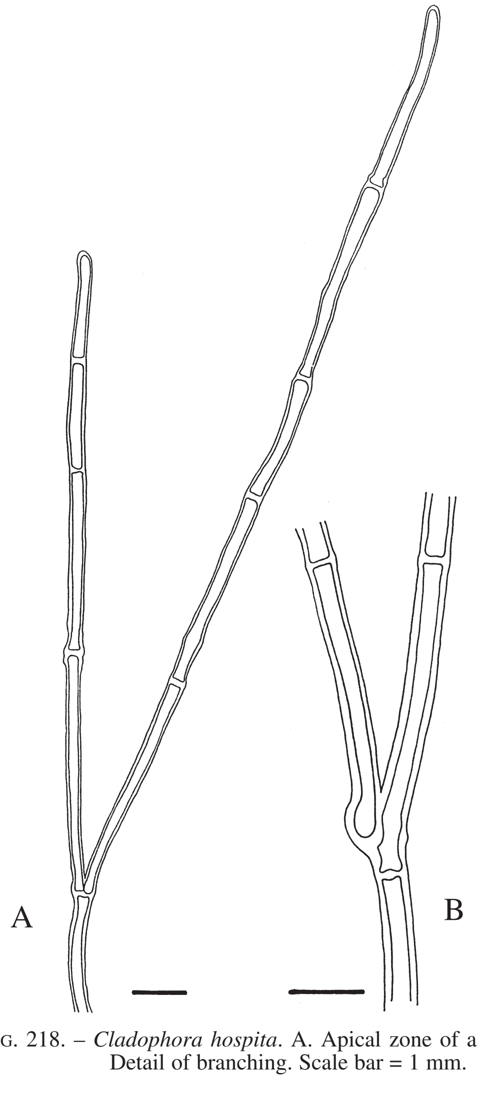

FIG. 218. – *Cladophora hospita*. A. Apical zone of a filament. B. Detail of branching. Scale bar = 1 mm.

together with *Nothogenia erinacea*; growing on mollusca and among the *Laminaria pallida* haptera, in the upper sublittoral zone; occurring also in the vertical walls of tide pools and in drift material, together with *Cladophora flagelliformis*. Specimens of *Cladophora hospita* often carry *Heringia mirabilis* as an epiphyte.

Namibian distribution: Lüderitz, Swakopmund, Torra Bay, Terrace Bay, Rocky Point, Cape Frio, Kunene River (Lawson *et al.*, 1990); Möwe Bay (Map 112).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997); Angola (Lawson and Price, 1969). Indian Ocean: St. Paul Island, South Africa (Silva *et al.*, 1996).

Remarks: *Cladophora hospita* was initially described by Chamisso (1821), as *Conferva hospita*, on the basis of material from the Cape of Good Hope and later, Kützing (1843) transferred the species to the genus *Cladophora*. Subsequently, Papenfuss (1940b) pointed out that the correct name for this taxon must be *Cladophora mirabilis* (C. Agardh) Rabenhorst, since it had been previously described by C. Agardh (1820) as *Conferva mirabilis*. Thus, *Cladophora mirabilis* was the name with which this species was known since the work of Papenfuss (1940b). More recently, however, Silva *et al.* (1996) stated that *Conferva mirabilis* C. Agardh is an illegitimate name because it had been previously used by Dillwyn (1808) to describe a blue-green algae, and therefore they restored the name *Cladophora hospita* [for more detailed information see the remarks of Papenfus (1940b: 5-6) and Silva *et al.* (1996: 775 and 910-911)].

Class BRYOPSIDOPHYCEAE
Order BRYOPSIDALES Schaffner (1922)
Family BRYOPSIDACEAE Bory de Saint Vincent (1829)
Genus *Bryopsis* Lamouroux (1809)

Key to species of *Bryopsis*:

1. Branches of limited growth regularly distichously arranged......................................*B. plumosa**
1. Branches of limited growth radially arranged, sometimes more or less distichous in the apical part of axes ....*B. hypnoides*

* In addition to the species referred to in this key, *B. cespitosa* Suhr ex Kützing and *B. tenuis* Levring were also recorded from Namibia. The scarcity of information that we have about these taxa do not permit us to include them in the key. We can only comment that Stegenga *et al.* (1997) included *B. tenuis* in *B. africana* Areschoug pointing out that this latter species is possibly synonymous with *B. cespitosa*. According to these authors, *B. africana* differs from *B. plumosa* and *B. hypnoides* by the branching type. In this way, *B. africana* consists of simple or only once branched axes bearing simple ramuli of various lengths irregularly arranged, often in intermittent series and sometimes secund. However, the other two species are composed of axes up to 3-4 times branched, with the branches bearing branchlets of limited growth pinnately arranged (*B. plumosa*) or radial (*B. hypnoides*). *B. plumosa* was not observed. More information about this taxon can be found in Burrows (1991), Stegenga *et al.* (1997) and in the remarks of *B. hypnoides*.

Bryopsis hypnoides Lamouroux
(Figs. 219-220)

Bryopsis hypnoides Lamouroux (1809), p. 333.

Selected specimens: Langstrand, 6-07-1989, BCF-A 12067; 5 km south of Swakopmund, 7-07-1989, BCF-A 12064; Swakopmund, beach, 8-07-1989, BCF-A 12065; Terrace Bay, February 1986, BCF-A 12066; Möwe Bay, Suider Kust, 6-02-1988, BCF-A 12063.

References: Setchell and Gardner (1920), Hamel (1931a), Feldmann (1937), Gayral (1966), Abbott and Hollenberg (1976), Jaasund (1976), Schnetter (1978), Humm (1979), Kapraun (1984), Noda (1987), Burrows (1991), Nizamuddin (1991), Coppejans (1995), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant forming dark green tufts 3-8.5 cm high, consisting of terete, branched, coenocytic filaments, 260-600 µm in diameter, basally joined in a caespitose rhizoidal base. Filaments up to 3(-4) times sparsely or irregularly branched, often joined by means of rhizoids, forming rope-like structures; basal zone of branches with numerous rhizoids surrounding the axes. Upper third of branches bearing branchlets of limited growth usually radially arranged, the lower ones often longer than the upper, adopting as a whole a more or less conical aspect; sometimes, upper branchlets of limited growth more or less opposite and almost distichously arranged; branchlets of limited growth cylindrical, rounded at apex and constricted at base, 100-240 µm in diameter, the lower ones up to 6 mm in length and some with rhizoidal proliferations at base; scars of limited growth branchlets visible in the lower half of axes bearing them. Plastids circular, elliptic or spindle shaped, 9-28 x (4-)6-11 µm, with 1-3 pyrenoids clearly visible.

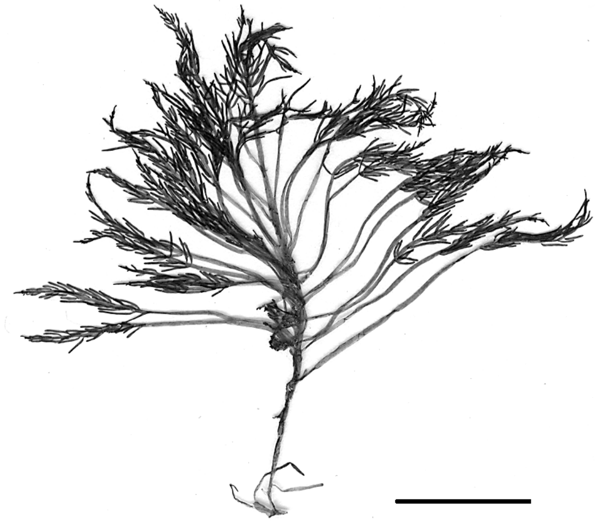

FIG. 219. – *Bryopsis hypnoides*. 5 km south of Swakopmund, 7-07-1989, BCF-A 12064. Scale bar = 1 cm.

Reproduction: Reproductive structures not seen.

Habitat: Epilithic or epiphyte on *Codium decorticatum*, in the lower eulittoral zone and in tide pools; occurring also in drift material.

Namibian distribution: Langstrand, Swakopmund, Terrace Bay, Möwe Bay (Map 113).

World distribution: Atlantic Ocean: Uruguay (Coll and Oliveira, 1999); Caribean Sea, Gulf of Mexico, Bermuda (Burrows, 1991; Wynne, 1998); North America (South and Tittley, 1986); South Africa (Stegenga *et al.*, 1997); Namibia; ?Sierra Leone (Aleem, 1978); Canary Islands (Gil-Rodríguez and Afonso-Carrillo, 1980); Portugal to Norway, British Isles (South and Tittley, 1986). Mediterranean Sea (Gallardo *et al.*, 1993). Indian Ocean: Madagascar, Mauritius, Tanzania, Kenya, Kuwait, Iran, Pakistan, Sri Lanka, India, Laccadive Islands (Silva *et al.*, 1996). Red Sea (Papenfuss, 1968b). Pacific Ocean: Korea (Kang, 1966); Japan (Noda, 1987); Panama to British Columbia (Abbott and Hollenberg, 1976).

Remarks: *Bryopsis hypnoides* was described by Lamouroux (1809) on the basis of material from a site nearby to Sète, in the French Mediterranean coast, and its present distribution includes tropical and temperate regions.

Aleem (1978) cited *B. hypnoides* from west African tropical coasts (Sierra Leone) for the first time, but Lawson and John (1987) pointed out that the record must be verified and they considered it doubtful.

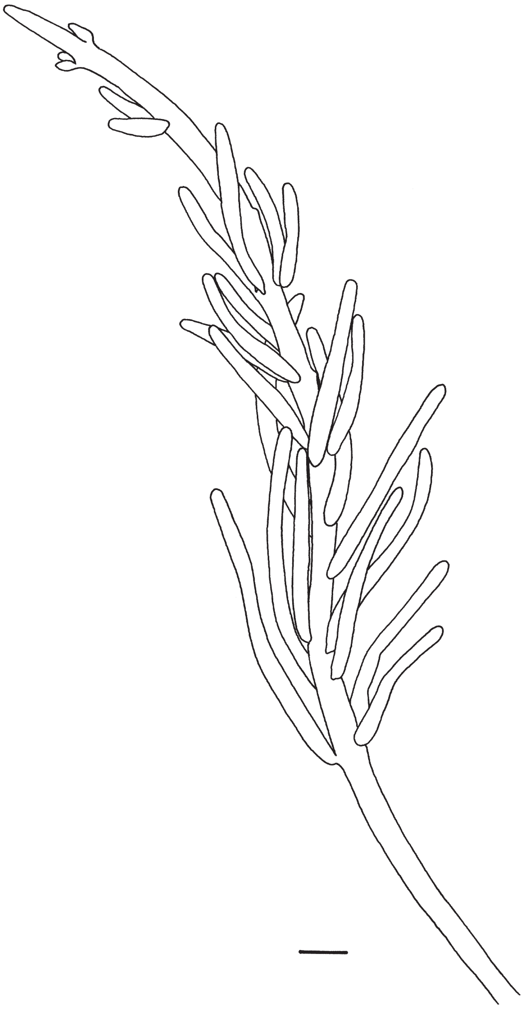

FIG. 220. – *Bryopsis hypnoides*. Upper part of an axis with branches of limited growth. Scale bar = 1 mm.

Our specimens agree quite well with the *B. hypnoides* descriptions consulted, although the arrangement of the branchlets of limited growth is practically distichous in the upper part of some specimens. In this way, these specimens show certain similarity with *Bryopsis plumosa* (Hudson) C. Agardh. This taxon, unlike *B. hypnoides*, had been already recorded from Namibia (Lawson *et al.*, 1990). The main difference between both species lies in the arrangement of branches, which is radial in *B. hypnoides* and irregularly distichous in *B. plumosa* (Hamel, 1931a; Kapraun and Shipley, 1990; Burrows, 1991). Moreover, according to Rietema (1975) the former species is monoecious whereas the latter is dioecious. However, Burrows (1991) remarked that the arrangement of branches in *B. hypnoides* is very variable and that it may at times appear almost distichous, a fact which has been also pointed out by Stegenga *et al.* (1997). In addition to this, according to Rietema (1975) and Shevlin (1982) both species would be interfertile, and therefore, they might be conspecific. Likewise, caryological studies on North Californian material of these species corroborate this fact (Kapraun and Shipley, 1990). According to this, and as far as the priority is concerned, the correct name for this species should be *B. plumosa* and its distribution quite wider. It is important to point out, however, that most works subsequent to that of Kapraun and Shipley (1990) still distinguish between *B. plumosa* and *B. hypnoides* (Burrows, 1991; Nizamuddin, 1991; Gallardo *et al.*, 1993; Coppejans, 1995; Silva *et al.*, 1996; Stegenga *et al.*, 1997; Wynne, 1998; Coll and Oliveira, 1999), the criterion which we have preferred to follow in this work, awaiting a global taxonomical study on this species.

Family CODIACEAE Kützing (1843)
Genus *Codium* Stackhouse (1797)

Key to species of *Codium*:

1. Utricles mucronate......*C. fragile* subsp. *capense*
1. Utricles not mucronate 2

2. Utricles 500-900(-1050) µm long ......*C. isaacii**
2. Utricles (800-)1000-1400(-2000) µm long.........
....*C. decorticatum*

* In addition to the species referred to in this key, *C. duthieae* P. Silva, was also reported from Namibia. This taxon is more characteristic of the Indian Ocean coasts than the Atlantic coasts and it is difficult to distinguish from *C. decorticatum*. Namibian records of this species should be confirmed before they are included in the flora (see remark in *C. decorticatum* and 85 note of the check list in page 31). *C. isaacii* was not observed. More information about this taxon can be found in Silva (1959) and Stegenga *et al.* (1997).

Codium decorticatum (Woodward) Howe
(Figs. 221-222)

Ulva decorticata Woodward (1797), p. 55.
Codium decorticatum (Woodward) Howe (1911), p. 494.

Type: K. Mr. Wigg. Mediterranean Sea.

Selected specimens: Langstrand, 6-07-1989, BCF-A 12069, with gametangia; 5 km south of Swakopmund, 6-07-1989, BCF-A 12068; Swakopmund, beach, 8-07-1989, BCF-A 12070, with gametangia; 29 km south of Kunene river mouth, 22-02-1986, BCF-A 12071, with gametangia.

References: Børgesen (1925), Hamel (1931a), Anand (1940), Silva (1960), Taylor (1960), Gayral (1966), Srinivasan (1969), André (1970), Ugadim (1973), Schnetter (1978), Kapraun (1984), Lawson and John (1987), Nizamuddin (1991).

Habit and vegetative structure: Plant erect, 8.5-18(-47) cm high, consisting of terete or slightly compressed, branched axes attached to the substratum by a basal disc; axes 3-7 mm in diameter in its median part. Branching usually dichotomous, sometimes pseudodichotomous or trichotomous, occasionally proliferous; dichotomies flattened, triangular, 5-33 mm in maximum breadth; ultimate branches more or less long, up to 7 cm in length, some of them somewhat spatulate. Utricles cylindrical or clavate, flat or rounded at apex, not mucronate, (0.8-) 1-1.4(-2) mm long per 200-680 µm broad, some narrower, 80-140 µm broad, usually without hairs or hair scars; medullary filaments (30-)40-60(-80) µm in diameter.

Reproduction: Gametangia more or less conical, ellipsoidal or lanceolate in outline, (240-)300-460 x 60-140 µm, placed in the upper third of utricles, (380-)420-575 µm below the apex.

Habitat: Epilithic in the upper sublittoral zone and in tide pools.

Namibian distribution: Swakopmund, Möwe Bay, Rocky Point (Lawson *et al.*, 1990); Langstrand, South Kunene (Map 114).

World distribution: Atlantic Ocean: Namibia (Swakopmund) to Gibraltar, Cape Verde Islands, Canary Islands, Madeira (Silva, 1960); Portugal, north of Iberian Peninsula, France, Azores (South and Tittley, 1986); Argentina (Puerto Madryn) to Brazil (Salvador), Caribbean Sea, Florida to North Carolina, Bermuda (Silva, 1960). Mediterranean Sea (Gallardo *et al.*, 1993). Indian Ocean: Seychelles, Amirante Islands, Tanzania, Kenya, Somalia, Yemen, Pakistan, Sri Lanka, India (Silva *et al.*, 1996).

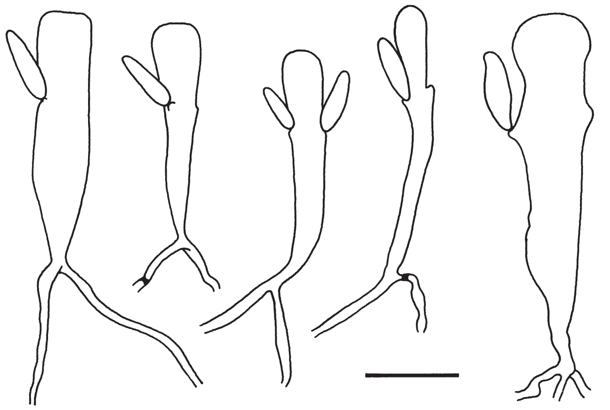

FIG. 221. – *Codium decorticatum*. Utricles with gametangia. Scale bar = 500 µm.

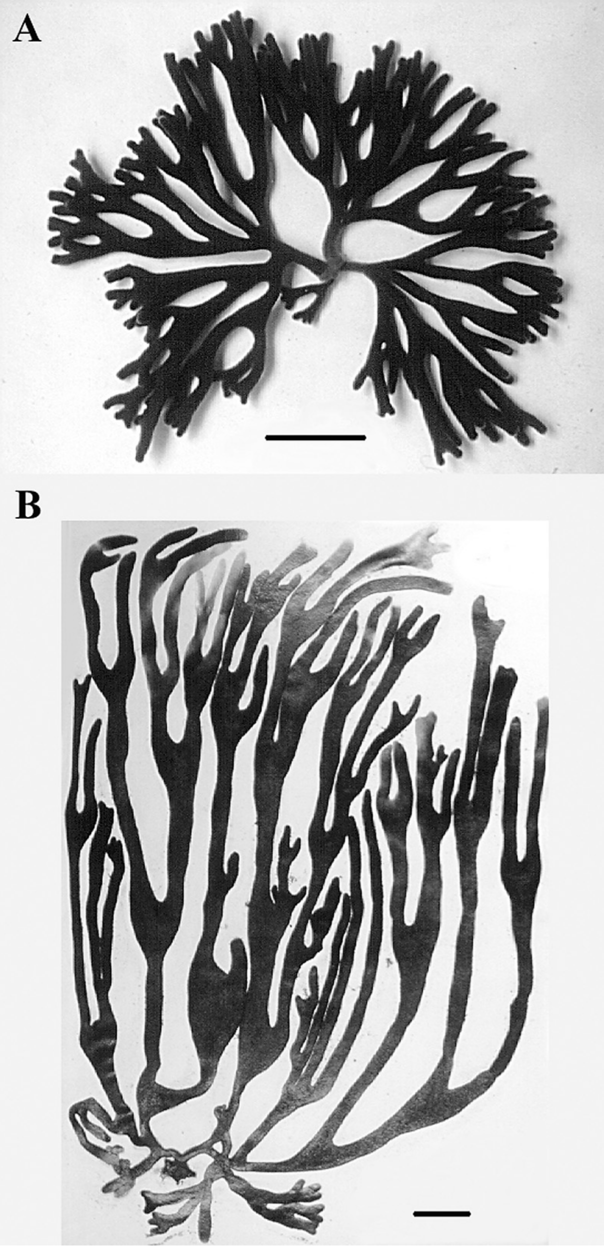

FIG. 222. – *Codium decorticatum*. A. 5 km south of Swakopmund, 6-07-1989, BCF-A 12068. B. Swakopmund, beach, 8-07-1989, BCF-A 12070. Scale bar = 3 cm.

Remarks: *Codium decorticatum* was initially described, as *Ulva decorticata*, by Woodward (1797) on the basis of material from the Mediterranean Sea and, according to the available literature, its present distribution also includes the warm-temperate and tropical regions of the Atlantic and Indian oceans (Lawson and John, 1987; Silva *et al.*, 1996). However, Silva (1960) and Silva *et al.* (1996) considered that the distribution of this species was probably restricted to the warm waters of the Atlantic and Mediterranean, and pointed out the possibility that many of the Indian records refer to *Codium indicum* S. Dixit.

As it was already pointed out by Silva (1959, 1960), *Codium decorticatum* is very similar to *C. duthieae* P. Silva, the latter occurring mainly in the Indian ocean (Silva *et al.*, 1996; Shameel *et al.*, 1996), but also recorded from the Atlantic coasts of South Africa (Silva, 1959; Stegenga *et al.*, 1997) and Namibia (Lawson *et al.*, 1990). According to the iconography and descriptions consulted, both species are morphologically and anatomically very similar, with the size of the gametangia the only feature which would distinguish them. Like this, *C. decorticatum* has gametangia relatively smaller [(144)185-300(390) x (58)70-125) µm] than *C. duthieae* [(235)270-430(500) x 70-180 µm]. However, Silva (1959, 1960) stated that both species show a wide range of morphological and anatomical variation, the reason for which Heede and Coppejans (1996) held that they are very difficult to distinguish.

In Namibia, *C. decorticatum* and *C. duthieae* have been recorded from the same localities (Swakopmund, Möwe Bay and Rocky Point) and it is fairly probable that both species had been mistaken. As far as our material is concerned, and taking into account the size of gametangia, it would to be closer to *C. duthieae* than to *C. decorticatum*. However, following the opinion of P. Silva (pers. com.), we have assigned it to the latter species, since it is a more typically Atlantic taxon. It is important to point out, however, that both Namibian and Angolan populations would be closer to those of *C. duthieae* from South Africa than those of *C. decorticatum* from the Mediterranean Sea, a fact which might be due to the effect of the Benguela current (P. Silva, pers. com.).

All things considered, we hold that *C. decorticatum* and *C. duthieae* could be conspecific and that a thorough study of this species should be carried out in order to clarify its taxonomy, particularly in this geographical area, where the distribution of both species seems to overlap.

Codium fragile (Suringar) Hariot subsp. ***capense*** P. Silva (Figs. 223-224)

Codium fragile (Suringar) Hariot subsp. *capense* P. Silva (1959), p. 153.

Type: Papenfuss 12 (UC), Melkbosch, Cape Province, 27.i.1937.

Selected specimens: 5 km south of Swakopmund, 6-07-1989, BCF-A 12240, with gametangia; *ibid*., 7-07-1989, BCF-A 12072, with gametangia.

References: Silva (1959), Simons (1969, 1976) Branch and Branch (1981), Stegenga *et al.* (1997).

Habit and vegetative structure: Plant erect, up to 20 cm high, consisting of terete, rounded at apex, branched axes, attached to the substratum by means of a basal disc 2.5-3.5 cm in diameter; axes 3-5 mm in diameter. Branching usually dichotomous, sometimes more or less lateral or with any trichotomy, occasionally proliferous; dichotomies not compressed, 5-10 mm in maximum breadth, the broader ones in the basal part of the plant. Utricles mucronate, cylindrical or more or less clavate, 800-1360 x 160-440(-580) μm, some narrower, 120-200 μm broad; mucron (16-)24(-32) μm long, that of the narrower utricles larger than that of the broader utricles, in which it is not always visible; medullary filaments 30-60 μm in diameter. Hairs not observed.

Reproduction: Gametangia conical or lanceolate in outline, 240-440 x 100-170(-190) μm, localized 420-600(-700) μm below the apex of utricle; 1-2 gametangia per utricle (up to 5 including the scars).

Habitat: Epilithic in the lower eulittoral zone and in tide pools.

Namibian distribution: Elizabeth Bay, Diaz Point, Lüderitz, Swakopmund, Torra Bay, Unjab, Rocky Point (Lawson *et al.*, 1990). According to P. Silva (pers. com.) Swakopmund is the northern boundary of *Codium fragile* subsp. *capense* (Map 115).

World distribution: Atlantic Ocean: South Africa, Namibia (Stegenga *et al.*, 1997). Indian Ocean: South Africa (Silva *et al.*, 1996).

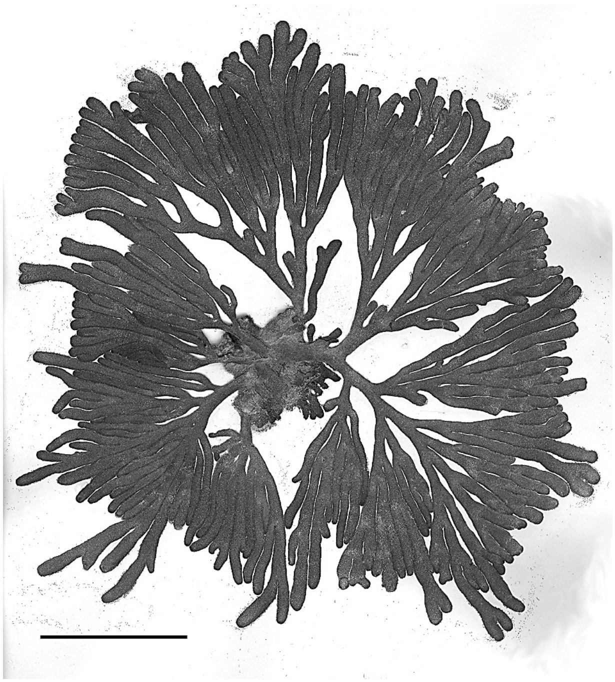

FIG. 224. – *Codium fragile* subsp. *capense*. 5 km south of Swakopmund, 6-07-1989, BCF-A 12240. Scale bar = 5 cm.

Remarks: *Codium fragile* is a taxon widespread in both the northern Pacific and northeastern Atlantic, but occurring also in New Zealand, Australia and Tasmania (Scagel *et al.*, 1986). It has been segregated in several subspecies of more restricted distribution (Silva, 1955, 1959; Silva and Womersley, 1956; among others). Particularly, the subspecies *capense* was created by Silva (1959) for the South African populations, which are sufficiently uniform and distinct as to consider them independently.

Our specimens are compatible with the description by Silva (1959) of this taxon, although our specimens have medullary filaments slightly thicker (30-60 μm in comparison with 26-46 μm is Silva's (1959) specimens) and both utricles and gametangia slightly broader [utricles up to 440(-580) μm in comparison with up to 270(-355) μm reported by Silva (1959); and gametangia 100-170(-190) μm in diameter in comparison with 70-130 according to this author]. Likewise, the utricles have a shorter mucron in our specimens [(16-)24(-32) μm long in comparison with up to 60 μm long in the specimens described by Silva (1959)].

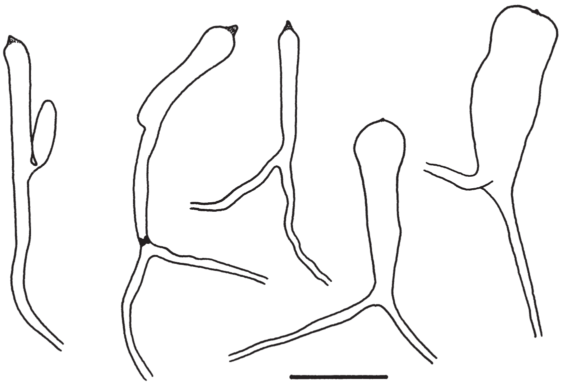

FIG. 223. – *Codium fragile* subsp. *capense*. Utricles, the one at left with one gametangium. Scale bar = 500 μm.

BIOGEOGRAPHICAL ASPECTS OF THE MARINE BENTHIC FLORA OF NAMIBIA

One of the main features that control the evolution of marine benthic flora of the southern hemisphere is isolation (Lüning, 1990). While at the norhtern hemisphere the polar, temperate and tropical zones are distributed in a practically continuous way along the coasts, which makes species migration and consequently the interaction between different flora possible, at the southern hemisphere the polar zones are isolated from the temperate ones and the later are separated by long distances from one another (southern ends of South America and South Africa, the south of Australia and New Zealand). This fact limits substantially the species migration, which is reduced to the dispersion of the great oceanic currents, and leads to an independent evolution of the flora by producing a high number of endemisms (Lüning, 1990).

The evolution of the marine benthic flora in South Africa has resulted from the effects of paleoceanographic events of the last 100 million years (Hommersand, 1986). As for the Atlantic coast, the main events that have controlled the history of the flora have probably been the tropicality of the South African climate until the second half of the Eocene, roughly 53 million years ago (Benson, 1984; Benson *et al.*, 1984), the relatively recent glaciation (9 million years) of the western part of the Antarctic continent in comparison to the eastern part (Ciesielski *et al.*, 1982), and the establishment of the West Wind Drift with the resulting formation of the subantarctic and subtropical convergences, and the appearance of the Benguela System (between 6 and 10 million years). According to Hommersand (1986), the first of these events would have permitted the Tethyan marine algal flora to predominate on the coasts of southern Africa until the mid Eocene. On the other hand, Hommersand (1986) suggested the possibility that some specimens of the South Pacific marine flora (south of Australia, Tasmania, New Zealand) would reach the Atlantic coasts of southern Africa: they would have been transported by currents that would cross the Antarctica through the Ross and Weddell seas before they were frozen (9 million years ago). In addition, these cold currents would have created an appropriate climate for the establishment of these species at the western coasts of southern Africa. Hommersand (1986) based his hypothesis on the similarity (regarding the red algae) between the flora of the west coast of southern Africa and those of Tasmania, New Zealand and the south of Australia. This similarity was corroborated later by Hommersand *et al.* (1994) in a study about the biogeography of the Gigartinaceae based on molecular data. The separation of the Antarctic continent and South America (29-22 million years ago) permitted the formation and development of the West Wind Drift and the creation of the subantarctic and subtropical convergences that isolated the Antarctic continent and prevented species migration. According to Hommersand (1986), this fact plus the establishment of the Benguela System are responsible for the independent evolution of the primitive flora of the Atlantic coast of southern Africa.

The biogeographical characteristics of the benthic populations of the coasts of Namibia and the coasts of South Africa have been generally considered together. Stephenson (1948) is possibly one of the first authors to take into account the coasts of Namibia in a biogeographical synthesis. He differentiated the southern coast of South Africa (eastwards from Cape Agulhas) from the west coast: he named the South Coast Marine Province, which has a fauna and a flora of a warm-temperate nature; and the West Coast Marine Province, which has a fauna and flora of cold-temperate nature. The author defined a transitional zone between both these provinces, which stretches from the south of the Cape Peninsula to Cape Agulhas. Stephenson (1948) remarked that the cold-temperate population of the West Coast stretches along the littoral of Namibia to the zone dominated by the tropical species of the western African coast, and he thought it is doubtful that there was a transitional zone dominated by warm-temperate species between both these populations. Later authors accepted this model with several modifications. Thus, Hommersand (1986) used the terms East Cape and West Cape to refer respectively to the South and West Coast Marine Provinces, and pointed out that the flora of Namibia is part of the West Cape. Likewise, Lüning (1990) distinguished between two biogeographic provinces on the coasts of southern Africa. On one hand, the South West African Province, that stretches from Cape Agulhas to Moçâmedes (at the south of Angola), which corresponds to the West Coast defined by Stephenson (1948); and on the other hand, the Agulhas Province that is equivalent to Stephenson's (1948) South Coast. Emanuel *et al.* (1992) defined two biogeographic provinces in the zone comprised between Cape Agulhas and the south of Angola, based on faunal studies: the Cool-temperate Southwest Coast, from Cape Agulhas to Lüderitz, and the Cool-temperate Northwest Coast, from this last locality to the South of Angola. The authors differentiated the Namaqua Subprovince, which comprises the northern half of the coasts of South Africa and stretches up to Lüderitz. More recently, Stegenga *et al.* (1997) used the term

Benguela Marine Province to refer to Stephenson's (1948) West Coast, and remarked that the only feature to distinguish the Namaqua Subprovince from the rest of the province, in terms of flora, is its reduced number of species. Stegenga *et al.* (1997) also remarked that, from the flora point of view, it would be better to consider the Cool-temperate Northwest Coast of Emanuel *et al.* (1992) as a subprovince within the Benguela Marine Province than as a province itself, and they suggested naming it Namib Subprovince.

Accordingly and to sum up, the coasts of southern Africa comprise two different phytogeographic provinces: the Agulhas Marine Province, that stretches from Cape Agulhas eastwards to Natal, and the Benguela Marine Province, from Cape Agulhas to Moçâmedes, at the south of Angola. The floras of both these provinces converge in a transitional zone defined by Cape Agulhas, that represents the eastern limit of the flora of Benguela, and Kommetjie, at the south of the Cape peninsula, which is the western limit of the flora of Agulhas. There are two different subprovinces at the Benguela Marine Province: the Namib subprovince, in the coastal stretch between Lüderitz and Moçâmedes, and the Namaqua subprovince, that includes the southern coast of Namibia and the northern half of the South African coasts. According to Stegenga *et al.* (1997), the flora of the Namib subprovince is dominated by characteristic species of the Benguela Province, with some species that penetrate to the tropical zone at the north and others characteristic of the Agulhas Province with a discontinuous distribution. On the other hand, the flora of the Namaqua Subprovince does not differentiate from the southern one, but it is simply depauperate (Stegenga *et al.*, 1997).

While most authors agree with the biogeographical features we described above, the nature of the marine fauna and flora of the Benguela Province has generated certain controversy. On the one hand, there are authors like Hedgpeth (1957), Knox (1960), Brown and Jarman (1978), Michanek (1979) and Hommersand (1986), who considered the biota as cold-temperate, according to the criteria of Stephenson (1948), who used the presence of large extensions of kelp at the zone (*Laminaria pallida* and *Ecklonia maxima*) as an argument. On the other hand, Ekman (1953), Briggs (1974), Hoek (1984), Bolton (1986), Lawson (1988) and Lüning (1990), among others, treated the zone as warm-temperate. Both the absence of characteristic species of cold-temperate zones, such as *Durvillaea antarctica*, and the fact that the flora is more related to the one of Uruguay and the Uruguayo-Bonaerense zone than to that of Patagonia (Lawson, 1988), are arguments to support this last point of view. In addition, Bolton (1986) pointed out that *Ecklonia maxima* is a warm-temperate species and that *Laminaria pallida* tolerates higher temperatures than other species of the same genus. Finally, Stegenga *et al.* (1997) took into account the modification of temperatures that the cold water upwelling generates in the Benguela Marine Province, and pointed out that the west coast from the Cape Peninsula towards the north should be considered as a transitional warm/cold-temperate zone, according to the current definition of the regions. The authors also commented on the need to make a global scale redefinition of the regions.

The first works to study specifically the marine benthic biota of Namibia from the biogeographical point of view were by Penrith and Kensley (1970a and b). They are mainly faunistic works in which the authors analyse the composition of the fauna in two localities on the coast (Lüderitz and Rocky Point, respectively) in order to determinate the transitional zone between the cold-temperate fauna of the Atlantic coast of South Africa and the tropical one of the western part of Africa. The authors concluded that the fauna of Lüderitz is representative of the South African Atlantic coast, while the one of Rocky Point shows a relatively important tropical component. Later on, and with the same aim as in the two previous works, Kensley and Penrith (1980) studied the fauna (and secondarily the flora) of the northern end of Namibia, between Cape Frio and the Kunene River. The authors, who did not find substantial differences with the fauna of Rocky Point, indicated that the apparent lack of kelp in the studied area is the main feature that distinguishs this zone from Rocky Point. As for the flora, the studies of Lawson *et al.* (1990) and Engledow *et al.* (1992) are outstanding. In the first one, the authors pointed out that the flora of Namibia represents an extension of the South African west coast flora, which is attenuated in a northern direction and suddenly ends in a zone near the border of Angola. Engledow *et al.* (1992) analysed the variation of the specific richness and the β-diversity among 8 zones distributed along the Atlantic coast of southern Africa, from the south of Angola to Cape Agulhas. Like Lawson *et al.* (1990), they concluded that the flora of Namibia represents an extension of the South African west coast flora with a sparse tropical influence at the northern end of the country. Engledow *et al.* (1992)

also pointed out that the number of species (especially of red algae) decreases gradually with the latitude, and that the effect of temperature, the scant heterogeneity and availability of habitats and the action of sand may account for the low specific richness observed at the central and northern zones of Namibia. In this sense, Engledow and Bolton (1994) remarked that the action of the sand, the hydrodynamism and the density of mussels are the main factors that control the α-diversity at the lower eulittoral zone of the coasts of Namibia. On the other hand, Engledow *et al.* (1992) pointed out that the high β-diversity values found between the south of Angola (São Nicolau-Kunene River) and the north of Namibia (Kunene River-Cape Cross) could mark the transitional zone between the Benguela and Angola currents. Likewise, the authors pointed out that the sea water temperature at the convergence zone of both these currents is too cold to allow the establishment of tropical species from the north and too warm for the temperate species (stenothermal) from the south, thus limiting the dispersion of both these floras.

According to our own data, the benthic marine flora of Namibia is currently represented by 196 taxa (once the taxa recorded at supraspecific level and the doubtful species are excluded; see page 21). As we already said in another section (page 23), it is a relatively poor flora, although we think that later studies, especially of the sublittoral zone, may increase substantially the number of species. Moreover, the indeterminate species we included in the catalogue must also be taken into account (see page 20). On the other hand, the distribution of the species number along the coast is very variable (Fig. 16, page 22) and mainly depends on the availability of colonisable substratum and the diversity of habitats, although the action of the sand, the hydrodynamism and the density of mussels can also have an important effect (Engledow *et al.*, 1992; Engledow and Bolton, 1994). Since the two first factors are generally limiting at the central and northern coasts of Namibia in comparison with the south and the Atlantic coasts of South Africa, and due to the high similarity between the flora of Namibia and that of the western coast of South Africa, most authors (Lawson *et al.*, 1990; Engledow *et al.*, 1992; Engledow and Bolton, 1994; Stegenga *et al.*, 1997) consider that the former is an extension of the latter with a decrease of species at the central and northern zones. While we agree with the fact that the flora of Namibia represents an extension of the flora of the Atlantic coast of South Africa (more than 75% of the taxa are also found on the west coast of South Africa; Fig. 226), and that in general it is relatively poorer than this one [196 taxa against 357 taxa (the doubtful and indeterminate species excluded) at the west coast of South Africa according to Stegenga *et al.* (1997)], when we divide the coast of Namibia into the three zones proposed by the other authors (southern, central and northern), our data indicate, on the contrary, that the number of species does not change significantly along the coast (Fig. 225). No doubt, this is due to the higher intensity of research on the Namibian coasts during recent years (Engledow, 1998; Rull Lluch, 1999). According to Engledow *et al.* (1992), the red algae, which is the most abundant group, are mainly responsible for the vari-

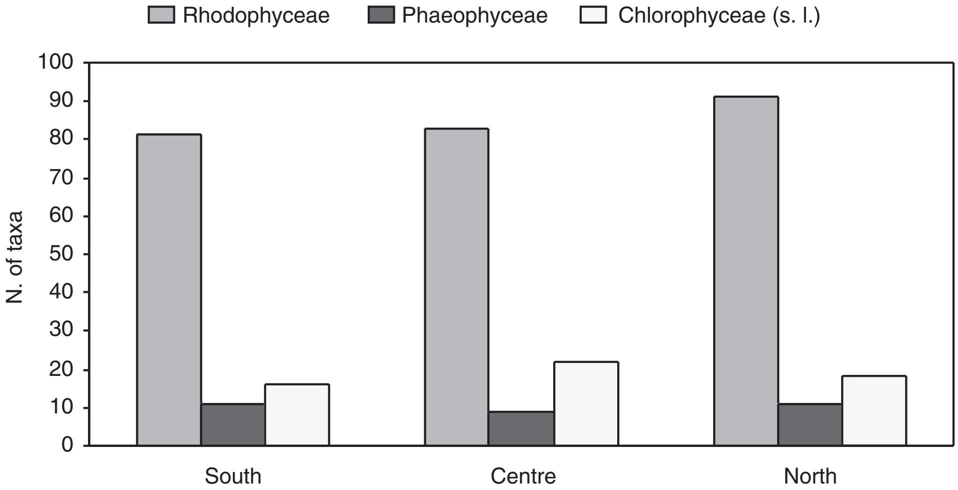

FIG. 225. – Number of taxa of Rhodophyceae, Phaeophyceae and Chlorophyceae *sensu lato* in the three areas in which the Namibian coast has been divided. South: from Orange river to Walvis Bay. Centre: from Walvis Bay to Mile 108. North: from Mile 108 to Kunene river.

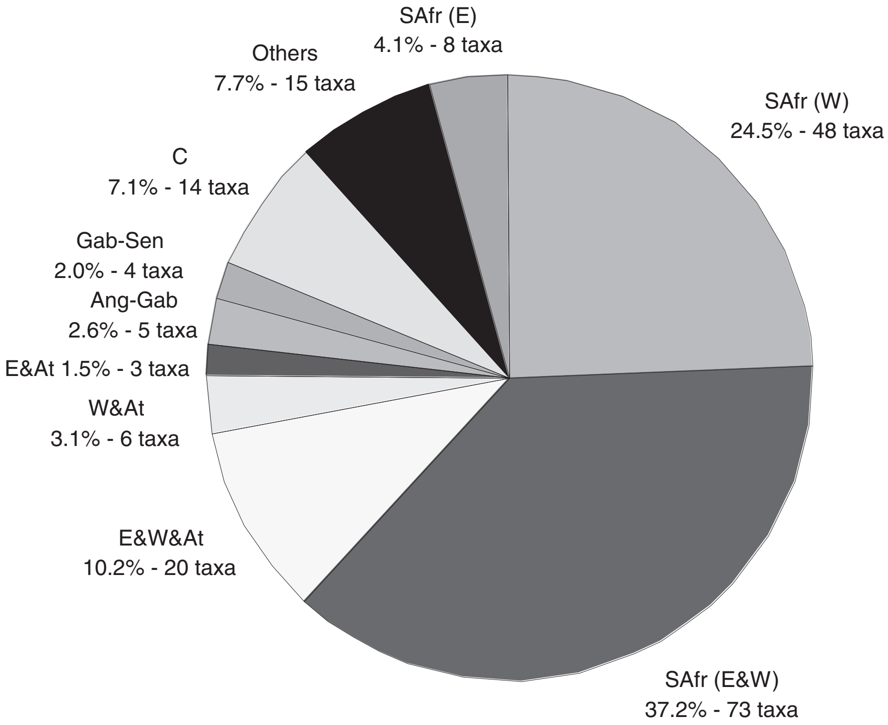

FIG. 226. – Proportion (in percentage and number of taxa) of different groups in which the marine benthic flora of Namibia has been divided (see the text). SAfr (E): Namibia and east coast of South Africa. SAfr (W): Namibia and west coast of South Africa. SAfr (E&W): Namibia and east and west coasts of South Africa. E&W&At: Namibia and east and west coasts of South Africa and Atlantic coasts of tropical Africa. W&At: Namibia and west coast of South Africa and Atlantic coasts of tropical Africa. E&At: Namibia and east coast of South Africa and Atlantic coasts of tropical Africa. Ang-Gab: Namibia and the coasts comprise between Angola and Gabon. Gab-Sen: Namibia and the coasts comprise between Gabon and Senegal, but not between Angola and Gabon. C: cosmopolitan. Others: only Namibia (neither South Africa nor Atlantic tropical Africa).

ation of the total number of taxa, while the Phaeophyceae and the Chlorophyceae (*sensu lato*), scantly represented at the benthic marine flora of Namibia, have a lower variation, especially the Phaeophyceae (Fig. 225).

The low proportion of Phaeophyceae is a general feature of the Benguela Marine Province (Bolton, 1986; Lüning, 1990). This fact considerably affects the R/P (Rhodophyceae / Phaeophyceae) and the (R+C)/P [(Rhodophyceae + Chlorophyceae *s. l.*) / Phaeophyceae] indexes, respectively proposed by Feldmann (1937) and Cheney (1977) for the comparison of floras, in a way that they reach very high values. Therefore, while at the temperate zones of the North Atlantic the R/P index varies between 1 and 2.7 and the (R+C)/P index between 1.8 and 3.7, at the temperate coasts of southern Africa the variation of both these indexes is 4.8-7.4 and 6.1-8.8 respectively (Table 1). These values are comparable and even superior to those of the tropical zones. Because of this fact, and in agreement with Bolton (1986), we consider that these indexes are not applicable to the Benguela Marine Province. Likewise, Coll and Oliveira (1999) remarked that the application of the R/P index to the flora of Uruguay gives a wrong idea of the reality, as its value (5.8) is superior to those of the equatorial zones. According to these authors, the scant proportion of Phaeophyceae is probably due to the low salinity of the water of the zone. Regarding the African coasts, Bolton (1986) remarked that both the isolation of the flora and the fact of the Benguela System is relatively recent, may partly explain why the Phaeophyceae have not proliferated as in other cold areas of the northern hemisphere. In general terms, and in spite of not having enough data, we think that this fact could be extended to the temperate coasts of the southern hemisphere as, in contrast to the northern hemisphere, they are less extensive and have been isolated for a long time span, which has made their floras evolve in a totally independent way. In contrast, both the continuity of the coasts from the Arctic to the tropical zones and the possible larger extension of the temperate zones until relatively recent times, roughly 0.7-3 million years ago, when the Arctic started to freeze permanently (Herman, 1985; Clark, 1982), may be responsible for the higher diversification of the Phaeophyceae in the northern hemisphere.

TABLE 1. – Number of Rhodophyceae (R), Phaeophyceae (P), Chlorophyceae *s.l.* (C) and total taxa (T) in different geographic areas of both hemispheres. R/P and (R+C)/P indexes are also indicate. * = Lawson and Price (1969), Lawson *et al.* (1975, 1995), John *et al.* (1979, 1981, 1994), Price *et al.* (1978, 1986, 1988, 1992).

Zone	T	R	P	C	R/P	(R+C)/P	References
Greenland	181	63	73	45	0.86	1.48	Alvarez *et al.* (1988)
Canada (Arctic)	177	57	65	55	0.88	1.72	Alvarez *et al.* (1988)
Norway (Arctic)	208	81	85	42	0.95	1.45	Alvarez *et al.* (1988)
Canada (Atlantic)	316	119	115	82	1.03	1.75	Alvarez *et al.* (1988)
USA (temperate Atlantic)	321	124	114	83	1.09	1.82	Alvarez *et al.* (1988)
Southern Norway	364	161	135	68	1.19	1.70	Alvarez *et al.* (1988)
United Kingdom	567	289	184	94	1.57	2.08	Alvarez *et al.* (1988)
France (Atlantic)	663	335	191	137	1.75	2.47	Alvarez *et al.* (1988)
Iberian Peninsula (Atlantic)	571	328	139	104	2.36	3.11	Alvarez *et al.* (1988)
USA (warm Atlantic)	327	189	70	68	2.70	3.67	Alvarez *et al.* (1988)
Tropical America (Atlantic)	743	425	115	203	3.70	5.46	Alvarez *et al.* (1988)
Tropical Africa (Atlantic)	299	197	42	60	4.69	6.12	Lawson and John (1987)
Namibia	196	147	20	29	7.35	8.80	This work
Amsterdam Island	23	19	3	1	6.33	6.67	Silva *et al.* (1996)
Uruguay	72	41	7	24	5.86	9.29	Coll and Oliveira (1999)
South Africa (W)	357	257	49	51	5.24	6.29	Stegenga *et al.* (1997)
Brazil	504	327	64	113	5.11	6.88	Oliveira Filho (1977)
South Africa (E)	720	492	102	126	4.82	6.06	Silva *et al.* (1996)
Mozambique	201	100	23	78	4.35	7.74	Silva *et al.* (1996)
St. Paul Island	69	52	12	5	4.33	4.75	Silva *et al.* (1996)
Madagascar	329	188	47	94	4.00	6.00	Silva *et al.* (1996)
Angola-Gabon	162	105	27	30	3.89	5.00	*
Tristan da Cunha	110	75	20	15	3.75	4.50	Baardseth (1941)
Tanzania	414	230	72	112	3.19	4.75	Silva *et al.* (1996)

Another characteristic aspect of the Benguela Marine Province flora is its high degree of endemism (Hommersand, 1986; Lüning, 1990; Stegenga *et al.*, 1997). Regarding the marine benthic flora of Namibia, 78 of the 196 mentioned taxa, (39.8% of the flora) would be endemic of southern Africa (the zone comprised between Moçâmedes, at the south of Angola, and Inhaca, at the south of Mozambique) according to Stegenga *et al.* (1997). However, according to our data, 24 of these 78 taxa have also been cited from localities outside the area Stegenga *et al.* (1997) defined as southern Africa (Argentina, northwest Africa, western Indian Ocean, South Australia, Amsterdam Island and St. Paul Island, among others) even though, in general, they are very old citations. If we exclude these 24 taxa and we add *Acrosorium cincinnatum*, the only endemic species of Namibia, the number of endemic taxa of southern Africa present at the flora of Namibia is still quite high (55 taxa; 28.1% of the flora). Approximately half of these 55 taxa, *Porphyra saldanhae, Pachymenia carnosa, Phyllymenia belangeri, Heydrichia groeneri, Leptophytum foveatum, Synarthrophyton munimentum, Gigartina bracteata, Iridaea elongata, Mazzaella capensis, Kallymenia agardhii, Pugetia harveyana, Thamnophyllis discigera, Trematocarpus fragilis, Carpoblepharis minima, Euptilota pappeana, Lomathamnion humile, Microcladia gloria-spei, Heterosiphonia pellucida, Acrosorium cincinnatum, Delesseria papenfussii, Placophora monocarpa, Papenfussiella gracilis, Enteromorpha atroviridis, Chaetomorpha robusta* and *Codium isaacii* (12.8% of the flora) can be considered endemic of the Benguela Marine Province. On the other hand, and as it can be observed in Figure 226, the species we have considered to be cosmopolitan according to the criteria of Giaccone *et al.* (1985), Stegenga *et al.* (1997), Womersley (1984, 1987, 1994, 1996 and 1998), Lawson and John (1987) and Scagel *et al.* (1986), are scantly represented in the marine benthic flora of Namibia (*Stylonema alsidii, Sahlingia subintegra, Acrochaetium daviesii, Gelidium pusillum, Gracilaria gracilis, Hildenbrandia rubra, Ectocarpus siliculosus, Colpomenia sinuosa, Entocladia viridis, Enteromorpha flexuosa, E. intestinalis, E. linza, E. prolifera* and *Chaetomorpha aerea*; 7.1% of the flora).

We divided the coastal zone comprised between south Mozambique and Senegal in four different biogeographical parts in order to characterize the marine flora of Namibia: the east coast of South Africa (Agulhas Marine Province and the transitional zone with the tropical flora of the Indian Ocean;

TABLE 2. – Distribution of 196 taxa of the marine benthic flora of Namibia along the coast comprised between South Africa and Senegal. Localities of the Namibian coast are included and arranged from South (left) to North (right). SE: South African East coast. SW: South African West coast. EB - KR: Namibia. EB: Elizabeth Bay. GR: Grossebucht (Kleinbogenfels and Fjord included). HB: Halifax Bay (Guano Bay and Essy Bay included). DP: Diaz Point. LÜ: Lüderitz. AB: Agate Beach. OB: Hottentots Bay (Saddle Hill North included). WB: Walvis Bay. LA: Langstrand. SK: Swakopmund (Miles 4 and 8 included). M0: Mile 30 (Mile 14 and Wlotzkasbaken included). M2: Mile 32. CC: Cape Cross. M8: Mile 108. TO: Toscanini. TB: Torra Bay. UN: Unjab. TE: Terrace Bay. MB: Möwe Bay. RP: Rocky Point. CF: Cape Frio. AF: Angra Fria. KS: South Kunene. HO: Honolulu. KR: Kunene River. A-G: Angola - Gabon. G-S: Gabon - Senegal. + : taxon recorded from the locality or zone considered.

TAXON	SE	SW	EB	GR	HB	DP	LÜ	AB	OB	WB	LA	SK	M0	M2	CC	M8	TO	TB	UN	TE	MB	RP	CF	AF	KS	HO	KR	A-G	G-S
Antithamnionella australis				■																									
Polysiphonia nigra							■	-	-	■																			
Iridaea elongata										■																			
Heterosiphonia crispella v. laxa																					■								
Haematocelis epiphytica-stadium																					■	■							
Gastroclonium reflexum												■	-	■	-	-	-	-	-	-	■	■	-	■	■				
Gracilariopsis longissima												■	■	■	■	■	-	-	-	-	-	■	-	-	■				
Acrosorium cincinnatum												■	-	-	-	-	-	-	-	■	■	■							
Hildenbrandia crouanii												■	-	-	-	■	-	-	-	-	-	-	-	-	■				
Entocladia leptochaete												■													■				
Cryptopleura calophylloides												■																	
Rhodymenia linearis												■																	
Antithamnion densum												■																	
Ulva nematoidea												■																	
Stragularia clavata												■																	
Basispora africana																					■	-	-	-	-	-	-	■	■
Heterosiphonia crispella v. crispella																				■	■	■	-	-	-	-	-	■	■
Gelidium pusillum												■	-	■	-	-	-	-	-	-	-	■	-	-	■	-	-	■	■
Pterosiphonia complanata												■	-	-	-	-	-	-	-	-	■	■	-	-	-	-	-	■	
Ulvella lens											■	■	-	-	-	-	-	-	-	-	■	-	■	■	■	-	-	■	
Codium decorticatum											■	■	-	-	-	-	-	-	-	-	■	■	-	-	■	-	-	■	■
Plocamium cartilagineum																				■	■	-	■	-	-	-	-	-	■
Audouinella hypneae												■																	■
Entocladia vagans							■																						■
Pedobesia lamourouxii							■																						■
Entocladia viridis	■						■																					■	■
Melobesia membranacea	■											■									■							■	■
Ceramium diaphanum	■						■			■								■										■	■
Ralfsia expansa	■		■									■											■					■	■
Bryopsis cespitosa	■																				■								
Stylonema cornu-cervi	■																								■				
Antithamnion eliseae	■																				■								
Arthrocardia palmata	■																				■								
Antithamnion secundum	■												■																
Schottera nicaeënsis	■											■																	
Enteromorpha bulbosa	■		■									■																	
Arthrocardia carinata	■						■					■																	
Centroceras clavulatum	■	■	■	-	-	■	■	-	-	-	-	■	-	-	-	-	-	■	-	■	■	■	-	-	■	-	-	■	■
Caulacanthus ustulatus	■	■	■	-	-	-	■	-	-	-	■	■	-	-	-	-	-	■	-	■	■	■	-	-	-	-	-	■	■
Hildenbrandia rubra	■	■	■	-	-	-	■	-	-	-	■	■	-	-	■	■	-	■	-	-	-	■	-	-	-	-	-	■	■
Porphyra capensis	■	■	■	■	-	■	■	-	-	■	■	■	-	-	■	-	-	-	■	■	-	■	■	■	-	■	-	■	
Chondria capensis	■	■	-	-	-	-	■	-	-	■	■	■	-	■	-	-	-	■	-	■	■	■	■	■	■	-	-	■	
Cladophora hospita	■	■	-	-	-	-	■	-	-	-	-	■	-	-	-	-	-	■	-	■	■	■	■	-	-	-	■	■	
Gracilaria gracilis	■	■	-	-	-	-	■	-	-	■	-	■	-	-	-	-	-	-	-	■	-	-	-	-	-	-	-	■	■
Ulva rigida	■	■	-	-	-	-	■	-	-	■	■	■	-	-	-	-	-	-	-	-	■	-	-	-	-	-	-	■	■
Ulva fasciata	■	■									■	■	-	■	-	■	-	-	-	-	-	■	-	-	■	-	-	■	■
Chaetomorpha aerea	■	■									■	■	-	-	-	■	-	-	-	-	-	■	-	-	-	-	-	-	■
Acrochaetium daviesii	■	■										■	■	■	-	-	-	-	-	-	■	-	-	-	■	-	-	■	■
Hypnea ecklonii	■	■										■	■	■	-	-	-	-	-	-	■	■	-	-	■	-	-	-	■
Enteromorpha intestinalis	■	■										■	-	-	■	■												■	■
Stylonema alsidii	■	■										■										■	-	-	-	-	-	■	■
Aglaothamnion hookeri	■	■										■													■	-	-	■	■
Sahlingia subintegra	■	■	■									■	■							■									■
Enteromorpha flexuosa	■	■														■	-	-	-	-	-	■	-	-	-	-	-	■	■
Plocamium suhrii	■	■																		■	-	■	-	-	-	-	-	■	
Enteromorpha prolifera	■	■																			■	■	-	-	-	-	-	-	■
Bachelotia antillarum	■	■																				■	-	-	-	-	-	■	■
Feldmannia irregularis	■	■																				■	-	-	-	-	-	-	■
Ceramium flaccidum	■	■	-	■	■	-	■															■	-	-	■	■	■	■	■
Grateloupia filicina	■	■	■	-	■	-	■													■	-	-	-	-	-	-	-	■	■
Anotrichium tenue	■	■	-	-	-	-	■																					■	
Colpomenia sinuosa	■	■	■	-	-	■	-	■																				■	■
Hymenena venosa	■	■	■	-	-	-	■																						■
Petalonia fascia	■	■	■	-	-	-	-	-	-	-	■	■																	■
Hypnea musciformis	■	■								■	-	■																■	■

TABLE 2 (Cont.). – Distribution of 196 taxa of the marine benthic flora of Namibia along the coast comprised between South Africa and Senegal.

TAXON	SE	SW	EB	GR	HB	DP	LÜ	AB	OB	WB	LA	SK	M0	M2	CC	M8	TO	TB	UN	TE	MB	RP	CF	AF	KS	HO	KR	A-G	G-S
Bryopsis plumosa	■	■	■	-	-	-	-	-	-	-	-	■																■	■
Acrosorium maculatum	■	■	-	-	-	-	■	-	-	-	-	■																■	
Enteromorpha linza		■	-	-	-	-	■	-	-	-	■	■																■	■
Rhodymenia pseudopalmata		■	-	-	-	-	■																					■	■
Gracilariopsis lemaneiformis		■										■										■							■
Chondracanthus teedei		■										■										■						■	■
Grateloupia doryphora		■	-	-	-	-	■	-	■	-	-	■									■							■	■
Kallymenia schizophylla		■	-	-	-	-	■	-	-	-	-	■	-	-	-	-	-	-	-	■	■	■	-	-	-	-	-	-	■
Pachymenia carnosa		■	■	-	-	-	■	-	-	-	-	■	-	-	-	-	-	-	-	■	■	■	■	■	-	-	■	■	
Ophidocladus simpliciusculus	■	■										■	-	■	-	■	-	-	-	-	-	■	-	-	■				
Streblocladia corymbifera	■	■								■	■	■	-	-	■	-	-	-	-	-	-	■	-	-	■				
Tayloriella tenebrosa	■	■										■	-	-	-	■	■	■	-	■	■	■	-	-	■				
Acrosorium acrospermum	■	■										■	-	-	-	-	■	■	-	■	-	■							
Rhodophyllis reptans	■	■										■	■	-	-	-	-	-	-	-	■	-	-	-	■				
Plocamium glomeratum	■	■										■	■	-	-	-	-	-	-	-	■	■	-	-	■				
Heringia mirabilis	■	■										■	-	-	-	-	-	-	-	■	■	■							
Pleonosporium filicinum	■	■									■	■									■								
Heterosiphonia dubia	■	■										■									■								
Polysiphonia scopulorum	■	■										■	-	■								■	-	-	■				
Griffithsia confervoides	■	■															■	■	-	■	■	■							
Ectocarpus siliculosus	■	■									■	■	■								■								
Acrochaetium secundatum	■	■										■													■				
Heterosiphonia crispa	■	■					■														■								
Ulva rhacodes	■	■										■						■											
Ahnfeltiopsis polyclada	■	■														■													
Acrochaetium moniliforme	■	■																■											
Antithamnion diminuatum var. *diminuatum*	■	■																■	-	-	■	■	-	-	■				
A. diminuatum var. *polyglandulum*	■	■																■	-	-	■	■							
Antithamnionella verticillata	■	■																			■	■	-	-	■				
Bornetia repens	■	■																			■	■							
Ptilothamnion polysporum	■	■																			■								
Placophora binderi	■	■																			■								
Endarachne binghamiae	■	■																				■							
Rhodothamniella floridula	■	■																				■							
Pachymenia cornea	■	■																					■						
Aiolocolax pulchellus	■	■										■													■				
Polysiphonia incompta	■	■							■																■				
Nothogenia ovalis	■	■	-	■	-	-	■														■								
Desmarestia firma	■	■	-	-	-	-	■														■								
Hypnea spicifera	■	■	-	-	-	-	■	■														■	-	-	■	-	■		
Aeodes orbitosa	■	■	■	■	■	■	■												■	-	■	■	■	■	-	-	■		
Polysiphonia namibiensis	■	■	-	■	-	-	-	-	■									■	-	-	■	-	-	-	■				
Hypnea tenuis	■	■	■	-	-	-	■	-	■	-	■	■															■		
Polysiphonia urbana	■	■	■	-	-	-	-	-	-	■	-	-	-	-	-	-	-	-	■	■	-	■	■	-	-	■			
Ahnfeltiopsis vermicularis	■	■	-	-	■	-	■	-	-	-	-	■	■	■	■	■	■	-	-	■	■	■	■	-	■	-	■		
Nothogenia erinacea	■	■	-	-	-	-	■	-	-	■	-	■	-	-	-	■	-	■	-	■	■	■	■	-	■				
Aristothamnion collabens	■	■	■	■	■	-	■	-	-	-	■	■	■	■	-	-	-	-	-	■	■	■	-	■	■				
Cladophora capensis	■	■	■	-	■	■	■	-	-	-	■	■	-	■	-	-	-	■	-	■	■	■	■						
Ahnfeltiopsis glomerata	■	■	■	-	-	■	■	■	-	-	-	■	-	■	-	-	■	-	-	■	■	■	■	■					
Chordariopsis capensis	■	■	■	-	-	-	■	-	-	-	-	■	-	-	-	-	-	■	-	■	■	■	■						
Plocamium rigidum	■	■	-	-	-	-	■	-	-	-	-	■	■	-	-	-	-	■	-	■	■	■							
Codium fragile subsp. *capense*	■	■	■	-	-	■	■	-	-	-	-	■	-	-	-	-	-	■	■	-	-	■							
Ahnfeltiopsis complicata	■	■	-	-	-	-	■	-	-	-	-	■	-	-	-	-	■	■	-	■	■								
Cladophora flagelliformis	■	■	■	-	-	-	■	-	-	-	-	■	■	■	-	■	-	■											
Laminaria pallida	■	■	■	-	-	-	■	-	-	■	-	■	-	-	-	-	-	-	-	■	■	■							
Suhria vittata	■	■	■	-	-	-	■	-	-	-	■	■	-	-	-	-	-	-	-	-	■	■							
Ceramium arenarium	■	■	-	-	-	-	■	-	-	-	■	■	-	-	-	-	-	-	-	-	■	■							
Pterosiphonia cloiophylla	■	■	-	-	-	-	■	■	-	-	-	■	-	-	-	-	-	-	-	■	-	■							
Gymnogongrus dilatatus	■	■	-	-	-	-	■	-	-	-	■	■	-	-	-	-	-	-	-	■	■								
Cladophora contexta	■	■	■	-	-	-	■	-	-	-	-	■	-	-	-	-	-	-	-	-	■								
Rhodymenia capensis	■	■								■	-	■	■																
Rhodymenia natalensis	■	■										■	■																
Erythrotrichia welwitschii	■	■										■																	
Carpoblapharis flaccida	■	■	-	-	-	-	■	-	-	■	-	■																	
Plocamium cornutum	■	■	■	-	-	■	■	-	-	-	-	■																	
Polysiphonia virgata	■	■	■	■	-	-	-	-	-	-	-	■																	
Chylocladia capensis	■	■	-	-	-	-	■	-	-	-	-	■																	
Herposiphonia didymosporangia	■	■	-	-	-	-	■	-	■																				
Stypocaulon funiculare	■	■	-	-	-	-	-	-	■																				
Champia lumbricalis	■	■	■	■	-	■	■	■																					
Splachnidium rugosum	■	■	■	■	■	-	■																						
Ecklonia maxima	■	■	■	-	■	-	■																						

TABLE 2 (Cont.). – Distribution of 196 taxa of the marine benthic flora of Namibia along the coast comprised between South Africa and Senegal.

TAXON	SE	SW	EB	GR	HB	DP	LÜ	AB	OB	WB	LA	SK	M0	M2	CC	M8	TO	TB	UN	TE	MB	RP	CF	AF	KS	HO	KRA-GG-S
Leathesia difformis	■	■	■	-	-	■	■																				
Sarcothalia stiriata	■	■	■	■	-	■	■																				
Scytosiphon lomentaria	■	■	■	-	-	-	■																				
Botryoglossum platycarpum	■	■	■	-	-	-	■																				
Trematocarpus flabellatus	■	■	■	-	-	-	■																				
Arthrocardia filicula	■	■	-	-	-	-	■																				
Pleonosporium harveyanum	■	■	-	-	-	-	■																				
Polyopes constrictus	■	■	-	-	-	-	■																				
Herposiphonia heringii	■	■	-	-	-	-	■																				
Dasya scoparia	■	■	-	-	-	-	■																				
Bostrychia scorpioides	■	■	-	-	-	-	■																				
Delesseria papenfussii		■	■																								
Placophora monocarpa		■	-	■																							
Colaconema plumosum		■	-	■																							
Peyssonnelia atropurpurea		■	-	-	-	■																					
Codium isaacii		■	-	-	-	-	■																				
Bryopsis tenuis		■	-	-	-	-	■																				
Heterosiphonia pellucida		■	-	-	-	-	■																				
Kallymenia agardhii		■	-	-	-	■	■																				
Sarcothalia scutellata		■	■	-	-	-	■																				
Neuroglossum binderianum		■	■	-	-	-	■																				
Botryocarpa prolifera		■	■	-	-	-	■																				
Heydrichia groeneri		■	-	■	-	■	■																				
Pugetia harveyana		■	-	■	-	■	■																				
Plocamium maxillosum		■	-	-	-	■	-	-	■																		
Euptilota pappeana		■	-	-	■	■	-	-	■																		
Lomathamnion humile		■	-	■	-	■	-	-	■																		
Trematocarpus fragilis		■	-	■	■	-	-	-	■																		
Enteromorpha atroviridis		■	-	■	-	-	■	-	-	-	-	■															
Schizymenia apoda		■	-	-	-	-	■	-	-	-	-	■															
Synarthrophyton munimentum		■	-	■	-	-	-	-	-	-	-	■															
Acrochaetium endophyticum		■										■															
Acrochaetium reductum		■									■	■	■				■										
Papenfussiella gracilis		■										■															
Thamnophyllis discigera		■	-	-	-	■	■	-	-	-	-	■															
Grateloupia longifolia		■	-	-	■	■	■	-	-	-	-	■	■														
Ceramium planum		■	-	-	-	-	■	-	-	-	■	■	■														
Gigartina bracteata		■	-	-	■	-	-	-	-	-	-	■	■														
Phyllymenia belangeri		■	-	-	-	-	■	-	-	-	-	■	-	-	-	-	-	■	-	■	-	■	■				
Mazzaella capensis		■	■	■	-	■	■	-	-	-	■	■	-	-	■	■	-	-	-	■	■	■	■	■	■	■	
Sarcothalia radula		■	■	-	■	■	■	■	-	-	-	■	-	-	-	-	-	-	-	■							
Rhodymenia obtusa		■	■	-	-	-	■	-	-	-	■	■	■	-	-	-	-	-	-	■	■						
Ceramium atrorubescens		■	-	-	-	-	■	-	-	■	■	■	-	-	-	-	-	-	■	■	■	■					
Ulva capensis		■	-	-	-	-	■	-	-	-	-	■	-	-	-	-	-	-	-	-	■	■					
Ballia sertularioides		■	-	-	■	■	■														■	■					
Carpoblepharis minima		■								■	-	■	■	-	-	-	-	-	-	-	■						
Streblocladia camptoclada		■									■	■	-	■	■	■	■	-	■	■	■	■	■	■	■	-	■
Chaetomorpha robusta		■										■	-	-	-	-	-	■	-	■	■	■					
Ectocarpus fasciculatus		■										■	-	-	-	■	-	-	-	-	-	■	■	■			
Bryopsis hypnoides		■									■	■	-	-	-	-	-	-	-	■	■						
Myriogramme livida		■										■													■		
Hincksia granulosa		■										■													■		
Lithophyllum neoatalayense		■																■	-	-	-	-	■				
Erythrotrichia boryana		■															■										
Leptophytum foveatum		■																■									
Platysiphonia intermedia		■	■	-	■	-	■	-	■											■	■						
Porphyra saldanhae		■																			■	-	■				
Microcladia gloria-spei		■																			■						
Acrochaetium catenulatum		■	■								■											■	-	-	■		

of warm nature); the west coast of South Africa (the lower part of the Benguela Marine Province); the part of coast that stretches from Angola to Gabon [tropical transitional African zone according to Lüning (1990)]; and the coast comprised between Gabon and Senegal (tropical African zone). From now on, unless specified, we will consider these two last zones together under the name Atlantic coast of tropical Africa. Taking into account these four areas, and excluding the cosmopolitan species, the main component of the marine benthic flora of Namibia (65.8%) is represented by taxa also found at the coasts of South Africa but not at the Atlantic coast of tropical Africa, the main part (37.2%) are present at both the Atlantic and the Indian Ocean coasts, a smaller part (24.5%) only at the Atlantic coast, and a very small part (4.1%) only at the Indian Ocean coast (Fig. 226; Table 2). A relatively important part of the flora of Namibia (14.8%) consists of taxa found at both South African coasts and the Atlantic coast of Tropical Africa, and only the 4.6% of the taxa present at Namibia are also found at the Atlantic coast of tropical Africa and not at the South African coasts (a 2.6% at the area comprised between Angola and Gabon). The remaining 7.7% consists of taxa recorded from Namibia but neither cited from the South African coasts nor from the Atlantic coast of tropical Africa. It includes *Acrosorium cincinnatum* (the only endemic species of Namibia), *Iridaea elongata* [a species considered to be endemic of the Benguela System that has been cited from South Africa (Delf and Michell, 1921) but that has not been taken into account in the study by Stegenga *et al.* (1997); it is possibly conspecific with *Mazzaella capensis*], *Ulva nematoidea* (a typical species of the South American Pacific coast and very similar to *U. fasciata*, with which it must have been mistaken), *Cryptopleura calophylloides* [a taxon only recorded from Uruguay and, according to Wynne (1986), possibly a synonym of *C. ramosa*, the latter a typical species from the eastern North Atlantic], *Rhodymenia linearis* (only cited from New Zealand and St. Paul Island), *Haematocelis epiphytica* and *Antithamnionella australis* (only known from Tristan da Cunha), *Antithamnion densum* (a temperate species also recorded from Tristan da Cunha, South Argentina, the European Atlantic, the American Pacific coast and Japan), *Hildenbrandia crouanii* (with a distribution which is difficult to describe due to the uncertain limitation of the taxon, but possibly widespread in temperate zones), *Heterosiphonia crispella* var. *laxa* (in general considered together with var. *crispella*) and five more species that have their distribution centre at the temperate zone of the North Atlantic (*Gracialariopsis longissima* –very similar to *Gracilaria gracilis*–, *Gastroclonium reflexum, Entocladia leptochaete* –also cited from India–, *Polysiphonia nigra* –also cited from Falkland Islands– and *Stragularia clavata* –also recorded from Brazil).

The group of taxa only found on the Atlantic coast of South Africa includes almost all the endemic species of the Benguela Marine Province and the ones with a more temperate character of the flora of Namibia. Among the latter it is important to highlight *Delesseria papenfussii, Codium isaacii, Heydrichia groeneri, Neuroglossum binderianum, Sarcothalia scutellata, Botryocarpa prolifera, Heterosiphonia pellucida, Placophora monocarpa, Pugetia harveyana, Kallimenia agardhii, Euptilota pappeana, Lomathamnion humile, Trematocarpus fragilis, Plocamium maxillosum* and *Bryopsis tenuis*, which have their northern distribution limit near Lüderitz (between Elizabeth Bay and Hottentot Bay; Table 2). However, we must point out that *Sarcothalia scutellata* and *Botryocarpa prolifera* have also been recorded from Mauritius (Dickie, 1874) and the Philippines (Dickie, 1876), respectively. Silva *et al.* (1996) remarked that the Mauritius record of *S. scutellata* is improbable and, in our opinion, the one of *B. prolifera* from Philippines, also unlikely. If these citations are erroneous, both species could be considered endemic of the Benguela Marine Province. *Enteromorpha atroviridis, Schizymenia apoda, Synarthrophyton munimentum, Papenfussiella gracilis, Thamnophyllis discigera, Grateloupia longifolia, Gigartina bracteata* and *Ceramium planum* reach Swakopmund, although the last three species have also been collected in drift material from Mile 30, 40 kilometres northwards Swakopmund, and *P. gracilis* has not been recorded from the southern zone of Namibia (Table 2). It is worth noting, in addition, that *S. apoda* has also been cited from Somalia (Lawson, 1980) and *C. planum* from south Mozambique (Pocock, 1958). Other species also have their northern distribution limit at Lüderitz or at Swakopmund (Table 2). They are species that have also been cited from the east coast of South Africa, but some could be considered to be more characteristic of the Atlantic coast, because their presence at the Indian coast is limited to Cape Agulhas, or is only supported by old and sometimes doubtful records (*Ecklonia maxima, Sarcothalia stiriata, Botryoglossum platycarpum* and *Polysiphonia virgata*).

One may think that the taxa only found at the east coast of South Africa (4.1% of the flora; 8 taxa), those found at both this area and the Atlantic coast of tropical Africa (1.5% of the flora; 3 taxa) and those only found at this last zone (4.6% of the flora; 9 taxa) may represent the warmest component of the marine benthic flora of Namibia. However, only 11 of these 20 taxa can be considered to be more or less widespread in warm-temperate and tropical zones (*Audouinella hypneae, Arthrocardia carinata, A. palmata, Ceramium diaphanum, Heterosiphonia crispella* var. *crispella, Basispora africana, Ralfsia expansa, Entocladia vagans, Ulvella lens, Pedobe-*

sia lamourouxi and *Codium decorticatum*). The rest are subcosmopolitan species or species with a more or less wide distribution in temperate areas (*Stylonema cornu-cervi, Melobesia membranacea, Schottera nicaeënsis, Plocamium cartilagineum, Pterosiphonia complanata* and *Enteromorpha bulbosa*), or species with a restricted distribution in determinate zones [*Antithamnion eliseae* (South Africa), *A. secundum* (South Africa and Japan) and *Bryopsis caespitosa* (South Africa and Cape Verde islands)]. Apart from the 11 taxa with warm-temperate and tropical distribution mentioned above, *Grateloupia doryphora, G. filicina, Bachelotia antillarum* and *Ulva fasciata* also present this kind of distribution. These species have also been cited from the west coast of South Africa (Table 2), although the two last species only from False Bay, the warmest area (Stegenga *et al.*, 1997). In brief, we can consider that the warmest component of the marine benthic flora of Namibia is composed of these 15 taxa, which represent 7.7% of the flora. Consequently, one may suppose that the distribution of these taxa in Namibia is restricted to the north coast, because the influence of the warm Angola current is more important in this area. In fact, there are taxa that occur only north of Terrace Bay (*Basispora africana, Antithamnion eliseae, Heterosiphonia crispella, Bachelotia antillarum* and *Arthrocardia palmata*). However, the main part has also been recorded from Langstrand or Swakopmund and some even from the south coast (Table 2). Among the latter, *Grateloupia filicina* is widespread in the Atlantic South African coast (Stegenga *et al.*, 1997) and must be a species with a more euritherm character. In contrast, *Ralfsia expansa* and *Pedobesia lamourouxi* are not found at the Atlantic South African coast and its presence in the south of Namibia could be due to erroneous citations. In this sense, Stegenga *et al.* (1997) remarked that *R. expansa* is a tropical species formerly cited from the South African coasts, but in fact, the west coast material corresponds to *R. verrucosa*. Likewise, *P. lamourouxi* is a typical species of the tropical Atlantic (Giaccone *et al.*, 1985) and in southern Africa it has only been recorded from Lüderitz, where the average temperature oscillates between 12°C and 14.8°C (Molloy and Bolton, 1996). Although Engledow *et al.* (1992) commented that during a few weeks every year (1-3 weeks) the temperature may reach 28°C at Lüderitz lagoon, we think that the citation of *P. lamourouxi* (Lawson *et al.*, 1990) may be erroneous. On the other hand, *Ulva fasciata*, which has been considered pantropical by several authors (Taylor, 1960; Giaccone *et al.*, 1985; Lawson and John, 1987), has a more or less continuous distribution from the border of Angola to Langstrand and it does not appear again until False Bay (Table 2). According to this, and to the available information, the tropical influence zone would stretch around Swakopmund, although north of Terrace Bay the warm effect of the Angolan water would be more important, since the number of taxa with a warm character is relatively higher at this area and their distribution more continuous (Table 2).

If we only take into account the non-cosmopolitan taxa found at the transitional tropical African zone (Angola-Gabon) and not at South Africa, we may infer that the influence of the flora of this area on that of Namibia is very weak. Likewise, the number of characteristic species of the flora of Benguela that reach the coasts of Angola is very low. Then, it seems that the transition between these two floras is not gradual but takes place suddenly, as other authors (Stephenson, 1948; Lawson *et al.*, 1990; Engledow *et al.*, 1992) have already noted. However, it must be taken into account that the area where the interaction between both floras occur is an especially dynamic zone controlled by the oscillation of the front between the currents of Benguela and Angola and by the variation of the upwelling intensity, and that the available information is based on isolated studies. It is highly probable that a more detailed study of this part of the coast, which includes the sublittoral zone and takes seasonal variability into account, would yield a different outlook of the interaction between the floras of Benguela and Angola.

As indicated in Table 2, there are some species with a more or less continuous distribution along the coast of Namibia and others that, in spite of being present at the Atlantic coast of South Africa, do not appear again until the northern coast of the country. Among the first set, that could be considered as representative of the marine benthic flora of Namibia, it is worth highlighting *Mazzaella capensis, Ahnfeltiopsis vermicularis, Nothogenia erinacea, Aristothamnion collabens, Ahnfeltiopsis glomerata, Cladophora capensis, Porphyra capensis, Chondria capensis, Cladophora hospita, Hildenbrandia rubra, Centroceras clavulatum* and *Caulacanthus ustulatus*. The last three are cosmopolitan or subcosmopolitan species, while the distribution of the rest is practically limited to the coasts of southern Africa. *Porphyra capensis, Chondria capensis* and

TABLE 3. – Similarity of the marine benthic flora of Namibia with that of other zones. TT = total number of taxa. TC = number of taxa in common with the flora of Namibia. TG = total number of genera. GC = number of genera in common with the flora of Namibia. Jaccard = similarity index of Jaccard.

Zone	TT	TC	Jaccard	TG	GC	Jaccard
Gabon-Senegal	299	42	0,09	135	58	0,30
Angola-Gabon	162	38	0,12	98	52	0,32
South Africa (W)	357	159	0,40	196	109	0,53
South Africa (E)	720	116	0,15	303	100	0,31
Mozambique	201	26	0,07	109	39	0,21
Madagascar	329	19	0,04	136	29	0,13
C. Frio (Brazil)	243	32	0,08	122	54	0,29
Uruguay	72	25	0,10	42	32	0,25
Tristan da Cunha	110	28	0,10	83	54	0,36
Gough Island	34	5	0,02	27	18	0,14
South Shetland	60	5	0,02	50	17	0,11
Signy Island	34	2	0,01	30	11	0,08
South Georgia	93	7	0,02	70	21	0,13
Amsterdam Island	23	8	0,04	20	15	0,12
St. Paul Island	69	23	0,10	51	37	0,28
Rottnest Island	347	15	0,03	192	43	0,16
New Zealand	562	29	0,04	255	80	0,27
Kaikoura (NZ)	282	20	0,04	180	65	0,28
Namibia	196	196	1,00	119	119	1,00

Cladophora hospita stretch to the south of Angola, and in this sense they could indicate the northern limit of the transitional zone between the flora of Namibia and that of the transitional tropical African zone (Angola-Gabon). Many of the species found in South Africa and on the northern coast of Namibia, but not at the central and southern zones of the country, have a certain warm character, as their western limit of distribution at the South African coast is placed at False Bay where the mean temperature is similar to the one at Walvis Bay and significantly superior to the one of the zone comprised between this locality and the Cape of Good Hope (Bolton, 1986). Among these species it is worth highlighting *Plocamium suhrii, Bachelotia antillarum, Antithamnionella verticillata, Bornetia repens, Ptilothamnion polysporum, Placophora binderi* and *Endarachne bingamiae*. Others, in contrast, are found on the coast comprised between the Cape of Good Hope and the border of Namibia (*Microcladia gloria-spei, Pachymenia cornea, Rhodothamniella floridula, Acrochaetium catenulatum, Lithophyllum neoatalayense, Leptophytum foveatum* and *Porphyra saldanhae*) and their absence at the southern and central part of Namibia could be more related to the intensity or season of study of this particular area than to temperature. In fact, some of these species have been identified recently (*L. neoatalayense, L. foveatum, P. saldanhae*) and it is possible that later studies may suggest a wider distribution. On the contrary, the presence of *Pachymenia cornea* in the north of Namibia could be attributed to an erroneous determination, as this species is very similar to *P. carnosa*, an endemic taxon of the Benguela System and more widespread on the coasts of Namibia (Table 2). According to Simons and Hewitt (1976) *P. cornea* occurs from East London (eastern coast of South Africa) to Cape Frio, in Namibia, which is compiled by Lawson *et al.* (1995). However, Lawson *et al.* (1990) did not include this species in the catalogue of seaweeds of Namibia and Stegenga *et al.* (1997) pointed out that it has only been collected from Doring Bay (central zone of the South African Atlantic coast) to East London.

Another feature of the marine benthic flora of Namibia that must be highlighted is its low similarity to other nearby floras, which is made evident by the values of the similarity index of Jaccard (Table 3). As could be expected, the flora of the Atlantic coast of South Africa is the one with which it has a higher similarity. For this reason and for the oceanographic features of the area, the marine benthic flora of Namibia has been considered as an extension of that of the South African west coast, and both of them constitute the flora of the Benguela Marine Province. Although it is not so evident, the similarities to the flora of the Indian coast of South Africa and to the one of the transitional tropical African zone (Angola-Gabon), with which the flora of Namibia shares its warmest component, also are remarkable. The same similarity is also observed with the flora of Saint Paul Island and that of Uruguay. The lowest affinity occurs with the flora of the subantarctic islands considered (Signy, South

Shetland and South Georgia). At the generic scale the similarity is slightly higher, but the relation to the compared floras is still more or less the same (Table 3). The highest affinity occurs with the flora of the west coast of South Africa, from which the flora of Namibia is derived, and the lowest affinity occurs with the above mentioned subantarctic islands. In the same way, the flora of the east coast of South Africa and that of the western coast of tropical Africa, show a high similarity, which is comparable to those of Tristan da Cunha and Saint Paul Island. According to Hommersand (1986), a part of the flora of these islands may have originated, in recent geological times, from the flora of South Africa. The affinity, although lower, of the flora of Namibia with the two considered floras of the Atlantic coast of South America and that of New Zealand is also remarkable. This relation to the flora of New Zealand, although very low, may support the argument by Hommersand (1986), according to which the flora of the Benguela Marine Province derives, in part, from that of the South Pacific (see page 197).

To sum up, we can consider that the marine benthic flora of Namibia, as a constituent part of the flora of the Benguela Marine Province, represents an extension of the flora of the Atlantic coast of South Africa, with which it has the highest similarity. It is a relatively poor flora, mainly due to the particularities of the coast, and although it has only one endemic species (*Acrosorium cincinnatum*), the proportion of endemisms from southern Africa and from the Benguela Marine Province is quite important (28.1% and 12.8% respectively). Another characteristic is the low proportion of Phaeophyceae, which is responsible for the R/P and (R+C)/P indexes showing extremely high values, which make them not applicable to this geographical area. The most representative species are *Mazzaella capensis, Ahnfeltiopsis vermicularis, Nothogenia erinacea, Aristothamnion collabens, Ahnfeltiopsis glomerata, Cladophora capensis, Porphyra capensis, Chondria capensis, Cladophora hospita, Hildenbrandia rubra, Centroceras clavulatum* and *Caulacanthus ustulatus*, in addition to *Delesseria papenfussii, Codium isaacii, Heydrichia groeneri, Neuroglossum binderianum, Sarcothalia scutellata, Botryocarpa prolifera, Heterosiphonia pellucida, Placophora monocarpa, Pugetia harveyana, Kallimenia agardhii, Euptilota pappeana, Lomathamnion humile, Trematocarpus fragilis, Plocamium maxillosum* and *Bryopsis tenuis*, which show a more temperate affinity and, in this sense, are restricted at the southern coast of the country. The warmest component is represented by *Audouinella hypneae, Arthrocardia carinata, A. palmata, Ceramium diaphanum, Heterosiphonia crispella* var. *crispella, Ralfsia expansa, Ulvella lens, Codium decorticatum, Bachelotia antillarum, Basispora africana* and *Ulva fasciata*. The distribution of these taxa at Namibia seems to indicate that the influence of the warm water from Angola may reach the surrounding area of Swakopmund, although north of Terrace Bay it would have a more important effect. The available data do not define clearly a transitional area between the flora of Namibia and that of the zone comprised between Angola and Gabon. Moçâmedes, at the south of Angola, has been established as the northern limit of the flora of Namibia. In contrast, it is difficult to establish accurately the southern limit of the flora of Angola, because, although the few species that reach the coasts of Namibia are concentrated at the north of Terrace Bay, they have also been cited from Swakopmund. In our opinion, and acknowledging the difficulties involved, we think that a detailed seasonal study of the northern part of Namibia should be carried out in order to establish the southern limit of the flora of Angola.

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PLATES

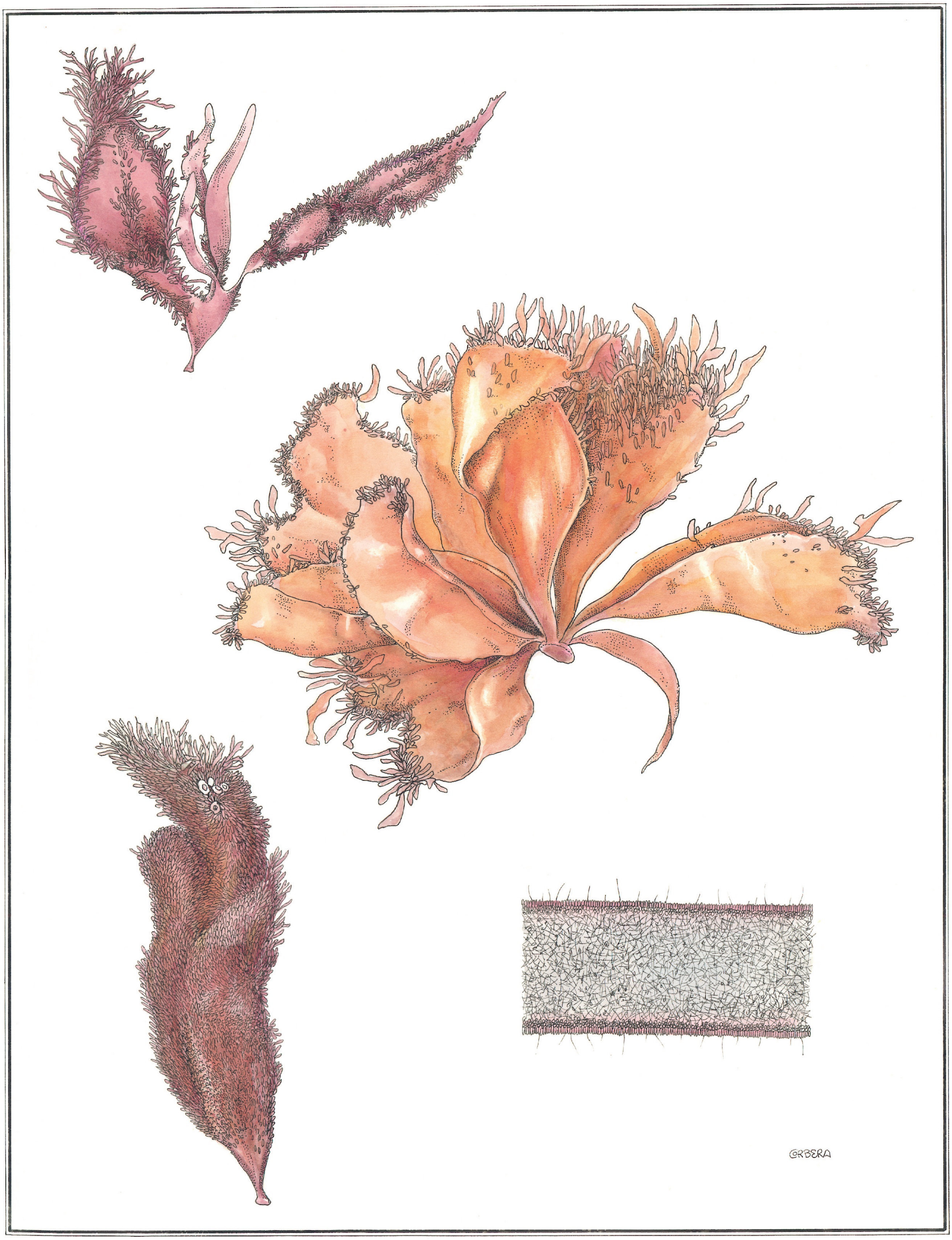


Plate 1. – *Nothogenia erinacea*. (Drawing by J. Corbera).

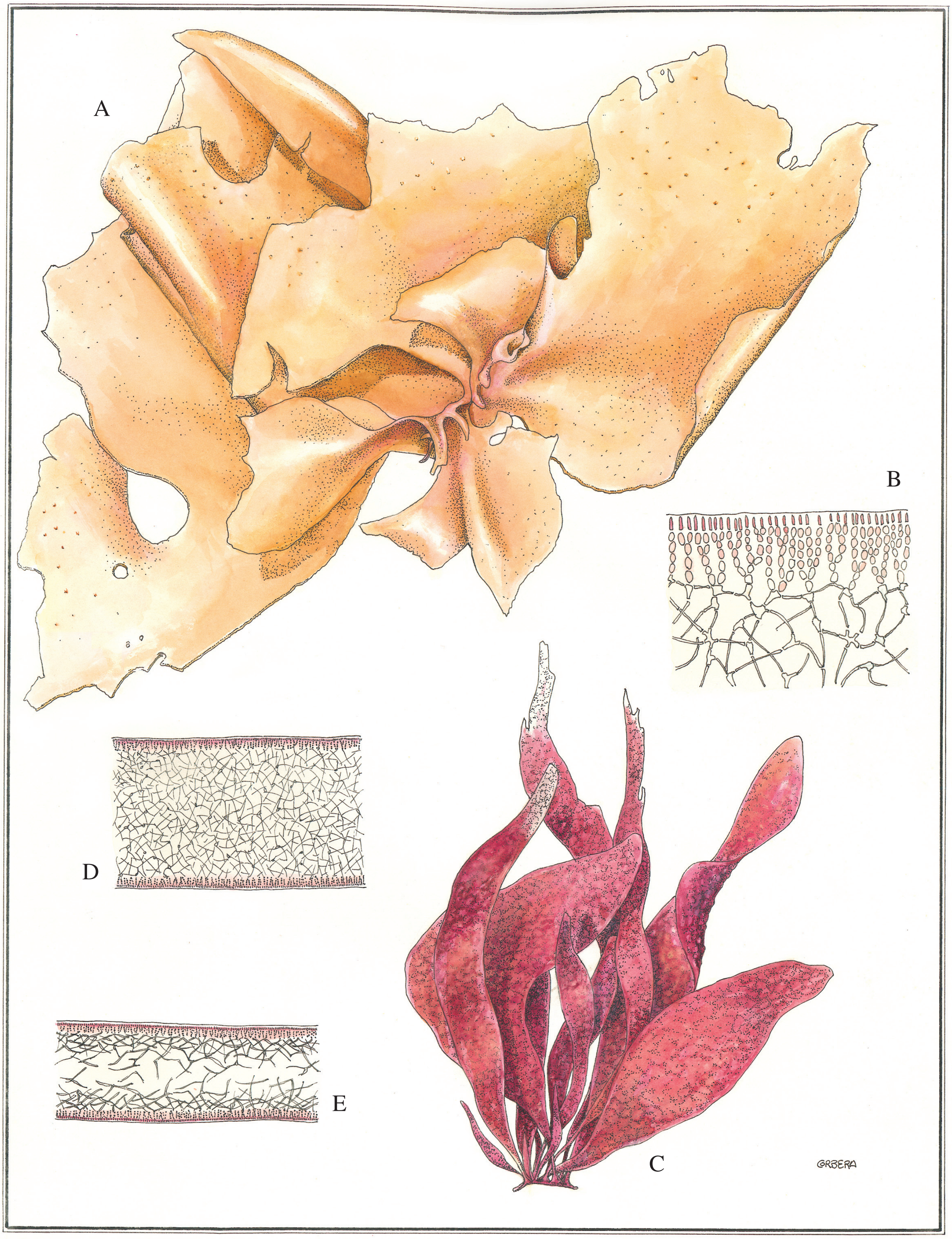


Plate 2. – A-B. *Aeodes orbitosa*. C-E. *Mazzaella capensis* (Drawing by J. Corbera).

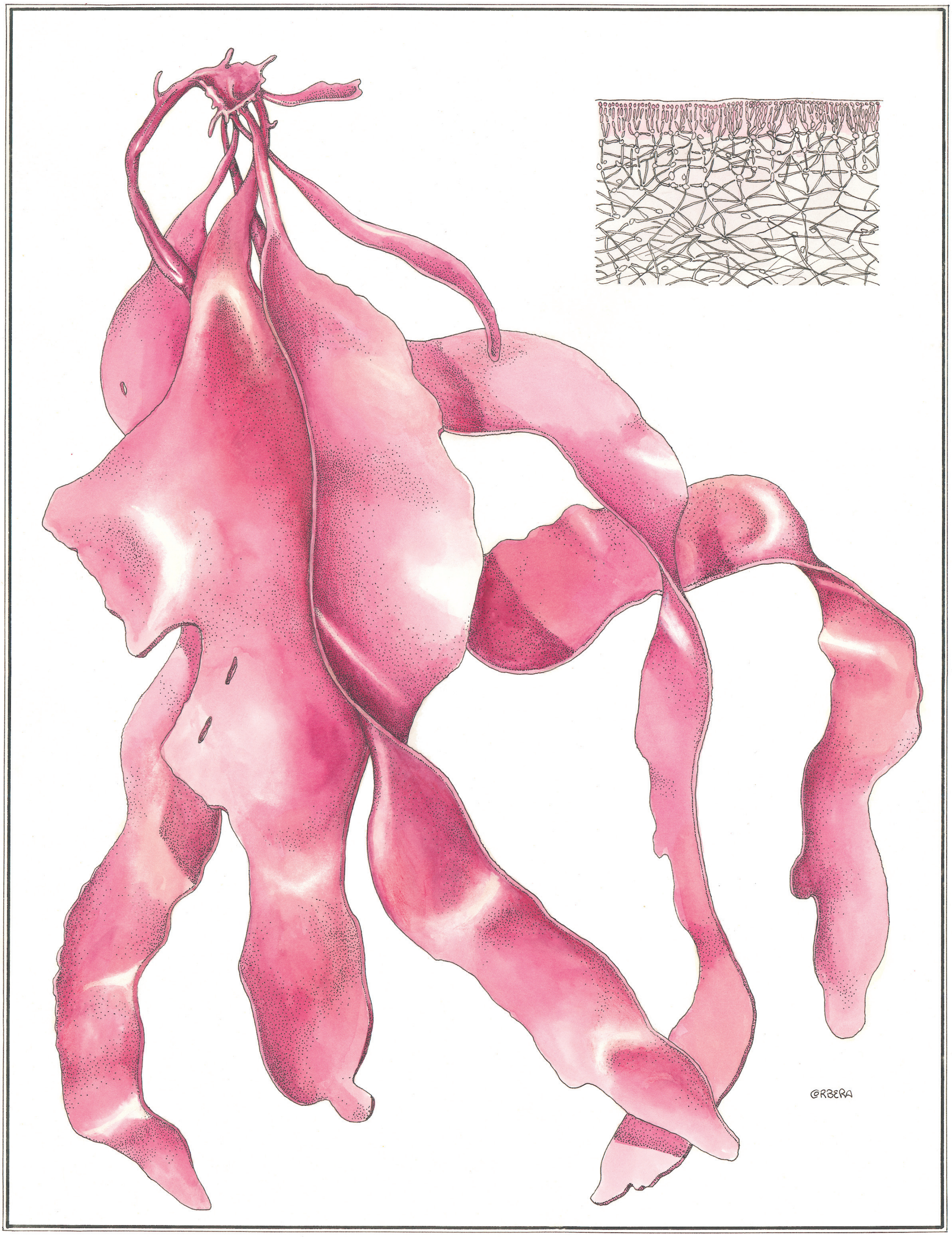


Plate 3. – *Pachymenia carnosa* (Drawing by J. Corbera).

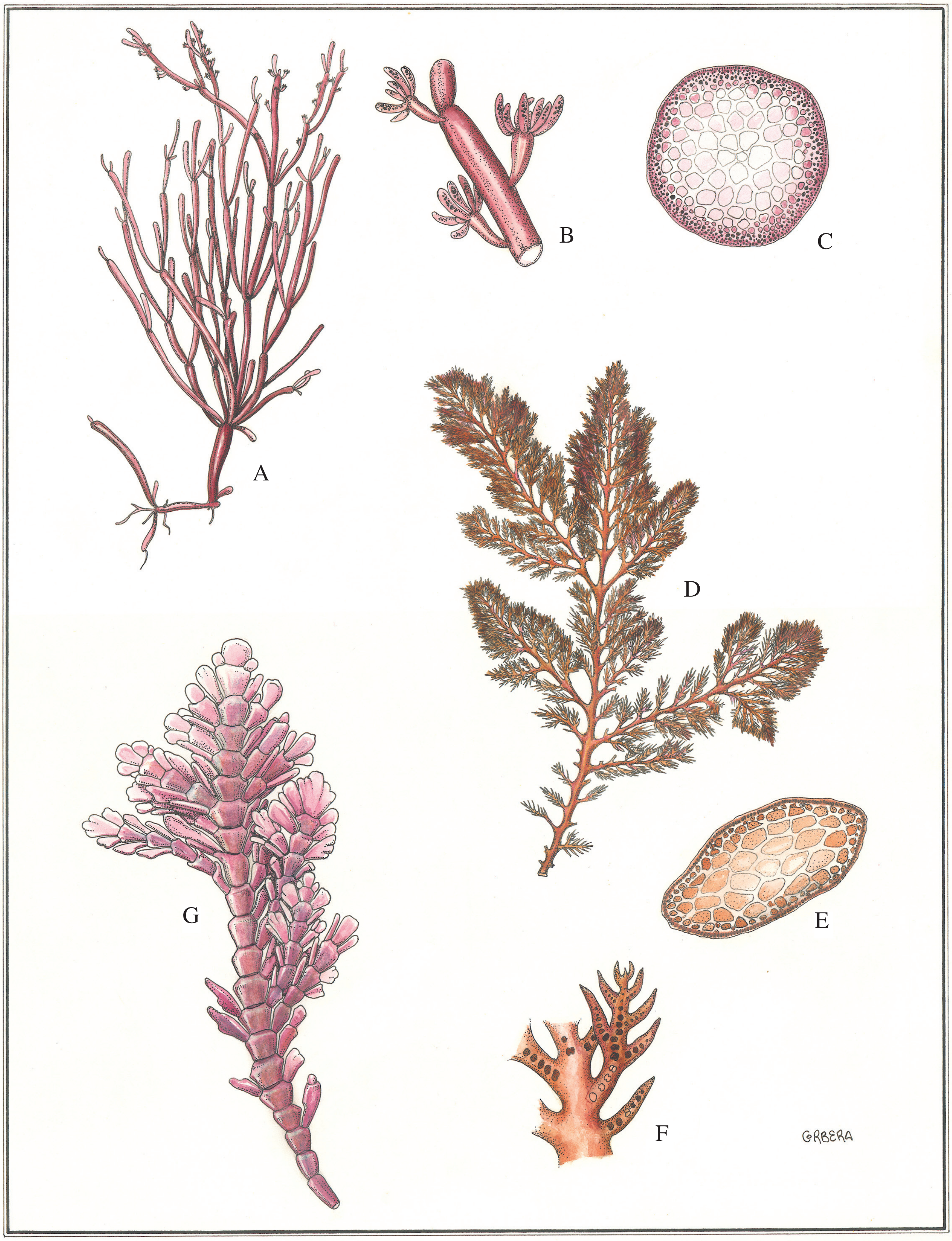
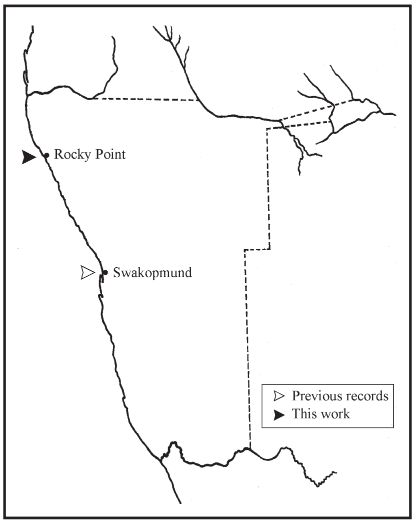
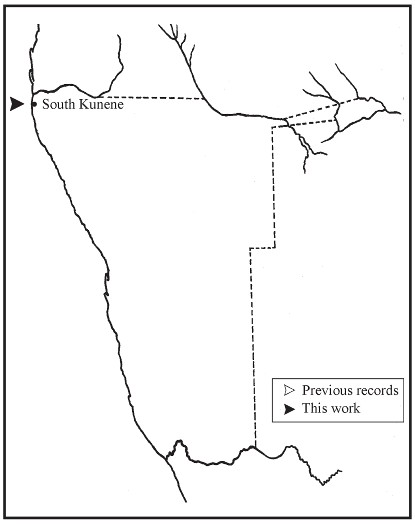


PLATE 4. – A-C. *Chondria capensis*. D-F. *Pterosiphonia complanata*. G. *Corallina sp*. (Drawing by J. Corbera).

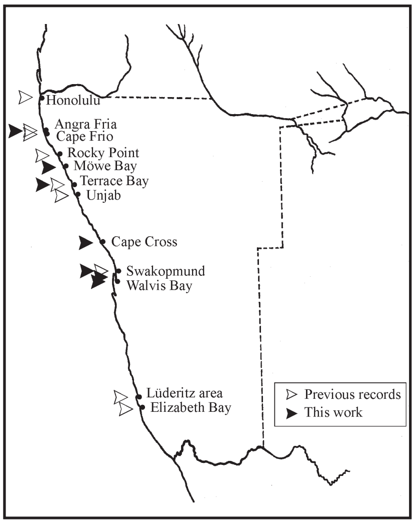
MAPS



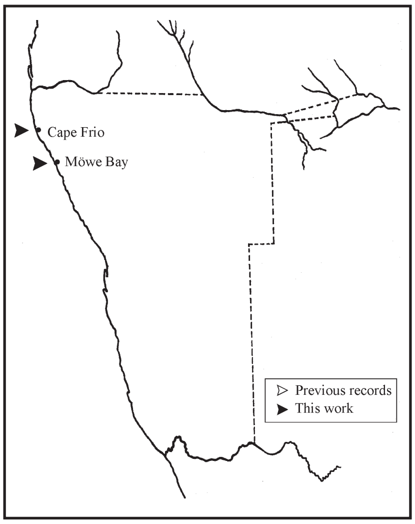
Map 1. – *Stylonema alsidii*



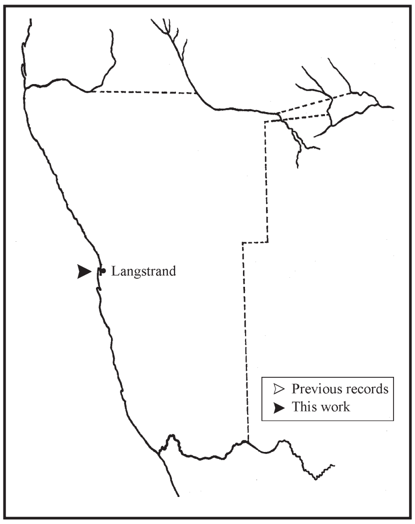
Map 2. – *Stylonema cornu-cervi*



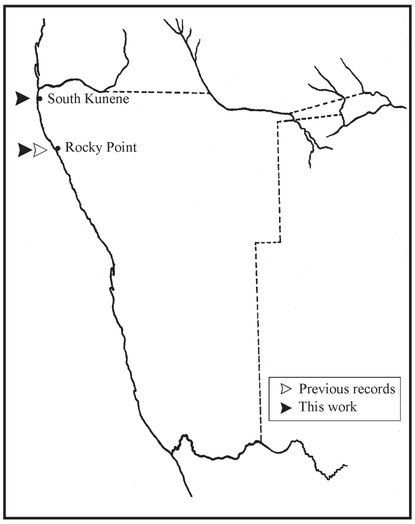
Map 3. – *Porphyra capensis*



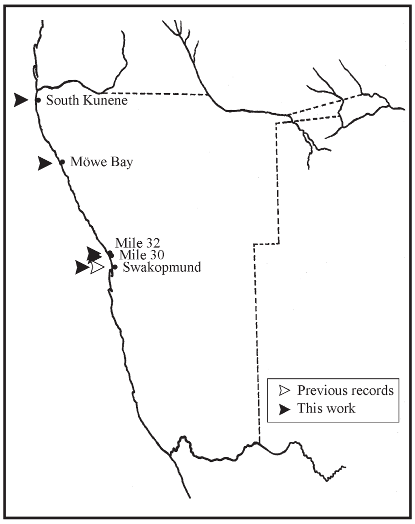
Map 4. – *Porphyra saldanhae*



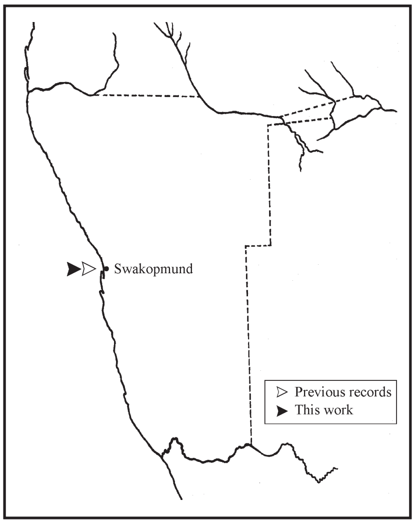
Map 5. – *Porphyra* sp.



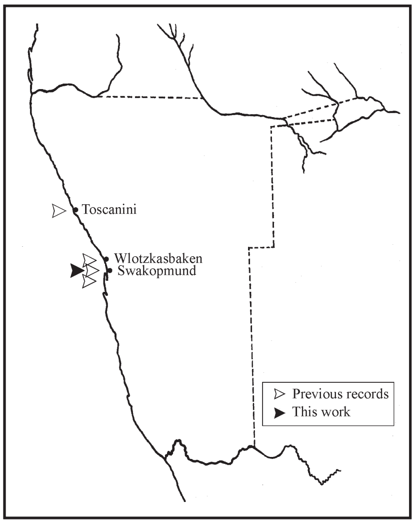
Map 6. – *Acrochaetium catenulatum*



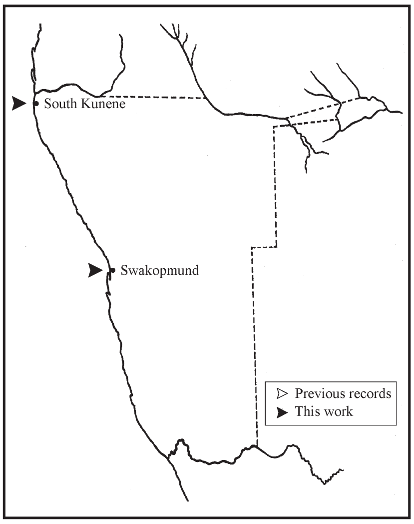
Map 7. – *Acrochaetium daviesii*



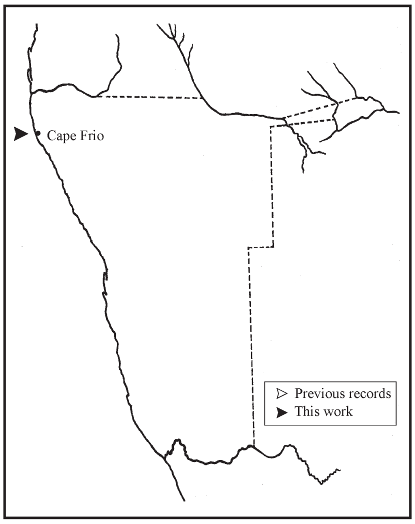
Map 8. – *Acrochaetium endophyticum*



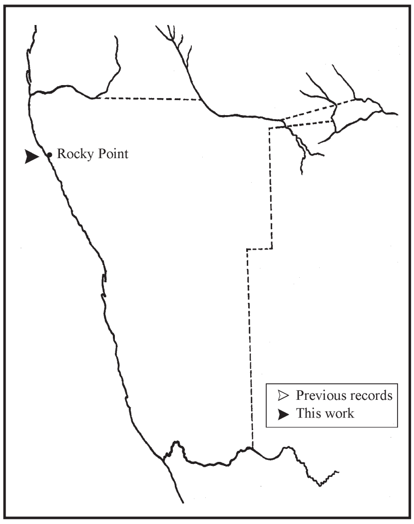
Map 9. – *Acrochaetium reductum*



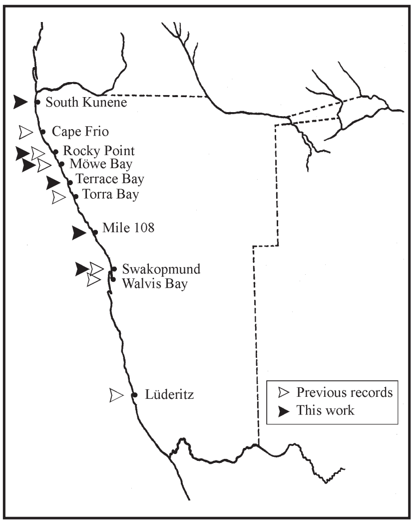
MAP 10. – *Acrochaetium secundatum*



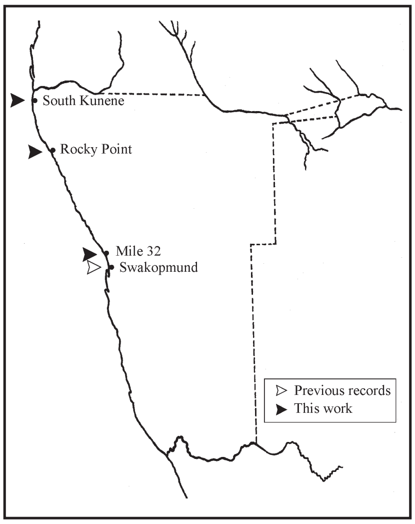
MAP 11. – *Acrochaetium* sp.



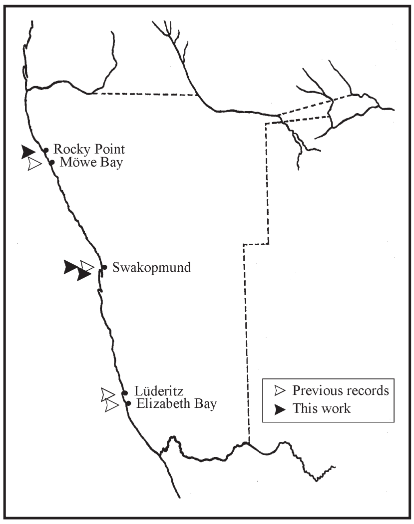
MAP 12. – *Rhodothamniella floridula*



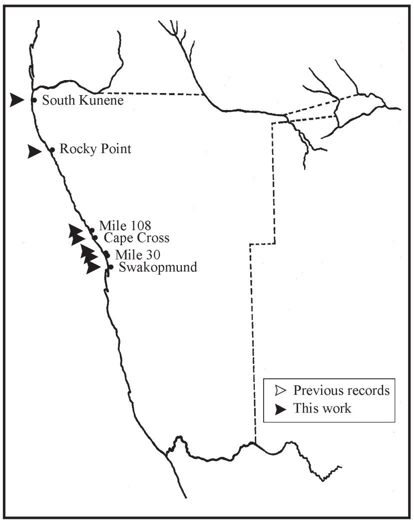
MAP 13. – *Nothogenia erinacea*



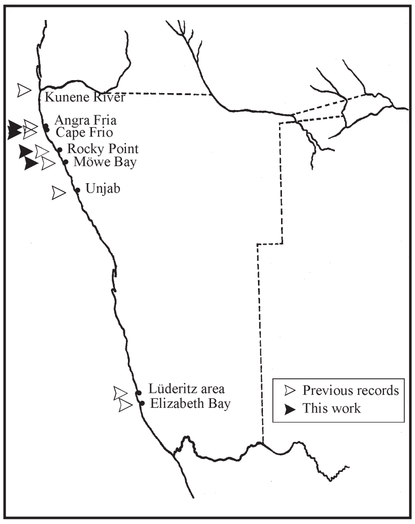
MAP 14. – *Gelidium pusillum*



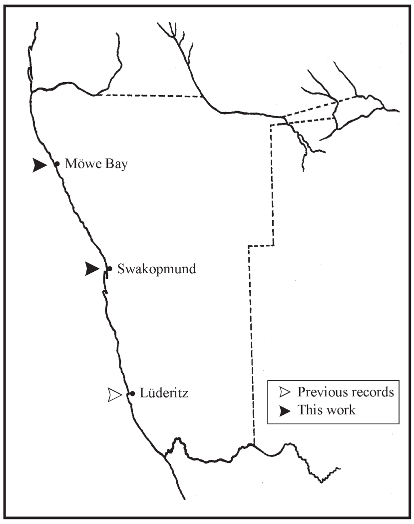
MAP 15. – *Suhria vittata*



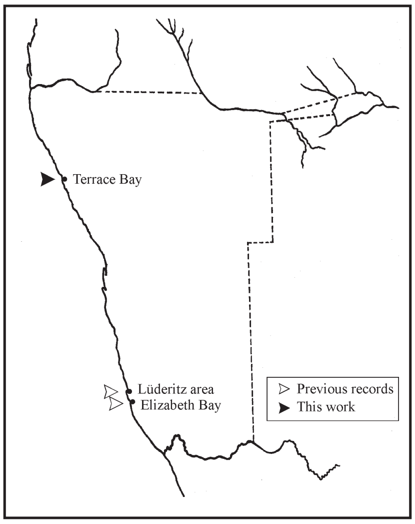
MAP 16. – *Gracilariopsis longissima*



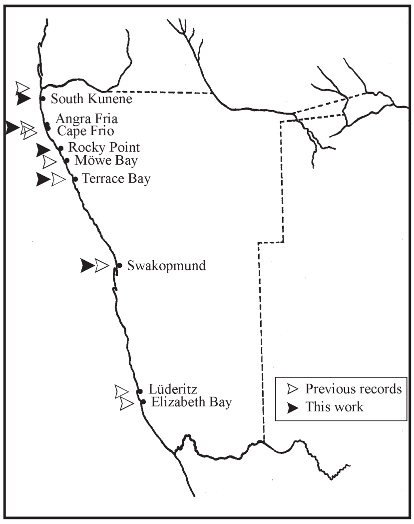
MAP 17. – *Aeodes orbitosa*



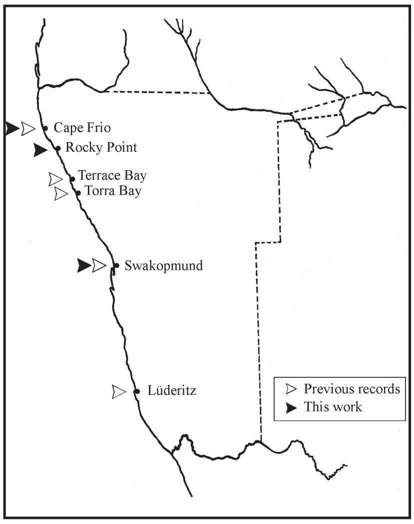
MAP 18. – *Grateloupia doryphora*



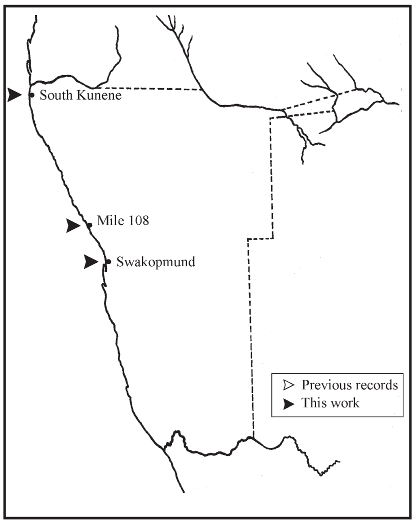
MAP 19. – *Grateloupia filicina*



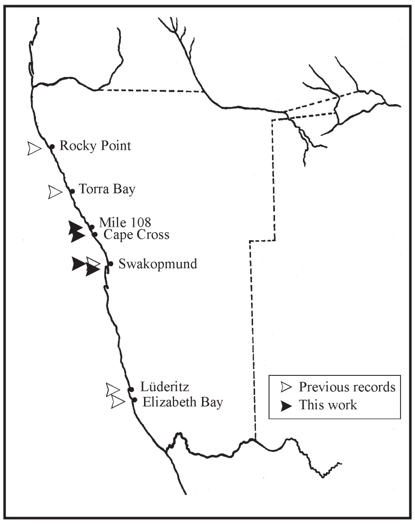
MAP 20. – *Pachymenia carnosa*



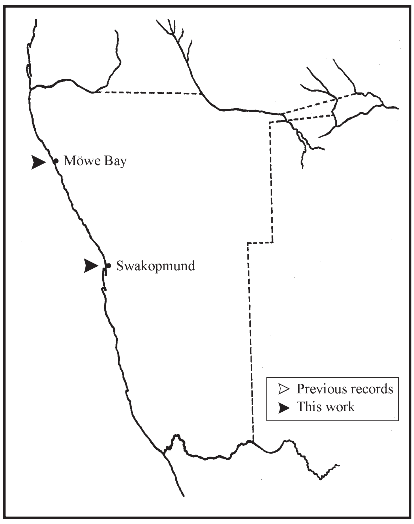
MAP 21. – *Phyllymenia belangeri*



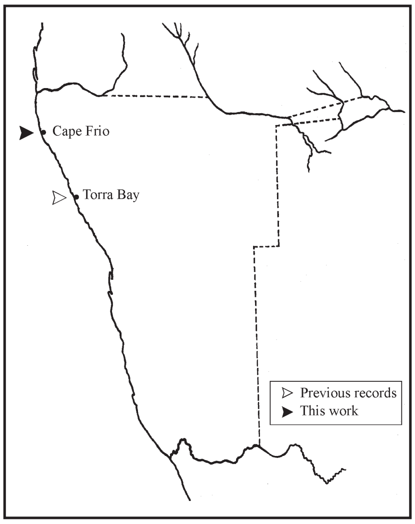
MAP 22. – *Hildenbrandia crouanii*



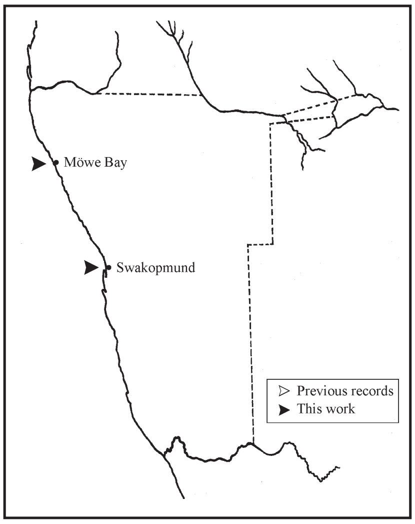
MAP 23. – *Hildenbrandia rubra*



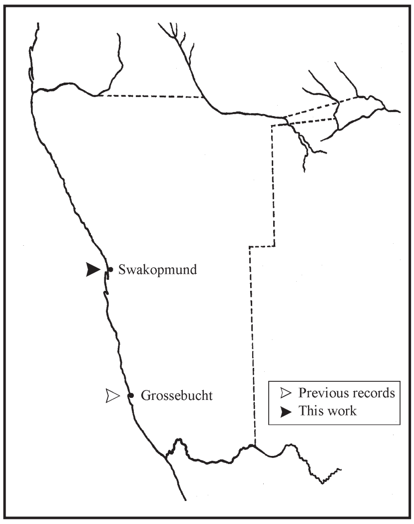
MAP 24. – *Corallina* sp.



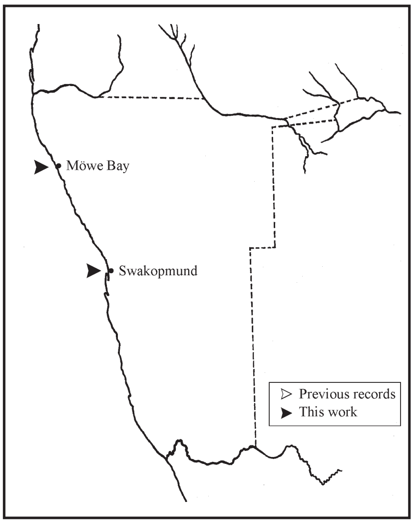
MAP 25. – *Lithophyllum neoatalay*ense



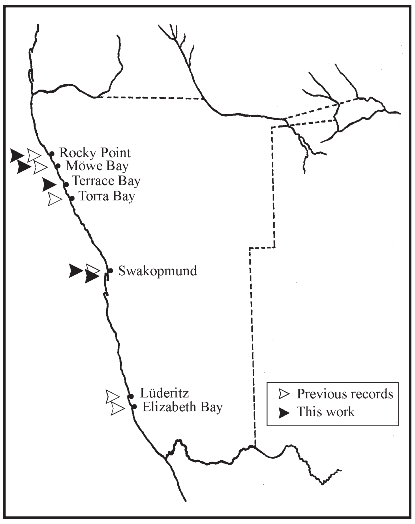
MAP 26. – *Melobesia membranacea*



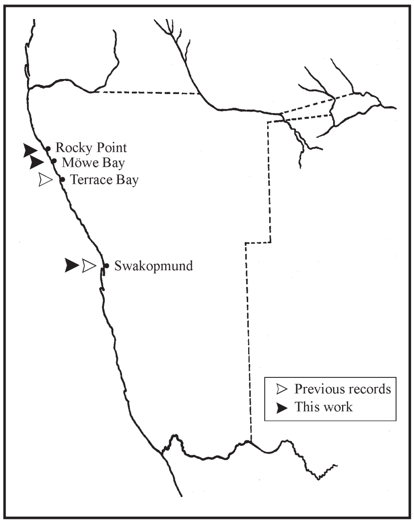
MAP 27. – *Synarthrophyton munimentum*



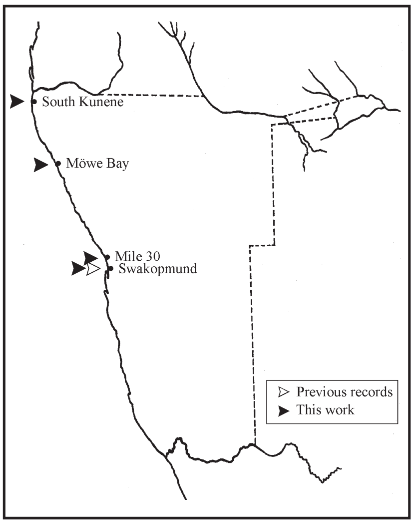
Map 28. – *Corallinaceae* ind.



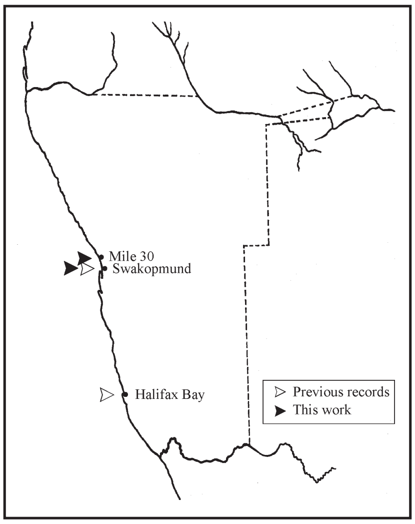
Map 29. – *Caulacanthus ustulatus*



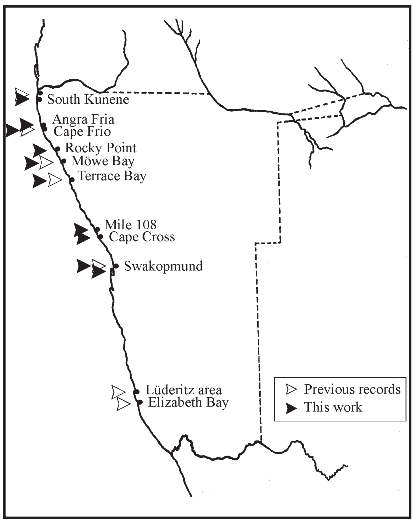
Map 30. – *Heringia mirabilis*



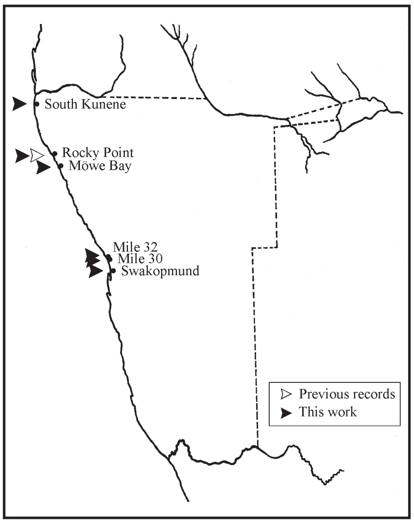
Map 31. – *Rhodophyllis reptans*



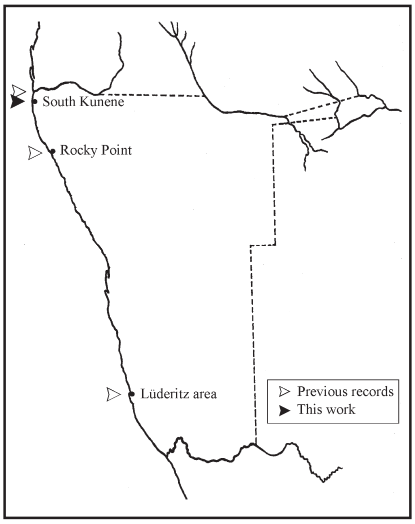
Map 32. – *Gigartina bracteata*



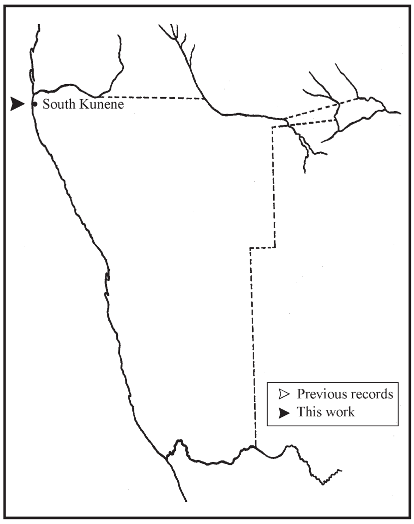
Map 33. – *Mazzaella capensis*



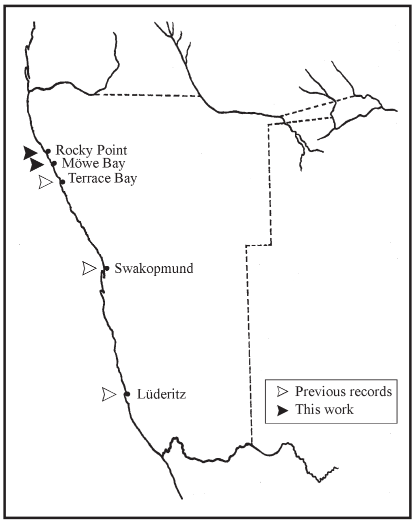
Map 34. – *Hypnea ecklonii*



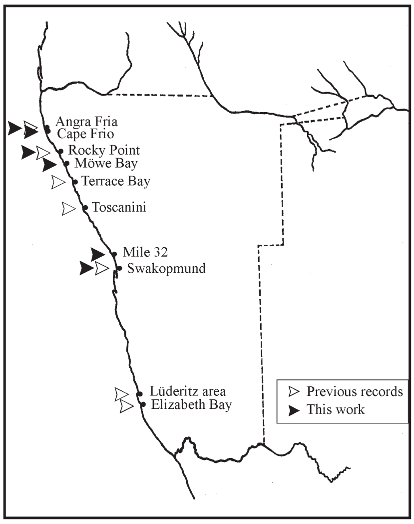
Map 35. – *Hypnea spicifera*



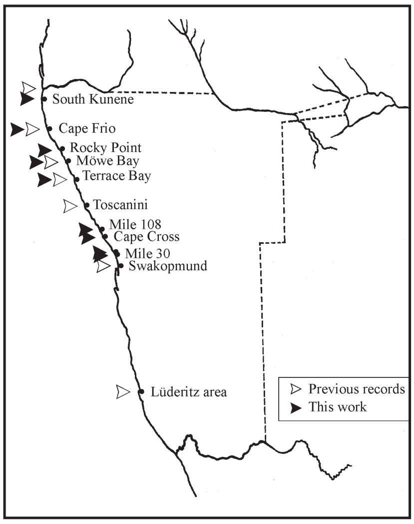
Map 36. – *Hypnea* sp.



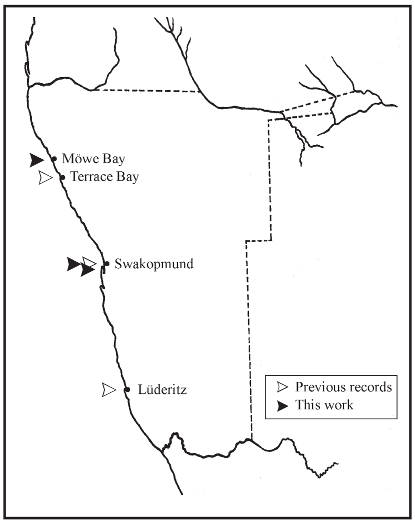
Map 37. – *Kallymenia schizophylla*



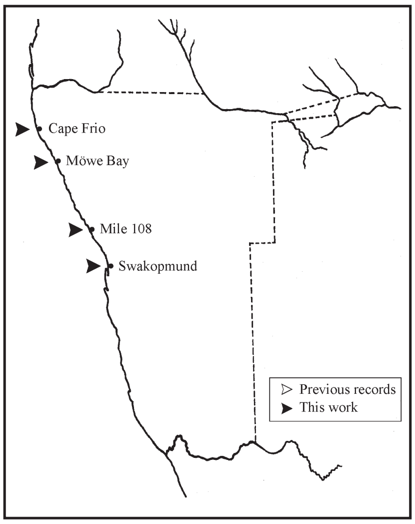
Map 38. – *Ahnfeltiopsis glomerata*



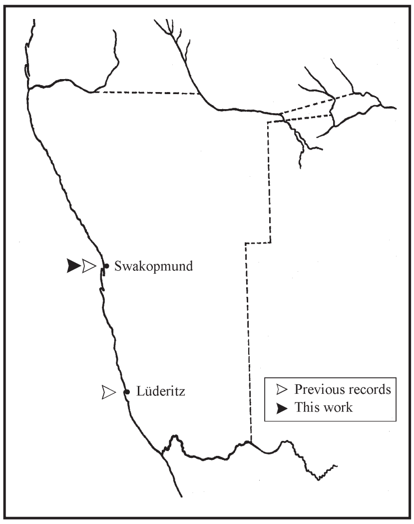
Map 39. – *Ahnfeltiopsis vermicularis*



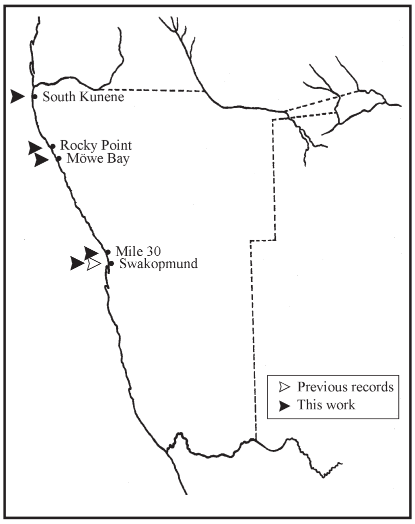
Map 40. – *Gymnogongrus dilatatus*



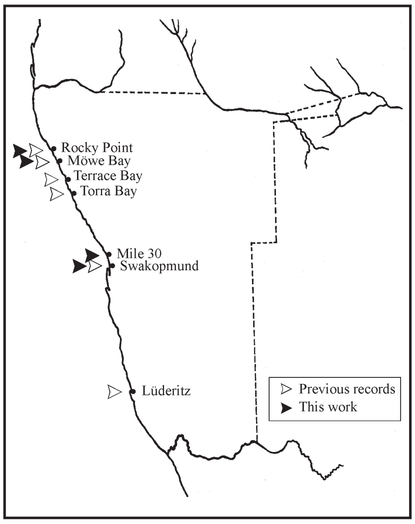
Map 41. – *Gymnogongrus* sp.



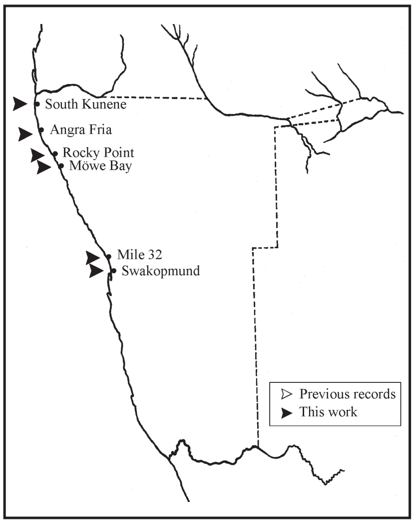
Map 42. – *Schizymenia apoda*



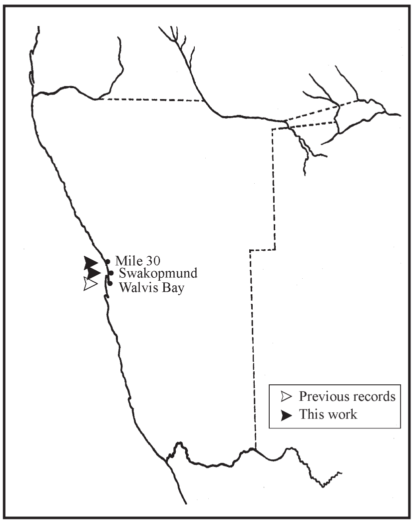
Map 43. – *Plocamium glomeratum*



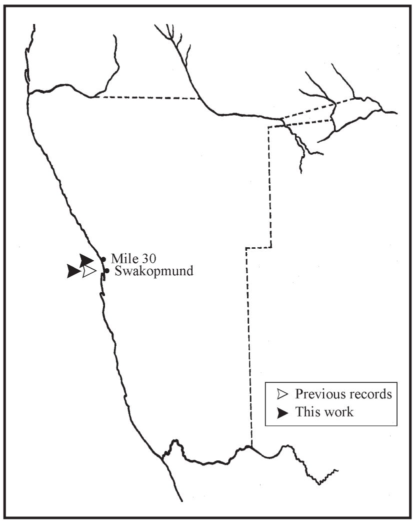
Map 44. – *Plocamium rigidum*



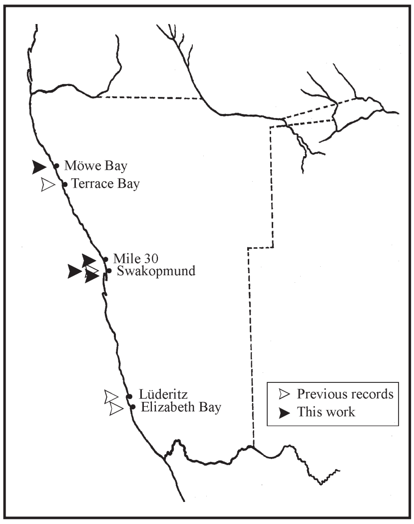
Map 45. – *Gastroclonium reflexum*



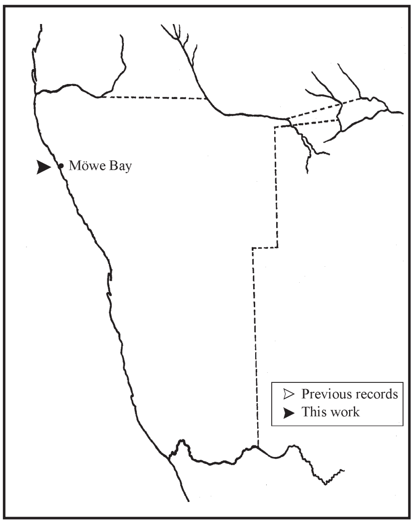
MAP 46. – *Rhodymenia capensis*



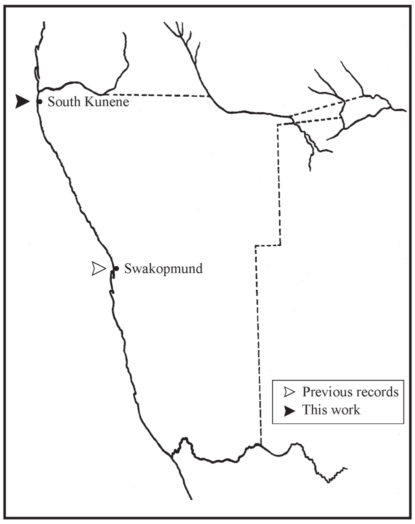
MAP 47. – *Rhodymenia natalensis*



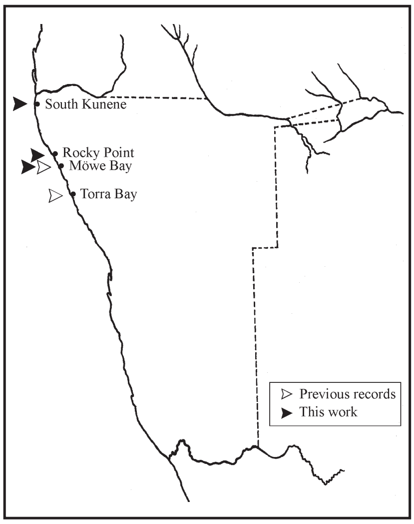
MAP 48. – *Rhodymenia obtusa*



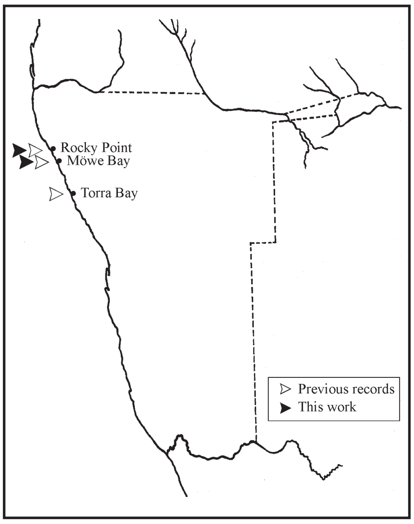
MAP 49. – *Rhodymeniaceae* ind.



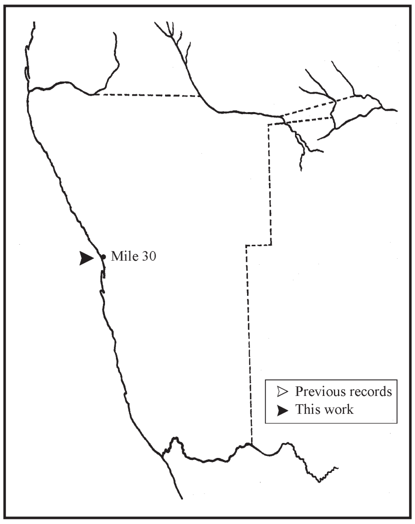
MAP 50. – *Aglaothamnion hookeri*



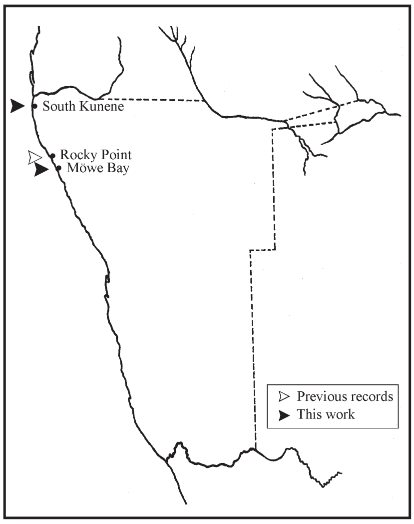
MAP 51. – *Antithamnion diminuatum* var. *diminuatum*



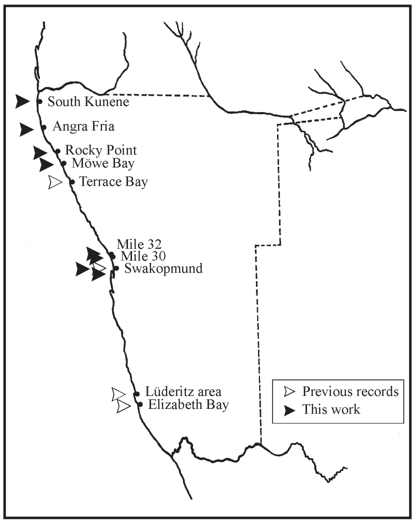
MAP 52. – *Antithamnion diminuatum* var. *polyglandulum*



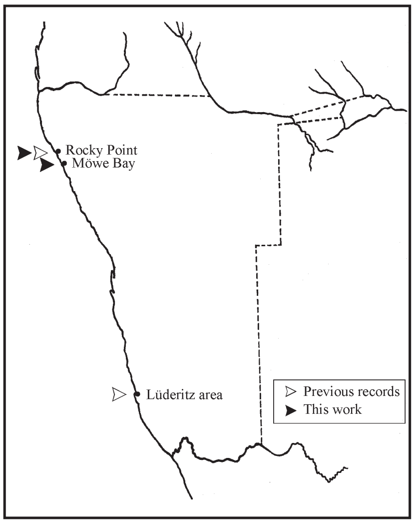
MAP 53. – *Antithamnion secundum*



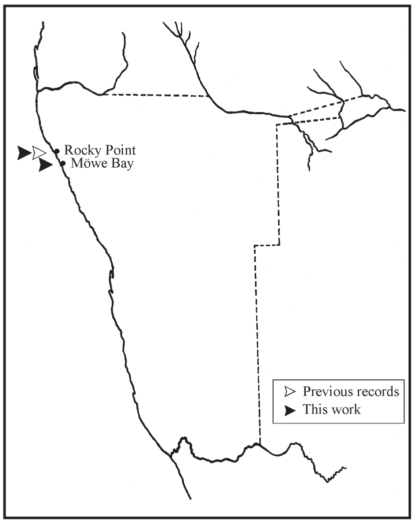
MAP 54. – *Antithamnionella verticillata*



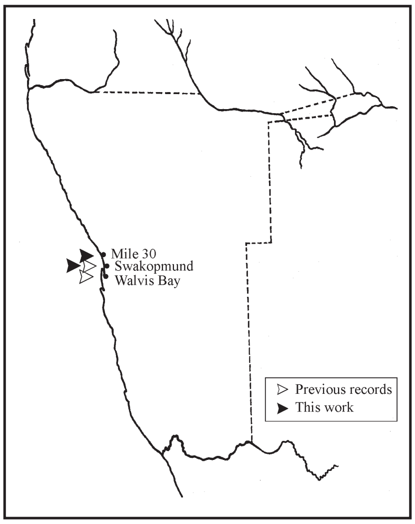
Map 55. – *Aristothamnion collabens*



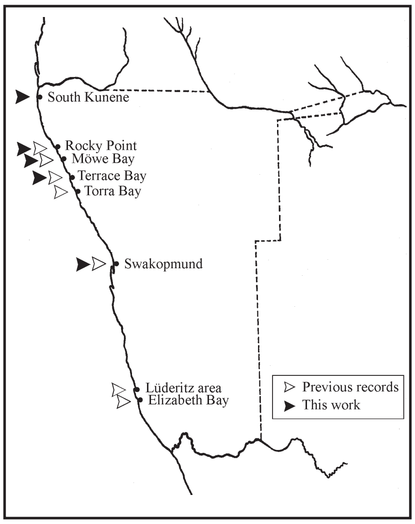
Map 56. – *Ballia sertularioides*



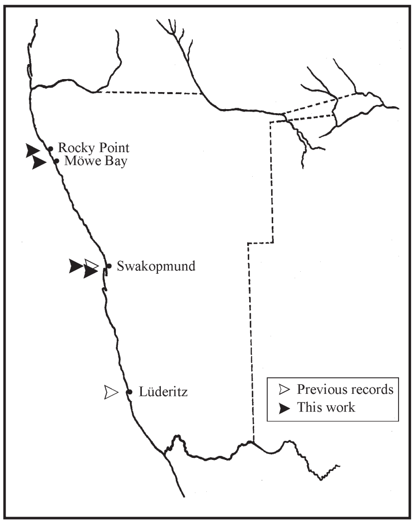
Map 57. – *Bornetia repens*



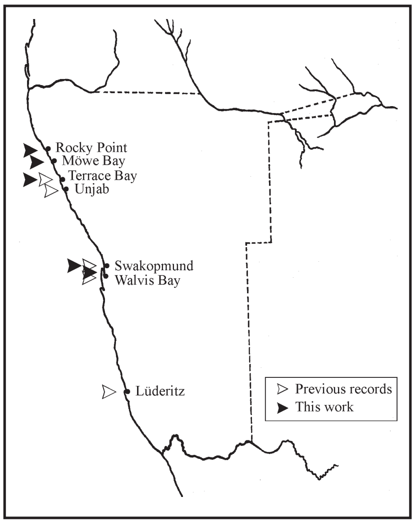
Map 58. – *Carpoblepharis minima*



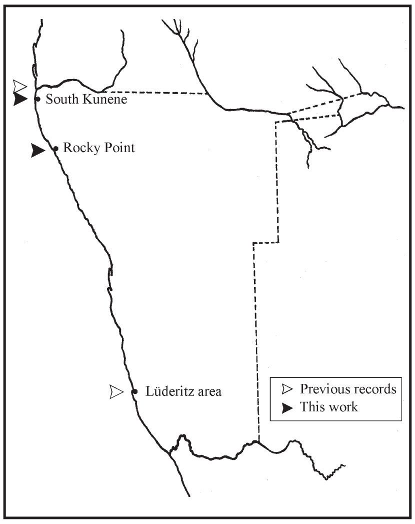
Map 59. – *Centroceras clavulatum*



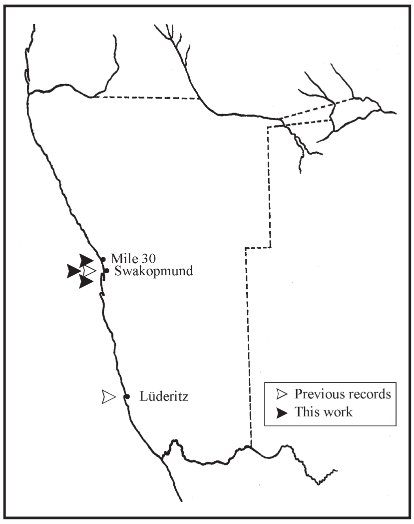
Map 60. – *Ceramium arenarium*



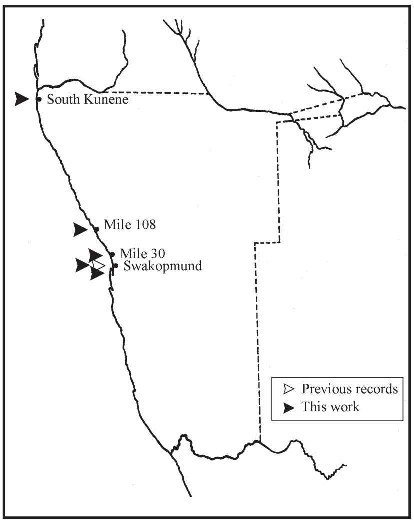
Map 61. – *Ceramium atrorubescens*



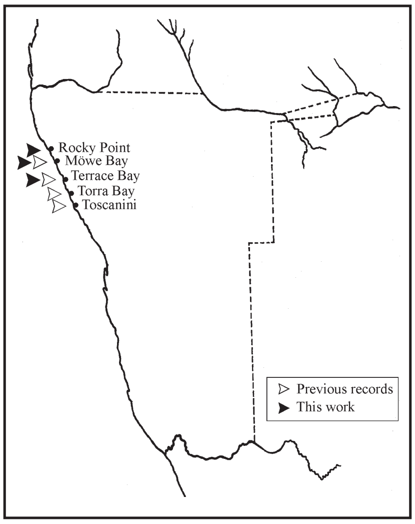
Map 62. – *Ceramium flaccidum*



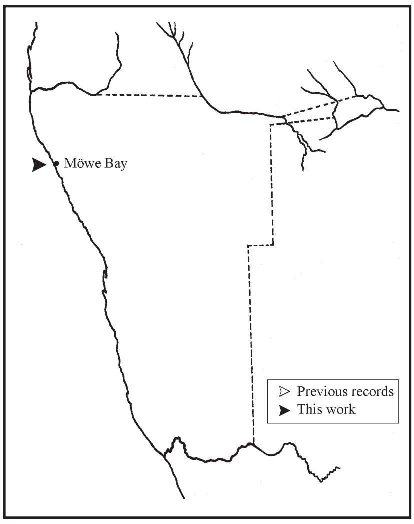
Map 63. – *Ceramium planum*



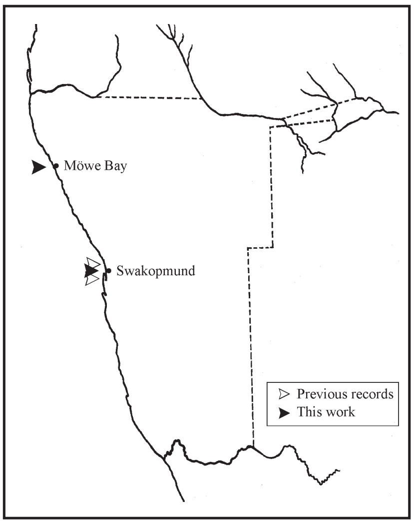
Map 64. – *Ceramium* sp.



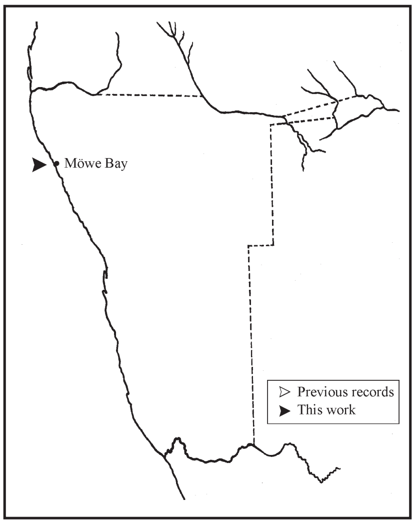
Map 65. – *Griffithsia confervoides*



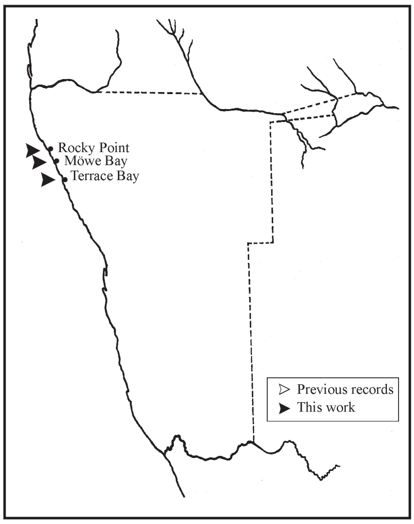
Map 66. – *Microcladia gloria-spei*



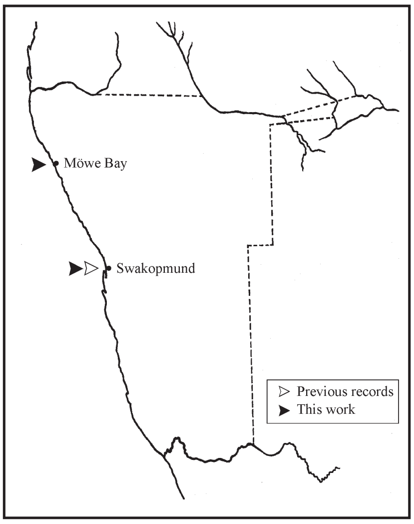
Map 67. – *Pleonosporium filicinum*



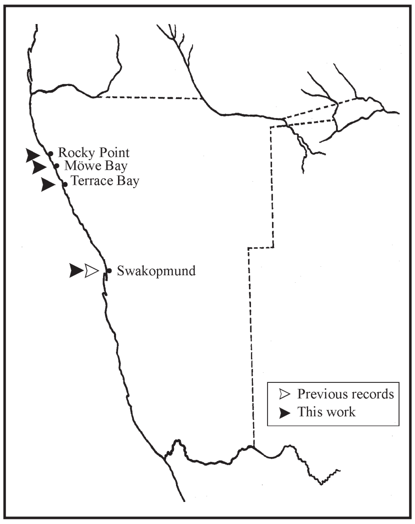
Map 68. – *Ptilothamnion polysporum*



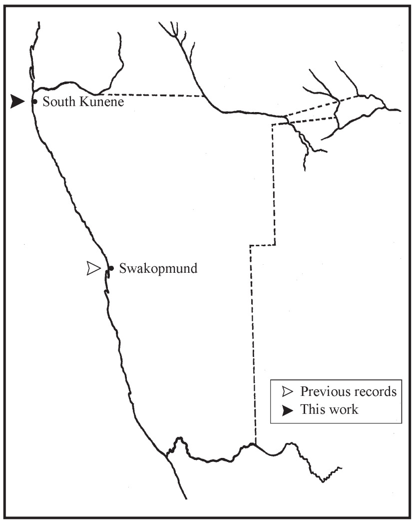
Map 69. – *Heterosiphonia crispella*



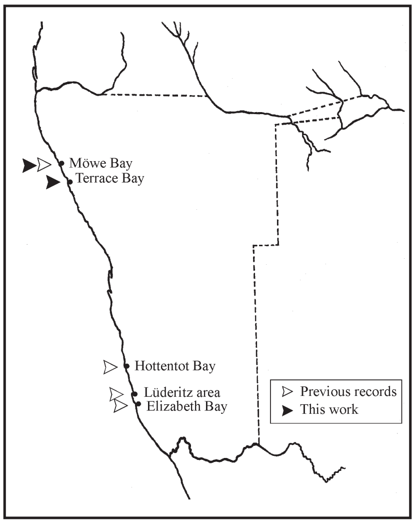
Map 70. – *Heterosiphonia dubia*



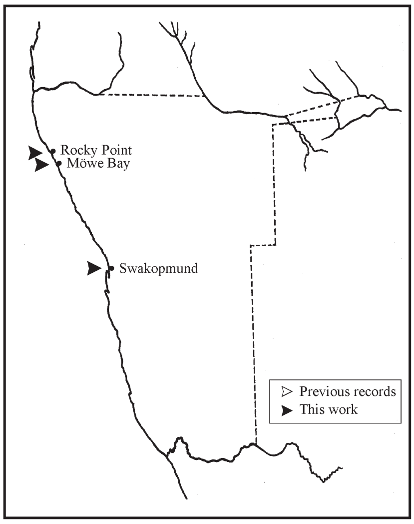
Map 71. – *Acrosorium cincinnatum*



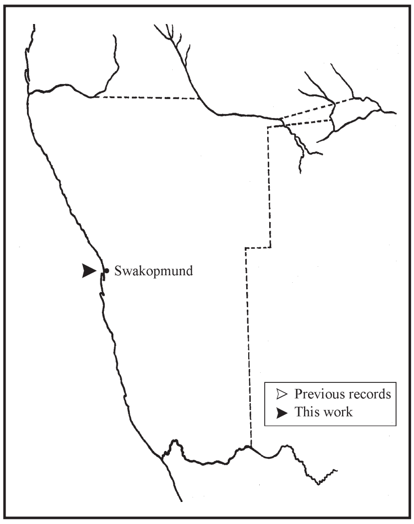
Map 72. – *Myriogramme livida*



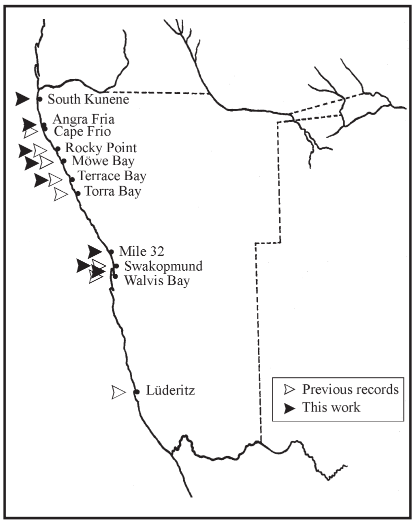
Map 73. – *Platysiphonia intermedia*



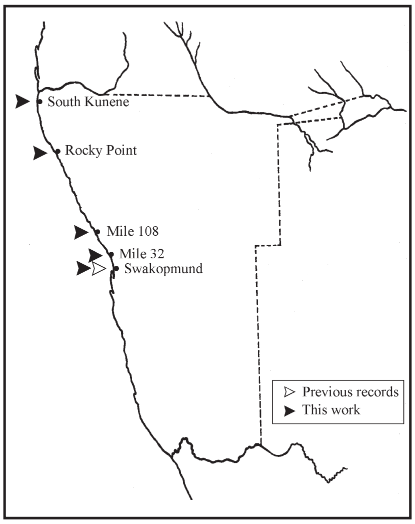
Map 74. – *Delesseriaceae* ind. 1



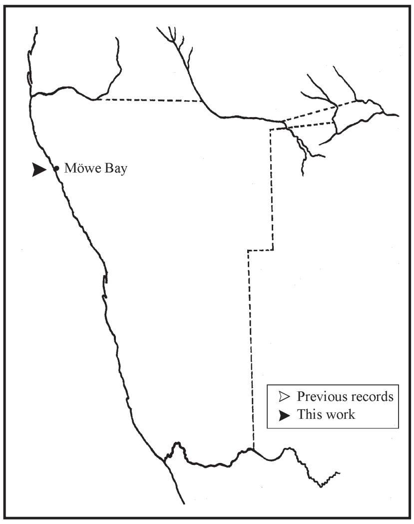
Map 75. – *Delesseriaceae* ind. 2



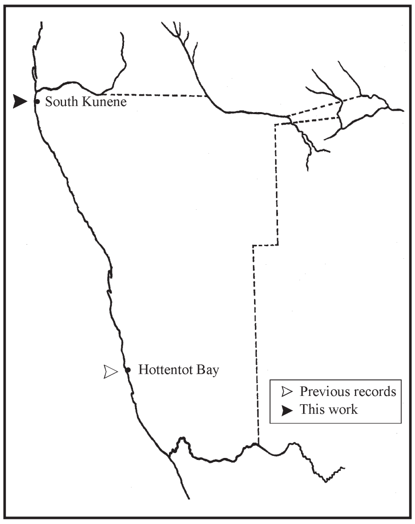
Map 76. – *Chondria capensis*



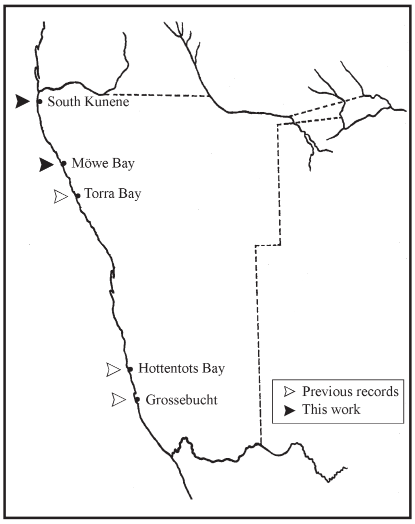
Map 77. – *Ophidocladus simpliciusculus*



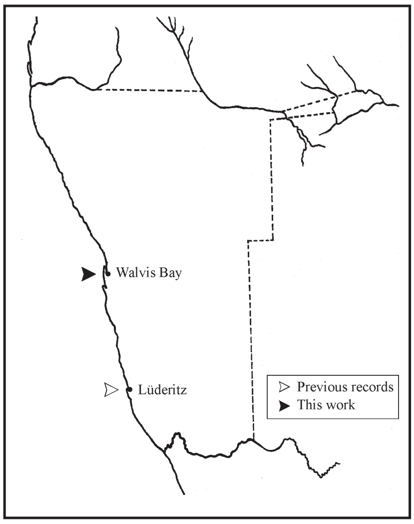
Map 78. – *Placophora binderi*



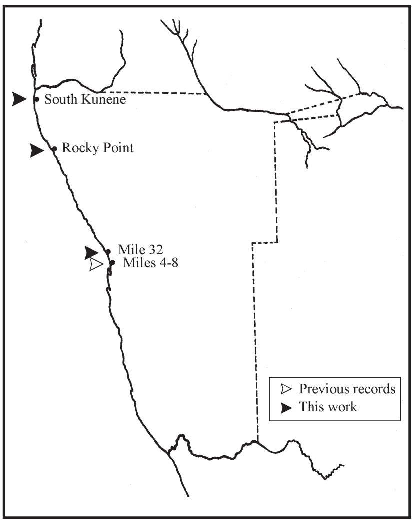
Map 79. – *Polysiphonia incompta*



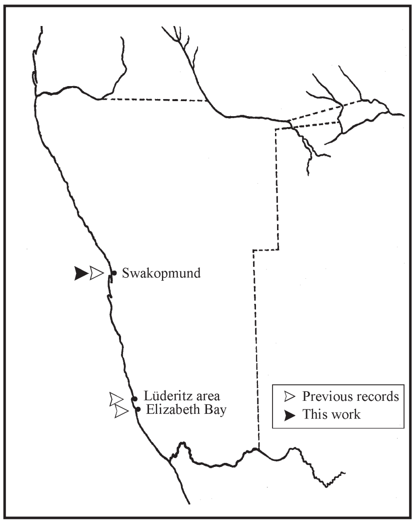
Map 80. – *Polysiphonia namibiensis*



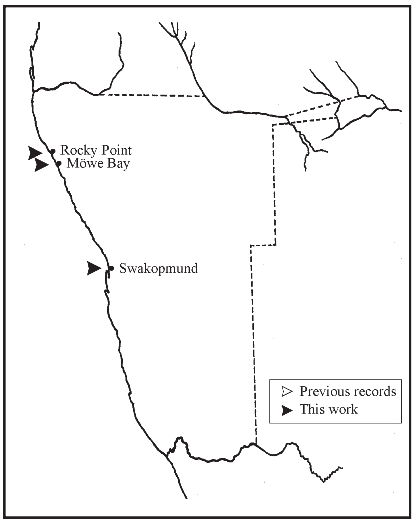
Map 81. – *Polysiphonia nigra*



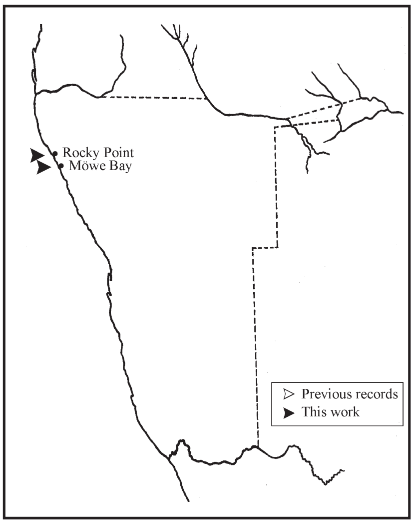
MAP 82. – *Polysiphonia scopulorum*



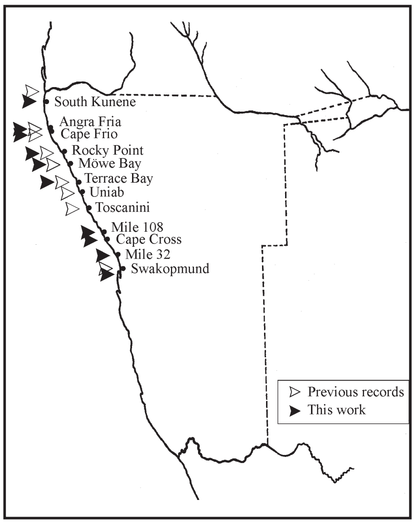
MAP 83. – *Polysiphonia virgata*



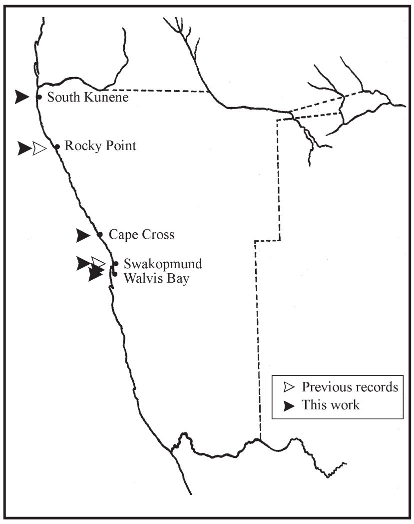
MAP 84. – *Pterosiphonia complanata*



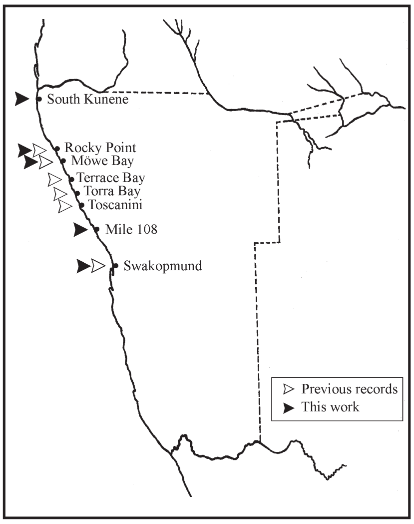
MAP 85. – *Pterosiphonia* cf. *dendroidea*



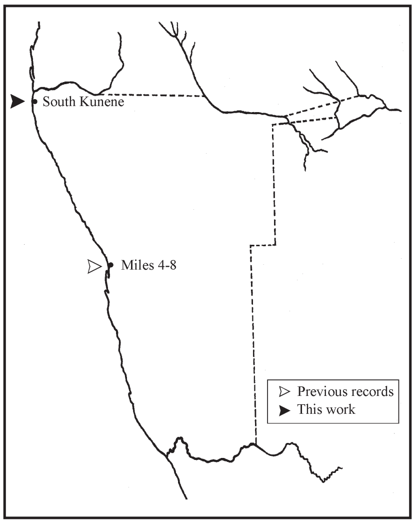
MAP 86. – *Streblocladia camptoclada*



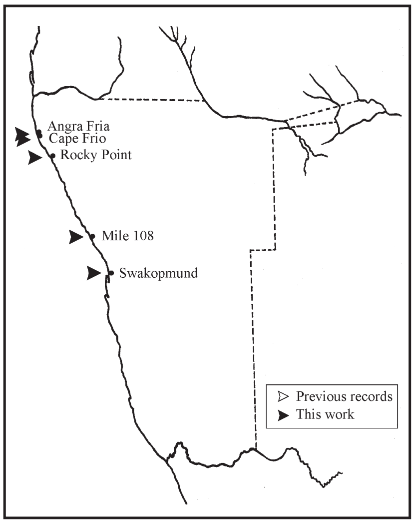
MAP 87. – *Streblocladia corymbifera*



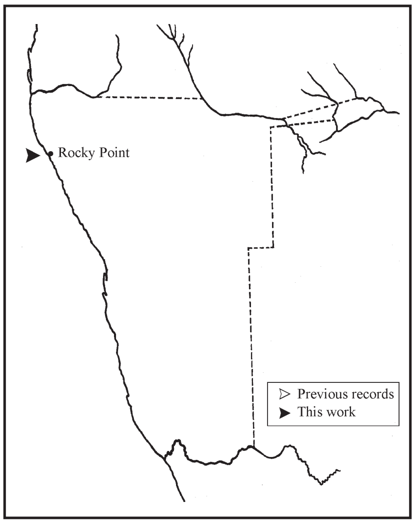
MAP 88. – *Tayloriella tenebrosa*



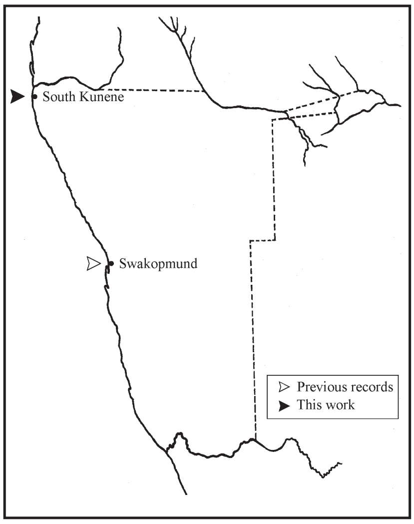
MAP 89. – *Aiolocolax pulchellus*



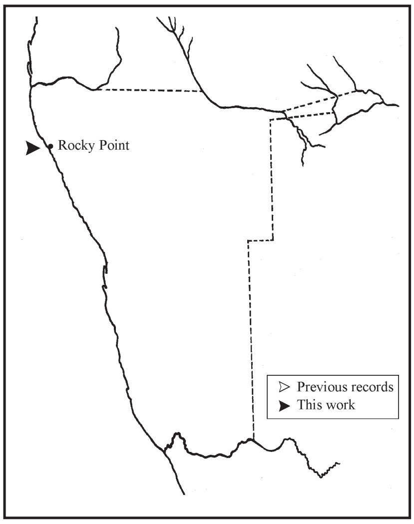
MAP 90. – *Ectocarpus fasciculatus*



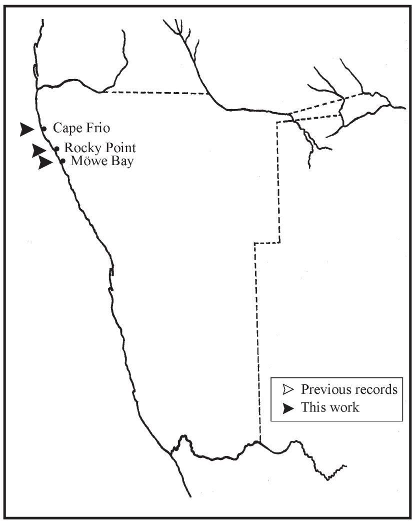
Map 91. – *Feldmannia irregularis*



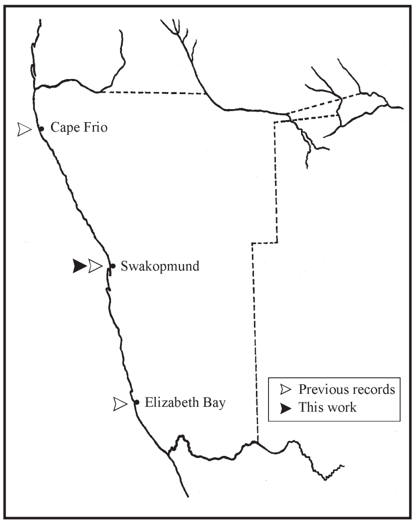
Map 92. – *Hincksia granulosa*



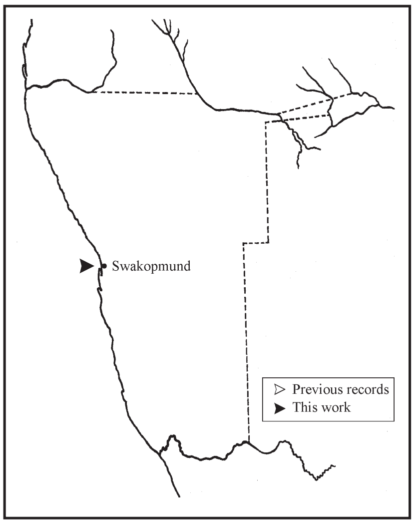
Map 93. – *Bachelotia antillarum*



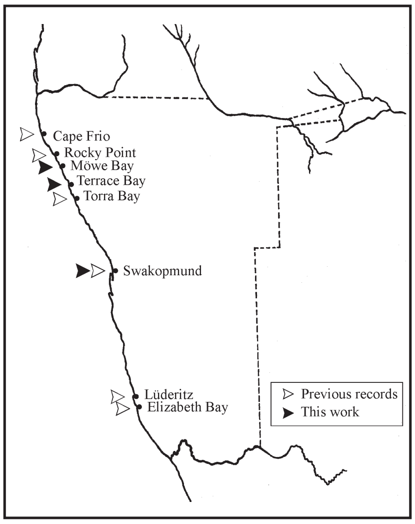
Map 94. – *Hapalospongidion* sp.



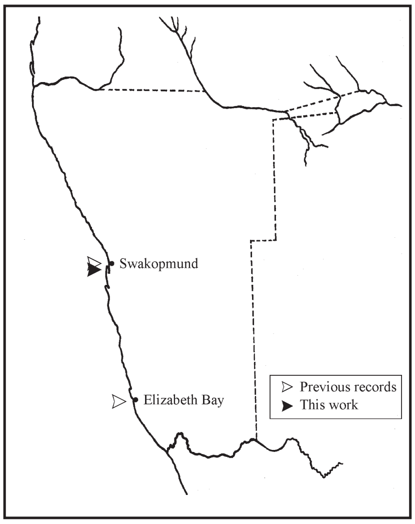
Map 95. – *Ralfsia expansa*



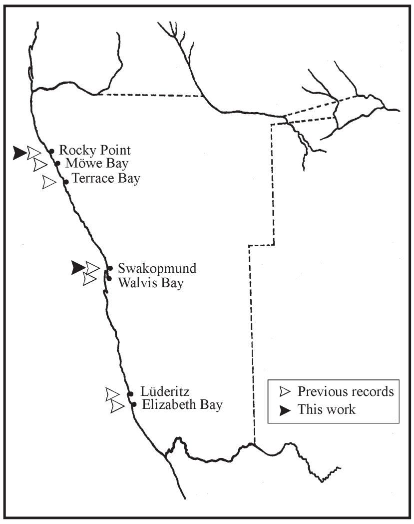
Map 96. – *Stragularia clavata*



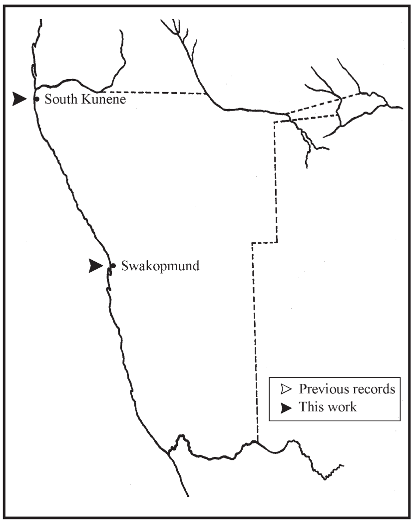
Map 97. – *Chordariopsis capensis*



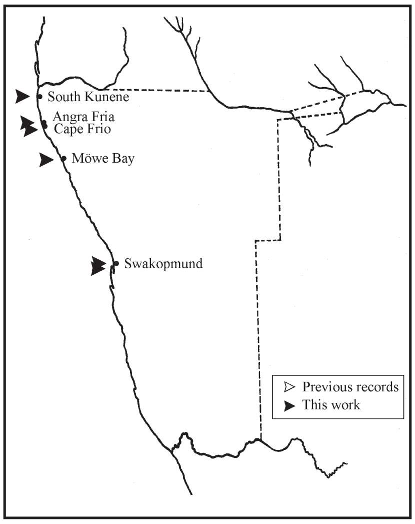
Map 98. – *Petalonia fascia*



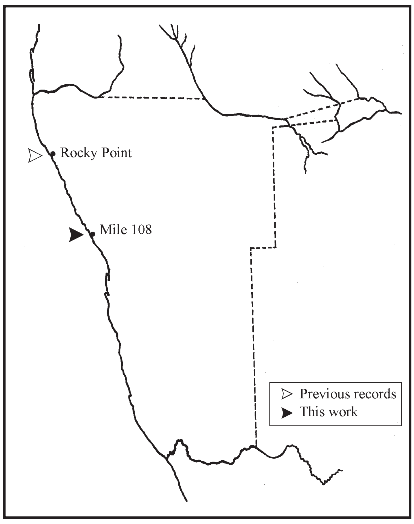
Map 99. – *Laminaria pallida*



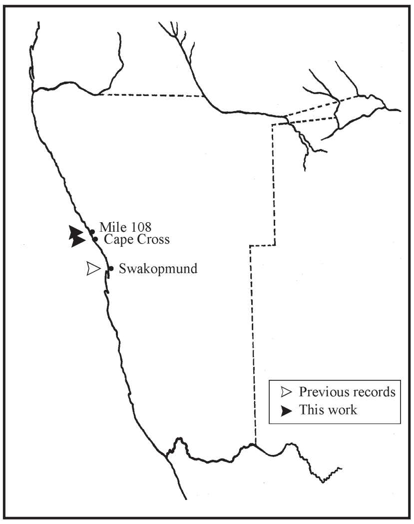
MAP 100. – *Entocladia leptochaete*



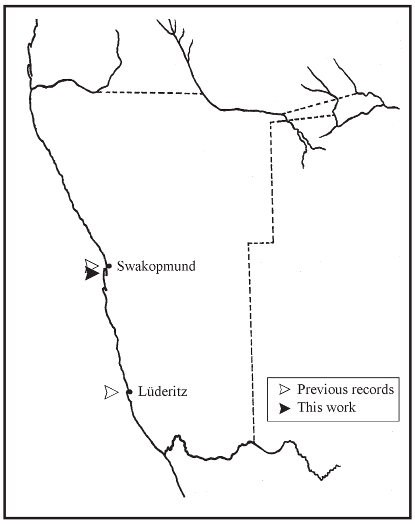
MAP 101. – *Ulvella lens*



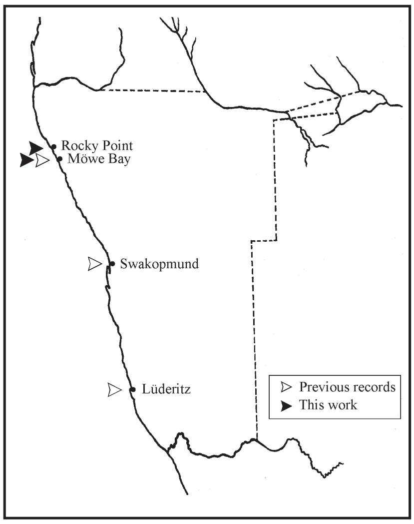
MAP 102. – *Enteromorpha flexuosa*



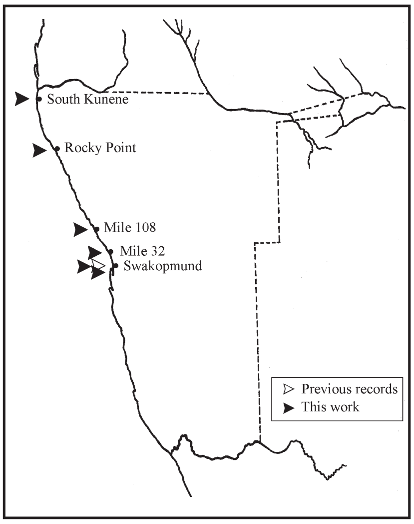
MAP 103. – *Enteromorpha intestinalis*



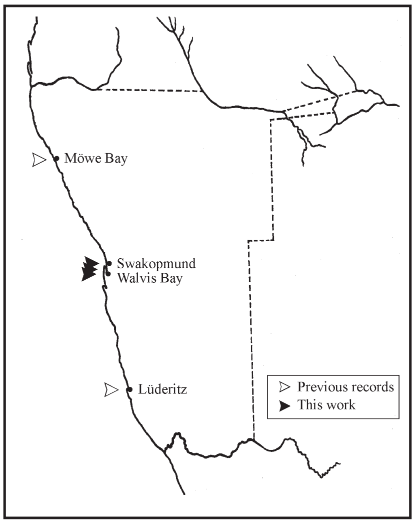
MAP 104. – *Enteromorpha linza*



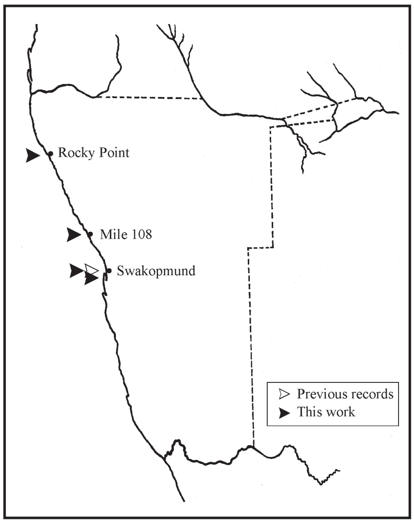
MAP 105. – *Ulva capensis*



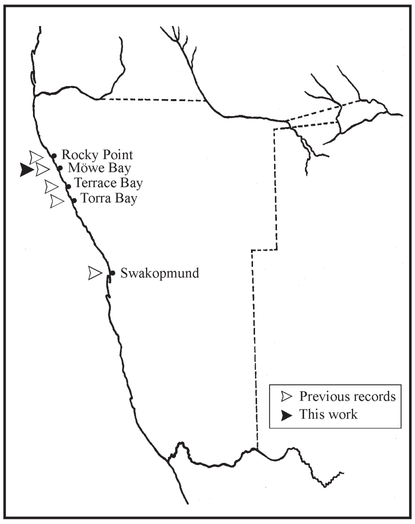
MAP 106. – *Ulva fasciata*



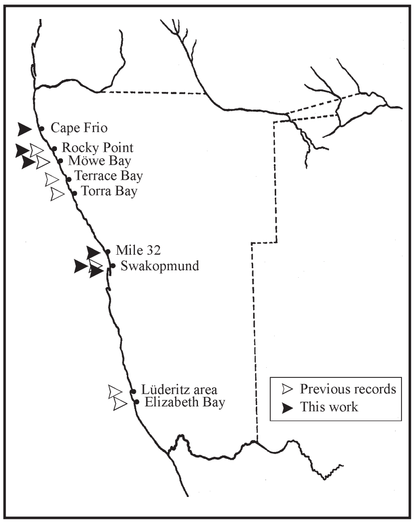
MAP 107. – *Ulva rigida*



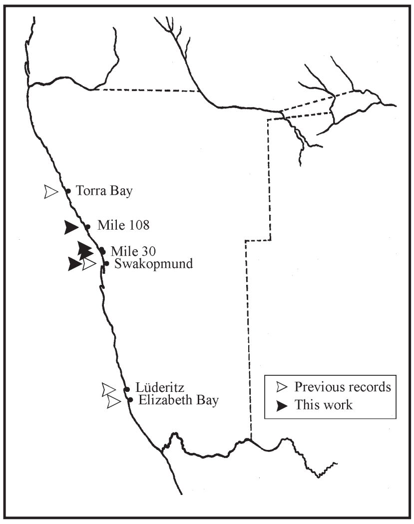
MAP 108. – *Chaetomorpha aerea*



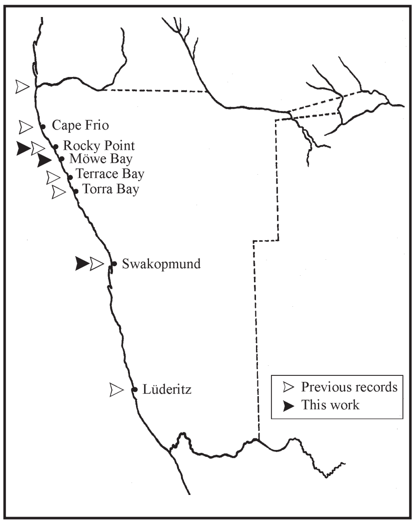
MAP 109. – *Chaetomorpha robusta*



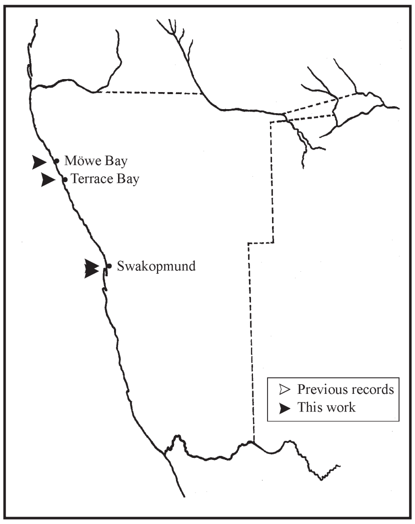
MAP 110. – *Cladophora capensis*



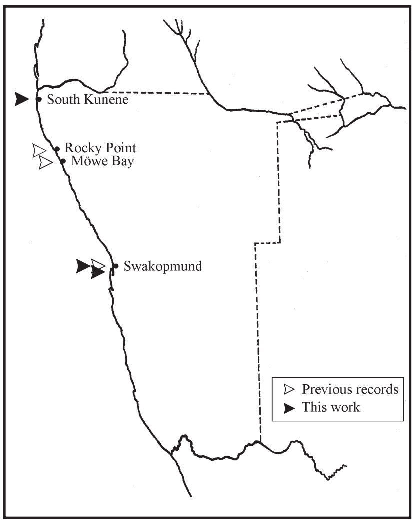
MAP 111. – *Cladophora flagelliformis*



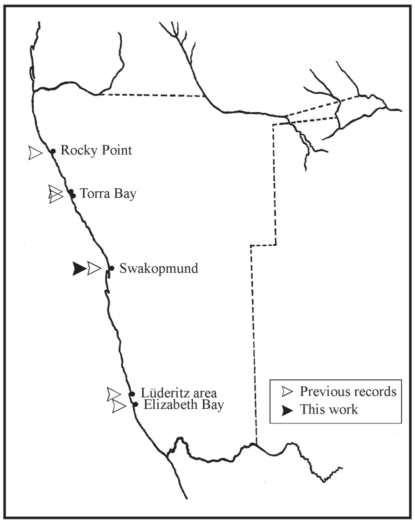
MAP 112. – *Cladophora hospita*



MAP 113. – *Bryopsis hypnoides*



MAP 114. – *Codium decorticatum*



MAP 115. – *Codium fragile* subsp. *capense*

KEYS TO THE GENERA

RHODOPHYTA

1. Plants heavily calcified 2
1. Plants uncalcified or with devil calcification 10

2. Plants crustose, non articulated 3
2. Plants articulated, with axes composed of uncalcified genicula and calcified intergenicula 9

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3. Tetrasporangia zonately divided 4

4. Cells joined by secondary pit connections .... *Lithophyllum*
4. Cells joined by cell fusions 5

5. Sporangial conceptacles uniporate .... *Spongites*
5. Sporangial conceptacles multiporate 6

6. Structure dimerous .... *Melobesia*
6. Structure monomerous 7

7. Medulla coaxial 8
7. Medulla not coaxial .... *Leptophytum*

8. Spermatangial filaments unbranched .... *Mesophyllum*
8. Spermatangial filaments mostly branched .... *Synarthrophyton*

9. Plants pinnately branched throughout; fertile intergenicula usually not bearing further ramifications .... *Corallina*
9. Plants pinnately branched in sterile parts and dichotomously in fertile parts; fertile intergenicula usually at the base of a dichotomy .... *Arthocardia*

10. Plants crustose 11
10. Plants of another form 14

11. Plants epiphytic, forming microscopic crusts 12
11. Plants epilithic, forming macroscopic crusts 13

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12. Crusts consisting of branched radial filaments having free ends .... *Erythrocladia*

13. Tetrasporangia in conceptacles .... *Hildenbrandia*
13. Tetrasporangia in sori .... *Haematocelis*

14. Plants consisting of horizontally expanded blades 15
14. Plants otherwise 16

15. Blades consisting of laterally coalesced polysiphonous filaments, showing in cross section groups of an axial cell and five pericentral cells; reproductive structures in erect branches .... *Placophora*
15. Blades lacking a polysiphonous structure; reproductive structures in nemathecia .... *Peyssonnelia*

16. Plants consisting wholly or in part of hollow cavities 17
16. Plants of another form 21

17. Plants consisting of sessile bladders; secretory cells absent .... *Nothogenia*
17. Plants otherwise; secretory cells present 18

18. Plants composed of a solid stipe bearing constricted hollow branches with internal septation .... *Gastroclonium*
18. Plants lacking a solid stipe; axes hollow throughout 19

19. Axes with internal monostromatic septa at regular intervals 20
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20. Segments usually shorter than broad; cystocarps with ostiole .... *Champia*
20. Segments usually longer than broad; cystocarps without ostiole .... *Chylocladia*

21. Plants foliaceous or flattened 22
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22. Blades monostromatic throughout 23
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24. Blades polystromatic throughout 28

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25. Blades without midrib or only with a faint midrib in the proximal parts 26

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26. Carposporangia terminal; macroscopic veins absent 27

27. Microscopic veins present .... *Acrosorium*
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28. Blades completely pseudo-parenchymatous 29
28. Blades with a filamentous medulla or with a medulla mixed pseudo-parenchyma and filaments 38

29. Blades in cross section with a regular pattern of horizontal and vertical cell rows 30
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30. Tetrasporangial sori located on proliferations or restricted to the blade margins 31

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73. Tetrasporangia cruciate 74

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81. Cells with pit connections...83

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91. Main axis with two or more laterals per cell 92
91. Main axis with one lateral per cell, or plants with a dichotomous branching pattern 94

92. Main axis with two laterals per cell...93
92. Main axis with three or more laterals per cell ....*Antithamnionella*

93. Apex of main axis over 50 µm in diameter; gland cells absent...*Ballia*
93. Apex of main axis less than 20 µm in diameter; gland cells usually present.......................*Antithamnion*

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94. Branching dichotomous 95

95. Reproductive structures in compact branch systems, lateral on the filaments ....*Bornetia*
95. Reproductive structures in whorls on subapical cells (male and tetrasporangial), or terminal (female)...*Griffithsia*

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98. Cells uninucleate; rhizoidal filaments not forming secondary connections to other cells; carposporophyte without involucral filaments .... *Aglaothamnion*
98. Cells multinucleate; rhizoidal filaments forming conspicuous secondary connections to other cells; carposporophyte with involucral filaments .... *Pleonosporium*

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99. Carposporophyte without involucral filaments 100

100. Tetrasporophyte forming polysporangia instead of tetrasporangia .... *Aristothamnion*
100. Tetrasporophyte forming tetrasporangia (sometimes bisporangia) .... *Aglaothamnion*

101. Branching sympodial, at regular intervals the main axis developing into a pseudolateral; pseudolaterals often in part uniseriate, pigmented 102
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102. Pseudolaterals distichously arranged, arising at intervals of two or more segments .... *Heterosiphonia*

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104. Pericentral cells transversely divided .... *Bostrichia*
104. Pericentral cells not transversely divided 105

105. Main axes bearing determinate and indeterminate laterals in more or less regular sequence, mostly with 3 determinate laterals between successive indeterminate laterals .... *Herposiphonia*
105. Branching pattern not as above 106

106. Plants with relatively extensive prostrate axes from which several relatively short erect axes arise 107
106. Plants mainly erect, although relatively short prostrate axes may occur 108

107. Pericentral cells 4; one tetrasporangium per segment .... *Polysiphonia*
107. Pericentral cells 12-28; two tetrasporangia per segment .... *Ophidocladus*

108. Axes with determinate laterals at intervals of 2-3(-4) segments, alternate and distichously arranged in the lower half of the plant and spirally arranged in the upper part .... *Tayloriella*
108. Branching pattern not as above 109

109. Apical zone of the plant with branch initials and trichoblasts unilaterally arranged, adaxial; first pericentral cell cut off opposite a lateral branch .... *Streblocladia*
109. Apical zone of the plant with branch initials and trichoblasts spirally arranged; first pericentral cell cut off directly underneath a lateral branch .... *Polysiphonia*

CHROMOPHYTA (PHAEOPHYCEAE)

1. Plants crustose, without free erect parts 2
1. Plants with free erect parts 5

2. Plants leathery; erect filaments more or less firmly adherent, not separating under slight pressure 3
2. Plants gelatinous; erect filaments loosely adherent and easily separating under slight pressure 4

3. Erect filaments curved at base and heavily adjoined, almost impossible to separate under pressure ....*Ralfsia*
3. Erect filaments vertically directed and moderately adjoined, separating somewhat under pressure ....*Stragularia*

4. Cells with several discoid plastids ....*Basispora*
4. Cells with one to few laminate plastids ....*Hapalospongidion*

5. Plants consisting mainly of uniseriate filaments 6
5. Plants with a more complex structure 9

6. Cells with plastids arranged in stellate groups; sporangia intercalary .... *Bachelotia*
6. Plastids not as above; sporangia lateral or terminal 7

7. Plastids elongate (ribbon shaped), each with several pyrenoids ....*Ectocarpus*
7. Plastids discoid or ovoid, each with usually one pyrenoid 8

8. Meristematic zones usually located at the base of long, unbranched filaments......................*Feldmannia*
8. Meristematic zones scattered throughout the plant ....*Hincksia*

9. Plants irregularly globose 10
9. Plants of another form 11

10. Plants pseudo-parenchymatous in structure, easily squashed into constituent filaments under pressure ....*Leathesia*
10. Plants parenchymatous in structure, not squashed into constituent filaments ....*Colpomenia*

11. Plants tubular, unbranched, constricted at intervals ....*Scytosiphon*
11. Plants of another form 12

12. Plants foliose or with flattened parts 13
12. Plants without flattened parts 18

13. Plants consisting of simple and more or less lanceolate blades shortly stipitate 14
13. Plants of another form 15

14. Central medulla loosely filamentous ....*Endarachne*
14. Central medulla mainly parenchymatous ....*Petalonia*

15. Plants consisting of fan-shaped blades ....*Zonaria*
15. Plants of another form 16

16. Plants differentiated into a rhizomatous holdfast, a more or less long cylindrical stipe and

a terminal blade 17
16. Plants not so differentiated, consisting of shortly stipitate flattened axes, once or twice pinnately branched, and with midrib and lateral veins .... *Desmarestia*

17. Terminal blade palmate .... *Laminaria*
17. Terminal blade compound and pinnate .... *Ecklonia*

18. Ultimate branches clearly polysiphonous, with a relatively large apical cell .... *Stypocaulon*
18. Ultimate branches not polysiphonous; apical cell not so large 19

19. Plants with a soft, filamentous central core and a mantle of free assimilatory filaments 20
19. Plants solid, without emergent free assimilatory filaments 21

20. Axes 4-6(-9) mm in diameter; central core rather loose .... *Myriogloea*
20. Axes 2-3 mm in diameter; central core fairly solid .... *Papenfussiella*

21. Axes less than 1 mm in diameter, bearing many laterals usually unbranched 22
21. Axes more than 1 mm in diameter (up to 1 cm); laterals not especially plentiful or crowded .... *Splachnidium*

22. Cortex compact; paraphyses unicellular .... *Chordariopsis*
22. Cortex consisting of loose assimilatory filaments; paraphyses multicellular .... *Chordaria*

CHLOROPHYTA (ULVOPHYCEAE, CLADOPHOROPHYCEAE AND BRYOPSIDOPHYCEAE)

1. Plants microscopic, consisting of prostrate, branched uniseriate filaments, sometimes forming pseudo-parenchymatous discs 2
1. Plants macroscopic, filamentous, pseudo-prenchymatous or parenchymatous 4

2. Plants forming pseudo-parenchymatous discs consisting of radiating filaments more or less laterally confluent 3
2. Plants not forming discs; filaments not confluent .... *Entocladia*

3. Radiating filaments laterally confluent throughout, forming regular discs .... *Ulvella*
3. Radiating filaments distally free; discs less regular .... *Stromatella*

4. Plants filamentous 5
4. Plants with a pseudo-parenchymatous or parenchymatous structure 8

5. Plants consisting of uniseriate filaments, either branched or unbranched 6
5. Plants consisting of coenocytic filaments 7

6. Filaments unbranched .... *Chaetomorpha*
6. Filaments branched .... *Cladophora*

7. Plants forming soft tufts of loosely branched filaments arising from a prostrate system of interwoven filaments; reproductive cells formed in lateral outgrowths of filaments .... *Pedobesia*
7. Plants bushy or caespitose, with the erect axes wholly or partially clothed with small branchlets either distichous or spirally arranged; reproductive cells formed in the ultimate branchlets .... *Bryopsis*

8. Plants internally differentiated into a medulla of interwoven, coenocytic, colourless

filaments and a peripheral cortex of pigmented utricles (swollen filament ends)
bearing hairs and gametangia .... *Codium*
8. Plants not so differentiated 9

9. Plants foliaceous, distromatic throughout .... *Ulva*
9. Plants tubular and hollow, at least near the base and margins .... *Enteromorpha*

TAXONOMIC INDEX