SEAWEED FLORA OF KARNATAKA COAST

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M. PALANISAMY
S.K. YADAV

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Front cover:
Luxuriant growth of green seaweed *Caulerpa taxifolia* (Vahl) C. Agardh

Back cover:
1. Panoramic view of a rockpool supporting mixed growth of seaweeds at Gorte coast
2. *Caulerpa racemosa* (Forssk.) J. Agardh
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PREFACE

The present book on "Seaweed Flora of Karnataka Coast" is an outcome of the extensive field explorations along the 320 km long stretch of Karnataka coast during the years 2014-17. During this period, around 1595 field numbers of seaweeds were collected from 74 stations in different seasons and all the relevant references were referred, with a first comprehensive taxonomic account of seaweed flora of the state, and documents 108 taxa of seaweeds, belonging to 54 genera, 31 families and 20 orders, including 42 taxa of Rhodophyceae (red algae), 36 taxa of Chlorophyceae (green algae) and 30 taxa of Phaeophyceae (brown algae). The book provides detailed references, descriptions, identification keys, seasonal occurrence and distribution of each taxon, with additional notes on nomenclature and economic importance of seaweeds. We hope that this book will serve as an important reference not only to the phycologists, students and researchers of academic fields but also to the government agencies, environmentalists and seaweed based industrialists in various ways for the welfare of human beings.

Authors are extremely thankful to Dr. A.A. Mao, Director, Botanical Survey of India, Kolkata for necessary facilities and encouragements. We would also like to express our gratitude to Dr. G.V.S. Murthy, Former Scientist G & Head of Office, Dr. C. Murugan, Scientist E & Former Head of Office, and Dr. M.U. Sharief, Scientist F & Head of Office, BSI, Southern Regional Centre, Coimbatore, Tamil Nadu for facilities and encouragements. We are also thankful to Dr. S.S. Dash, Scientist 'E' & in-charge, Technical Section, Dr. D.K. Agrawala, Scientist 'E' & in-charge, Publication Section, Dr. S. Nagaraju, Botanist and all the team members of the Publication Section, Botanical Survey of India, Kolkata for their kind support and help in editing, composing and finalizing this publication.

Authors are also thankful to our field team members Mr. M. Nagarathinam, Mr. R. Meiyalagan (late), Mr. K. Sivaramakrishnan for their generous support during field explorations, Mr. R. Suresh and Mr. A.T. Durgadas, Artists, BSI, SRC, Coimbatore for illustrations, Mr. V. Ramesh, Photographer, SRC, Coimbatore for editing and making photo plates, and the research scholars Mr. Aron Santhosh Kumar Y., Mr. Vivek S. and Ms. Vianny A. for their help in various ways.

We would also like to acknowledge the help rendered by the Superintendent of Police (SP), Coastal Security Police, Malpe, Karnataka and the Karwar Coast Guard for extending necessary support during field explorations and collection of seaweeds from the St. Mary's Island and other coastal localities of Karnataka.

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FOREWORD

One of the Sustainable Development Goals (SDG) of the United Nations is Life Below Water. Marine ecosystem is one of the important and integral components of the aquatic ecosystems of the country. India has about 7,500 km length of coastline and about 2.5 million km^2 of Exclusive Economic Zone (EEZ), endowed with rich marine biodiversity. The Indian coastline has a massive network of beaches, backwaters, estuaries, creeks, cliffs, lagoons, mangroves and coral reefs, spreading into 9 maritime states and 4 UTs, which supports a large number of marine flora and fauna. Survey, explorations and documentation of the marine flora of the country is a prerequisite towards its proper conservation, sustainable utilization and vision of the Blue economy.

The present book titled "Seaweed Flora of Karnataka Coast" is second in series of BSI publication on marine flora, after Seaweeds of Kerala coast, India. The book presents a comprehensive taxonomic account of the seaweed flora of Karnataka state. It is an outcome of the extensive field explorations and collections of 1595 field numbers of seaweed samples, done by the authors from 74 localities all along the 320 km long coastline of Karnataka. The book accounts 108 taxa of seaweeds, under 54 genera, 31 families and 20 orders, and includes 42 taxa of Rhodophyceae, 36 taxa of Chlorophyceae and 30 taxa of Phaeophyceae and provides detailed taxonomic descriptions, keys, occurrence and distribution of each taxon.

I congratulate both the authors for their endeavors and bringing out this valuable series on Seaweeds of Karnataka state in public domain. I am sure, this book will serve as an important reference for the botanical fraternity in general and for phycologists, students and researchers in particular.

(A.A. Mao)

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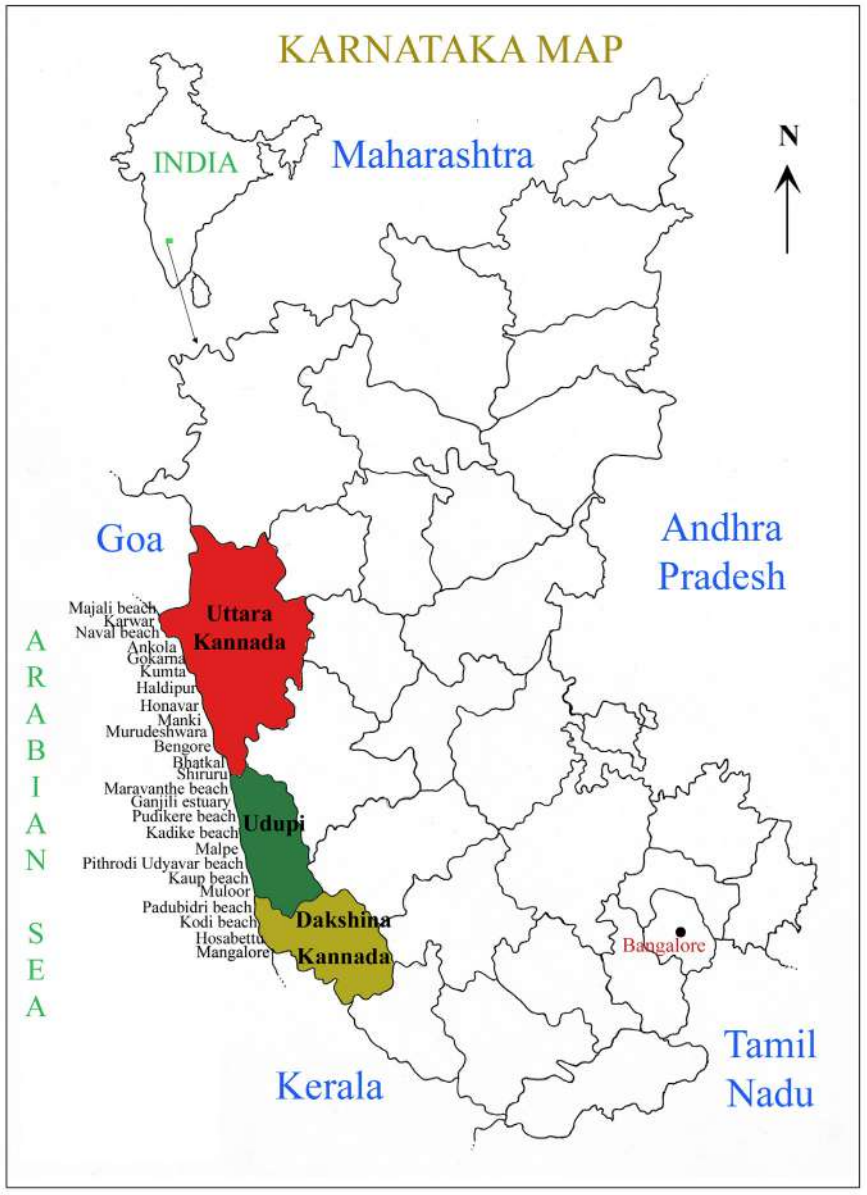

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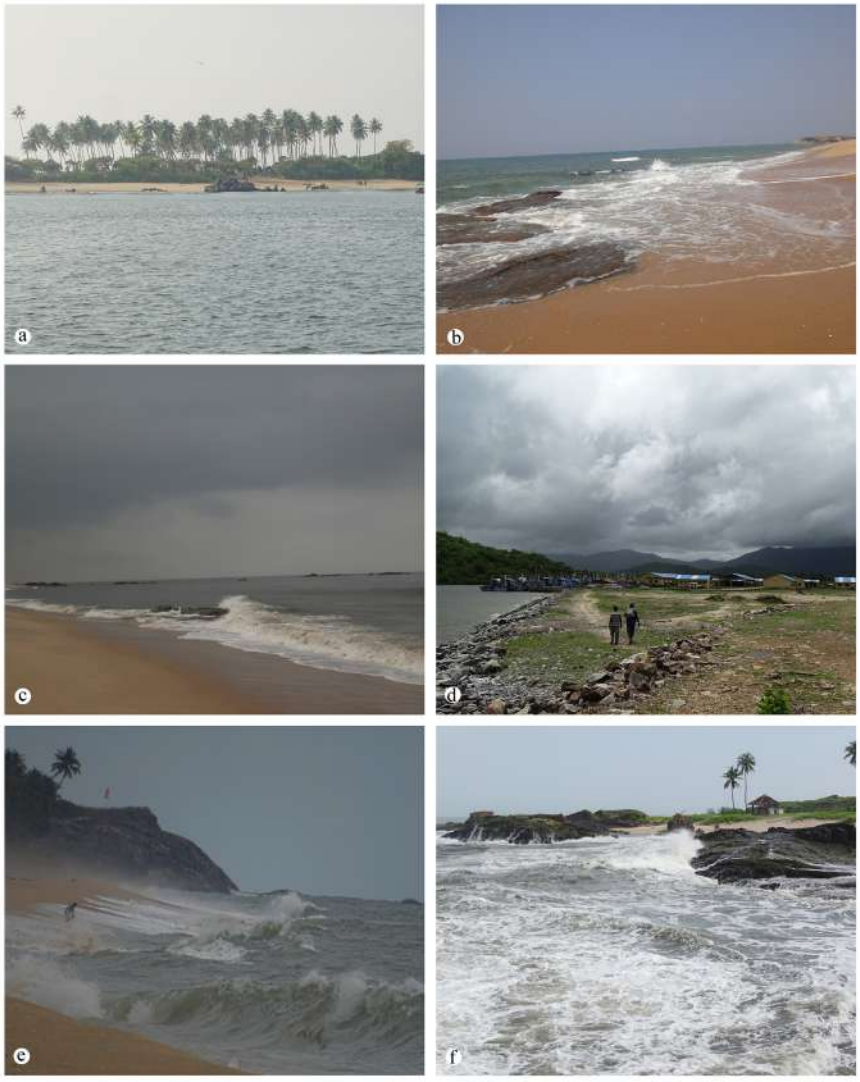

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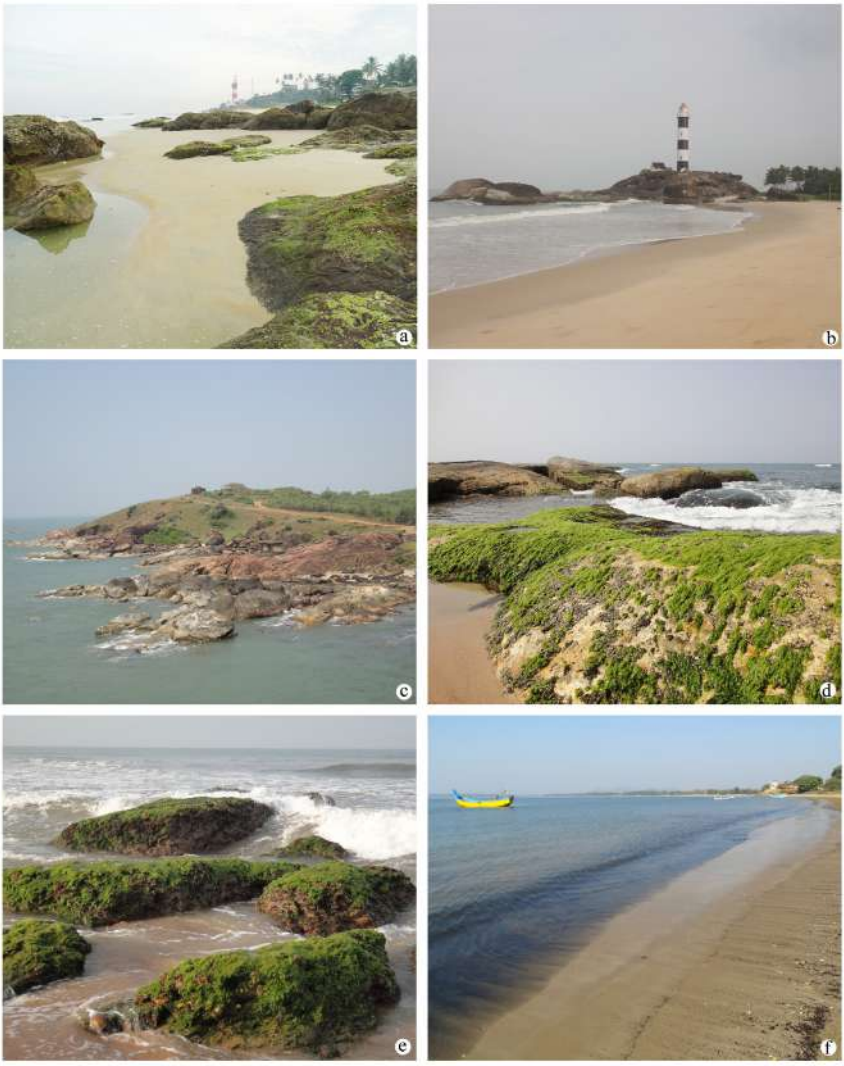

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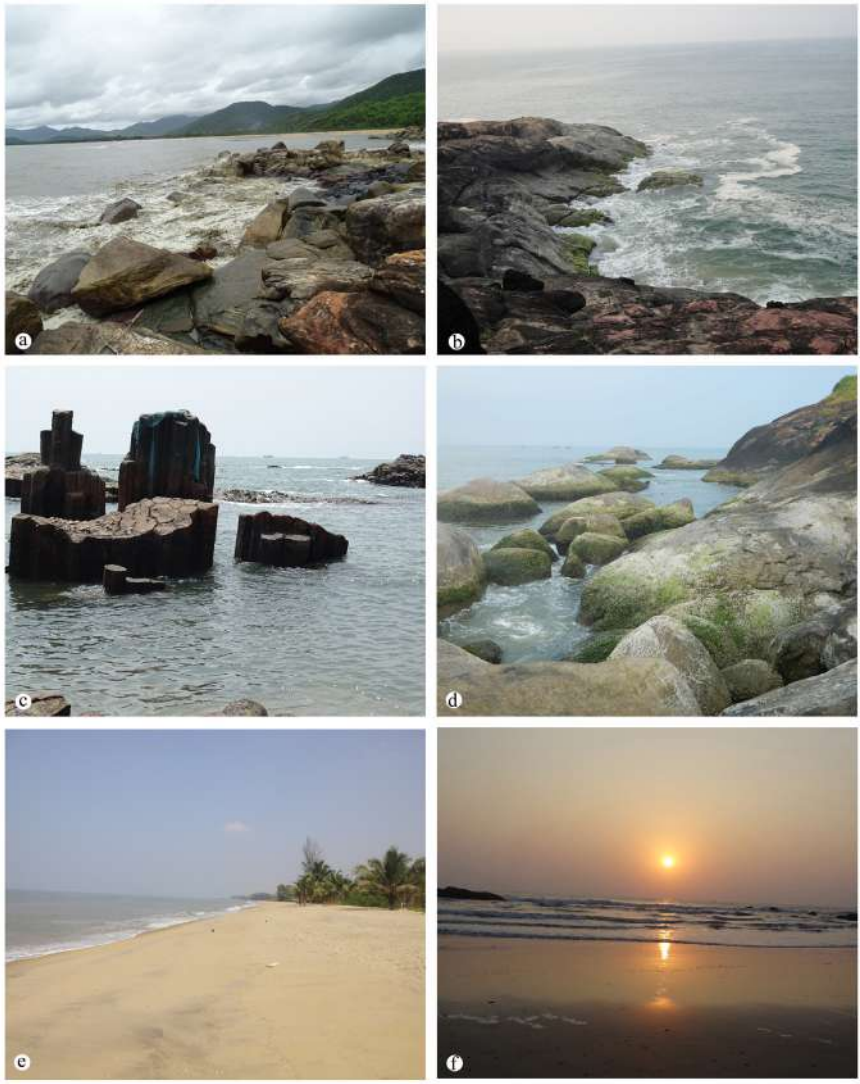

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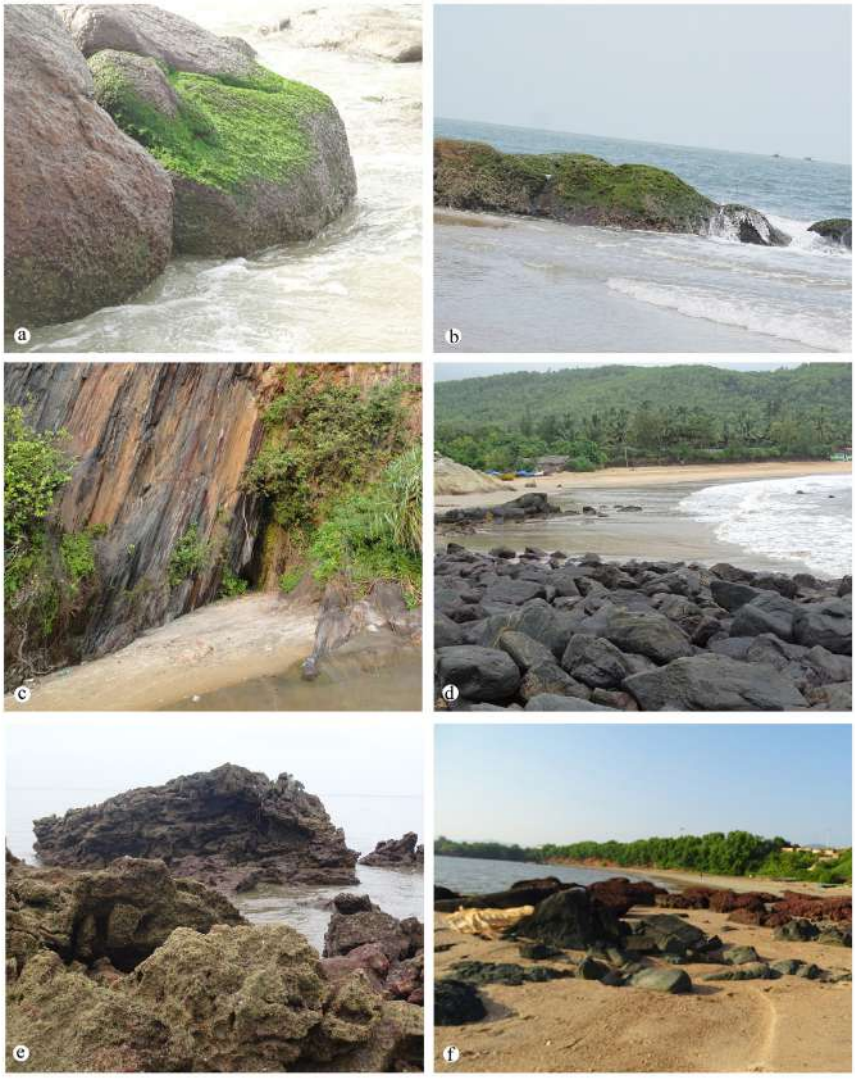

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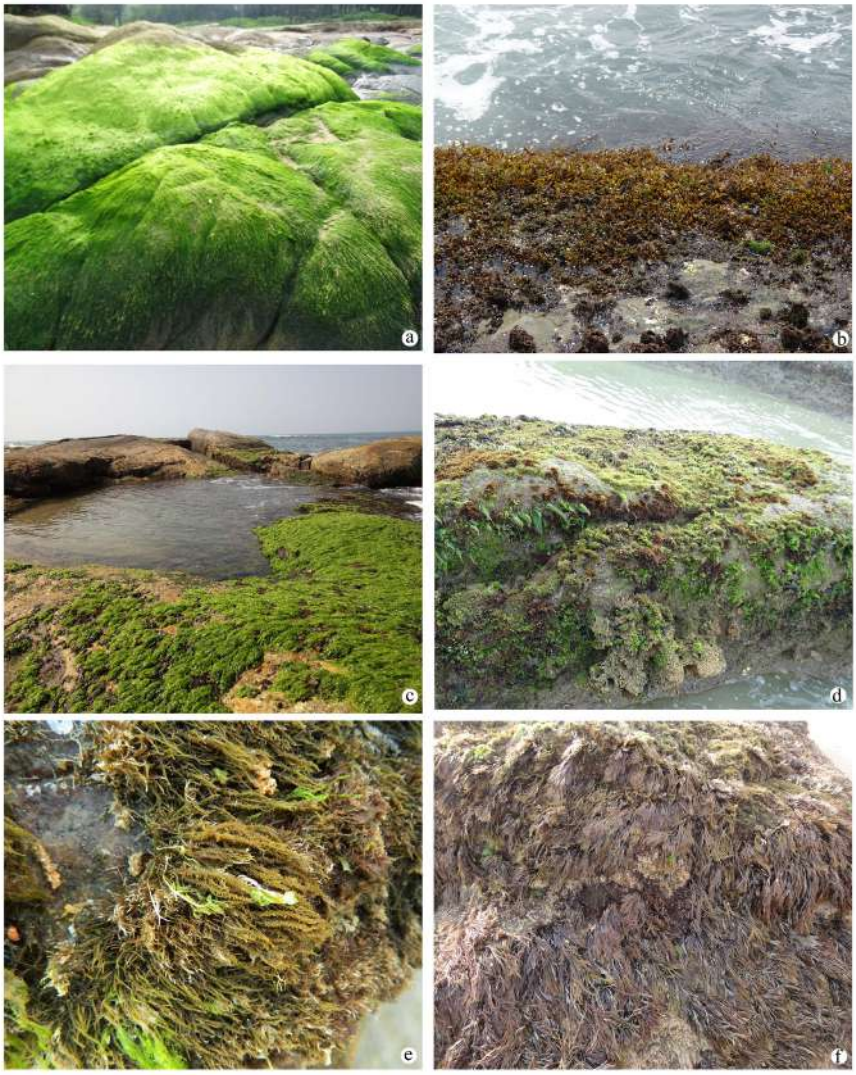

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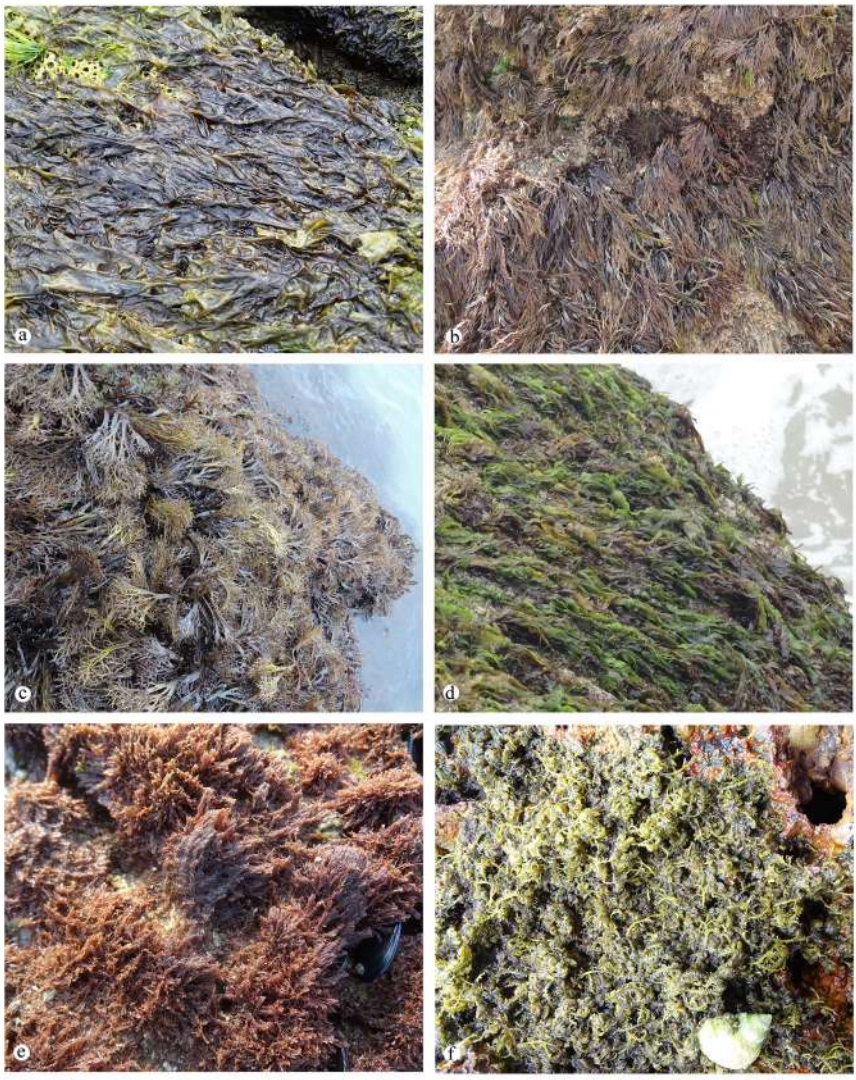

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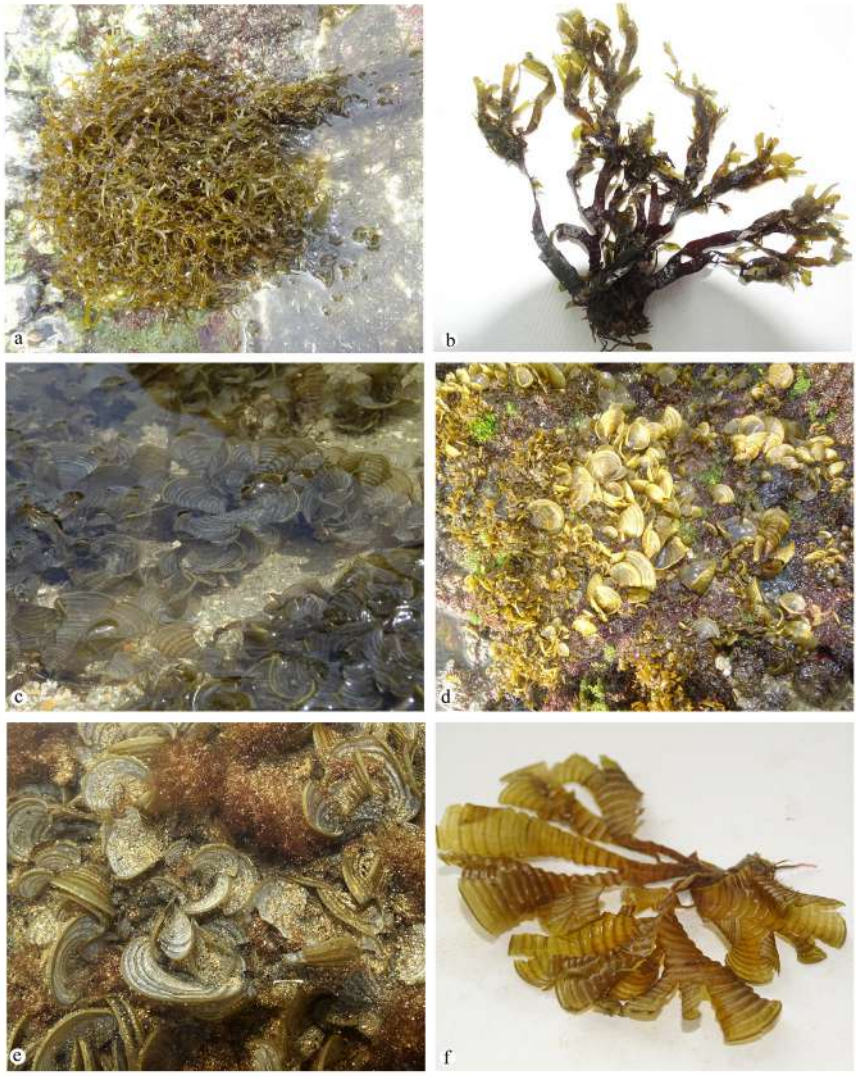

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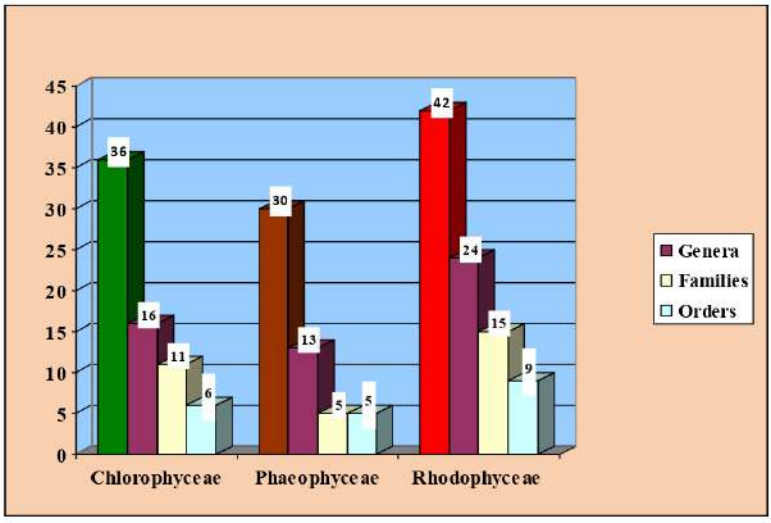
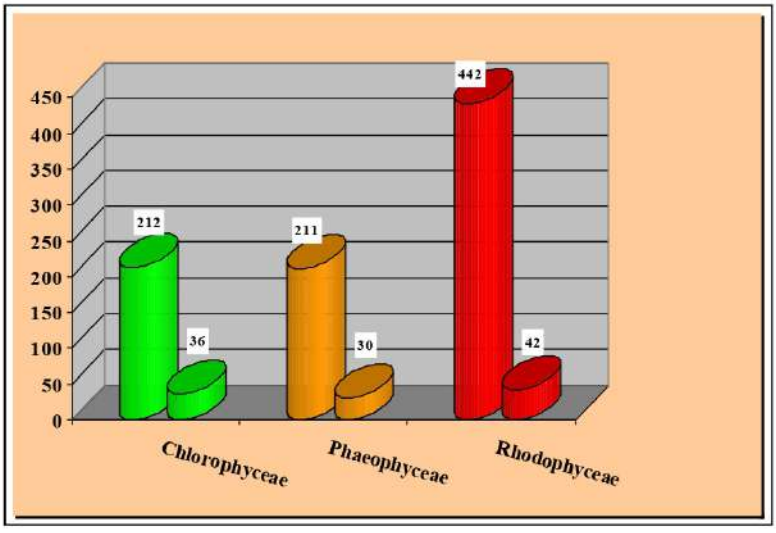


Graph 1. Comparative account of the orders, families, genera and species of seaweeds recorded in Karnataka coast.



Graph 2. Comparative account of various classes of seaweeds of Karnataka and India.

INTRODUCTION

The teeming life which Nature abounds
Is treasured secret in solemn grounds
For man to bring to his knowledge door
The wonder gift of the Ocean floor.

Srinivasan, 1973

Marine ecosystems are the largest aquatic ecosystems on the Earth and support more than half of the total global biodiversity. They include the intertidal zones, tidal zones, deep sea, coral reefs, salt marshes, estuaries, lagoons and mangroves ecosystems and form an essential component for the sustainability of the marine and terrestrial environments.

Algae are a group of primitive autotrophic plants, which are mostly aquatic in nature and show a wide range of variations ranging from unicellular forms such as *Chlamydomonas*, *Chlorella*, *Diatoms* etc. to multicellular forms like *Fucus*, *Sargassum* etc. The marine algae are broadly classified into two types namely: Marine Micro Algae and Marine Macro Algae. The marine micro algae are the microscopic algae (phytoplanktons) and can be observed only under the microscopes. Whereas, the marine macro algae, popularly called as Seaweeds, include all those marine algae which can be seen without the uses of Microscopes. The plant body of the seaweed is called thallus which include three parts; holdfast, stipe and frond. Characteristically, they are mainly epilithic and grow on solid substrata such as rocks, bedrocks, pebbles, mollusc shells and corals. However, they are also found growing on coastal litters such as plastic ropes, nets and decayed wooden pieces and as epiphytes on other plants like seagrasses and mangroves in shallow, intertidal and sub–tidal zones and deep waters of sea, even up to a depth of 150 m or up to a depth that can receive more than 0.12% of the incident light (Markager & Sand–Jensen, 1994).

Seaweeds belong to the division Thallophyta of the sub–kingdom Cryptogamae. They are broadly classified into three classes *viz.* Chlorophyceae (Green), Phaeophyceae (Brown) and Rhodophyceae (Red), based on the type of photosynthetic pigments, nature of storage foods and cell wall components. In marine ecosystems, it plays an important role of the primary food producers in food chain and provides habitats and breeding ground for numerous aquatic flora and fauna. Seaweeds are economically one of the most important marine natural resources and are used as food, fodder and as raw materials for various industries like pharmaceutical, textile, dairy, phycocolloids (agar–agar, agaroids, algin, carageenans), fertilizers, cosmetics, rubber, paper products, biofuels (Khambaty & al., 2012). Therefore, 'seaweeds' should not be misunderstood as 'weeds', on contrary, they are very important and valuable plant resources of the nature.

Globally, ca 10,500 taxa of seaweeds have been reported which includes ca 7,000 taxa of Rhodophyceae, 2,000 taxa of Phaeophyceae and 1,500 taxa

of Chlorophyceae (http://www.seaweed.ie/). In India, 865 taxa of seaweeds, belonging to 234 genera have been reported so far. These seaweeds comprise 442 species of Rhodophyceae in 151 genera, 212 species of Chlorophyceae in 46 genera and 211 species of Phaeophyceae in 50 genera (Rao & Gupta, 2015).

India (8°–37° N and 68°–97° E), is one of the seventeen megadiversity countries (www.conservation.org) and the 7th largest country in the world with 2.4% of the global geographical area. The country has a coastline of ca 7,500 km and an Exclusive Economic Zone (EEZ) of around 2.5 million km^2. The Indian coastline has a massive network of beaches, backwaters, estuaries, creeks, cliffs, lagoons, mangroves and coral reefs, which supports a large number of marine flora and fauna. The coastline includes 97 major estuaries, 34 major lagoons, 31 mangroves areas, 5 coral reefs and 31 Marine Protected Areas (Singh, 2003). The pattern of distribution and diversity of seaweeds in various maritime states in India varies greatly. Tamil Nadu coast shows the highest number of seaweeds with 426 species (Anon.,1978), followed by Maharashtra coast with 240 species (Sonali, 2010); Gujarat coast with 198 species (Jha & al., 2009); Kerala coast with 147 species (Yadav, 2016; Palanisamy & al., 2020), Lakshadweep islands with 82 species (Anon., 1979) and Andaman & Nicobar islands with 80 species (Muthuvelan & al., 2001); Karnataka with 78 species (Kaladharan & al., 2011); Diu island with 70 species (Mantri & Subba Rao, 2005); Andhra Pradesh with 65 species (Anon, 1984); West Bengal with 14 species (Mukhopadhyay & Pal, 2002); Odisha with 14 species (Sahoo & al., 2003). However, many of the maritime states have not been explored intensively. Hence, there is a necessity of intensive field exploration in the unexplored or less explored coastal states so that we can bring an updated national seaweed flora. Taxonomic studies play an important role in the conservation of biodiversity. Many of the habitats like the coral reefs, the floor of the deep sea etc. are poorly explored and no one knows the exact number of species (Wilson, 1988). Considering the above facts, the present taxonomic studies on the seaweed flora of Karnataka coast has been taken into account.

AREA OF STUDY

Karnataka (**Map 1**), located between 11° 31' – 18° 45' N latitude and 74° 12' – 78° 40' E longitude in the central part of the west coast of India, is well known for its beautiful forests and rich biodiversity. The state constitutes a part of the Western Ghats, one of the 25 global hotspots. The coastline of Karnataka, also called as Karavali stretches, is about 320 km in length and is located between 12° 45' – 15° 00' N latitude and 74° 00' – 75° 00' E longitude. The state has 27000 sq. km. continental shelf and 87 000 sq. km. of Exclusive Economic Zone (EEZ). The shelf off has an average width of about 80 km and the depth of 90 -120 m. The coastline of Karnataka starts from Uchila near Mangalore (Kerala – Karnataka border) in the south and end at Majali, Karwar in the north (Karnataka - Goa border). It is bounded by the states of Maharashtra and Goa in the north and north-west, Kerala and Tamil Nadu in the South, the Arabian Sea in the West and Andhra Pradesh in the East. The state has a total land area of 1, 91,791 sq.km, accounting for 5.83% of the total area of the country and extends to about 750 km from North to South and about 400 km from East to West. It is the eighth largest state in India and has been divied into 30 districts, of which only three districts *i.e.* Dakshina Kannada, Udupi and Uttara Kannada are the coastal districts.

The entire coastline is almost narrow, interrupted at numerous points by rivers, rivulets, creeks, lagoons, cliffs, sanddunes and beaches. The northern coast is rocky while the southern coast is sandy with scattered rocks and several linear beaches (Plates 1, 2, 3, 4). There are 14 rivers and several rivulets, originating from the Western Ghats join the Arabian Sea in the state and support the Mangrove vegetation. The mangroves are sparsely distributes along the coast in the estuaries areas. The important rivers of the coastal Karnataka are Netravati, Gurupur, Gangoli, Sitanadi, Aghanashini, Kali and Sharavati. There are about 26 estuaries with more than 70000 ha water spread area and 80000 ha of brackish water area, making the 3 coastal districts of Karnataka very rich in marine biodiversity. There are several islands including St. Mary's islands, Netrani islands etc. which supports the reach biodiversity in the state. There is one major port *i.e*. New Mangalore port and 10 minor ports located at Karwar, Old Mangalore, Belekeni, Tadri, Honnavar, Bhatkal, Kundapur, Hangarakatta, Malpe and Pudubidri. The coastline of the state is also gifted with several beautiful beaches like Majali, Devbag, Karwar, Gokarna, Om, Murudeshwar, Anjadiv, Kalibag, Maravanthe, Kaup, Malpe, Panambur, Mangalore, Someshwar, Surathkal, Ullal etc. which attract large number of visitors / tourists (Plates 5). At many places, artificially laid stones were found to protect the coastline. These man made stones support as habitats and ultimately lead to the growth of seaweeds (Plate 6). Coastal plants (Plates 7, 8) palys an important role to naturally maintaining the coastal environment and protecting the coastline from erosion. Like plants, coastal fauna (Plate 9) is an important component of the marine biodiversity of Karnataka coast. Fishing is the main occupation of the local people in coastal areas (Plate 10).

GEOLOGY

The geology of Karnataka is largely confined to two oldest eras namely the Archean and the Proterozic. The substantial part of the North Karnataka is covered by Deccan plateau, representing the volcanic activities at the down of the Cenozoic era. The eastern part of the state is largely intruded by granites and granitoids of about 2600 to 2500 million years age.

METEOROLOGY

Climate

The state of Karnataka is usually endowed with four distinct climates. However, it is largely influenced by the south–west monsoon. The winter season usually starts from January to February, followed by summer season from March to May, monsoon season from June to September and post monsoon season from October to December. The climate is usually warm–humid. The average maximum mean daily temperature in the coastal region is 30^0 C (April–May) and minimum is 17^0C (December–January). The seasonal variations in coastal temperature are minimal.

Rainfall

The annual rainfall in the state usually varies from 50 to 420 cm. The amount of rainfall is found significantly higher in the coastal regions because of the Western Ghats and receives maximum during the South-West monsoon season.

Wind

The nature of wind over the coastal region of Karnataka is highly variable. During the southwest monsoon, the coastal region of the state comes under the direct threat of cyclone and heavy wind originating from the Arabian Sea.

Tides

The tidal nature in the Arabian Sea along the Karnataka coastline is not always uniform throughout the year. The wave activity becomes very strong and violent during the south–west monsoon. The average tidal value of the coast ranges from -0.1 to 2.3 m. During the high tides in monsoon season, the magnitude of the coastal erosion increases in the coastal areas particularly in low altitude areas such as Uchila, Someshwar, Maravanthe etc.

REVIEW OF LITERATURE

The first record of any algal collection from the Indian Ocean was made by Hermann in 1672, who collected *Amphiroa,* a coralline alga from the Cape of Good Hope, South Africa. Later, J.G. Koenig (1728–1789), who visited India under a Morivian missionary in 1768, made several extensive marine algal collections from the coast of Tranquebar, South India (Srinivasan, 1965). Subsequently, a number of expeditions *viz*., Galathea expedition (1845–1847), Novara (1857–1859), Preussische (1859–1863), Challenger (1872–1876), Investigator (1890–1892) and Siboga (1899–1900) were carried out during the 18th and 19th centuries by foreign workers for the collection of seaweeds from the Indian coasts. However, the momentum in algal research came in India only during the end of 19th century when Prof. M.O.P. Iyengar (1886–1966), the Father of Indian Algology, published a note on seaweeds of the Krusadai Island in the Gulf of Mannar in 1927. Later, he published a series of papers on algal research. Subsequently, Boergesen (1928–1938), published a series of articles between 1928–1938 and recorded more than 150 taxa including 5 new genera and 38 species from the west coast of India, particularly from the coasts of Bombay and Gujarat. Parallely, several other workers were also involved in studying various aspects of the marine algae from other parts of the country. Dixit (1930) worked on the chemical properties, mainly the iodine content of several seaweeds and published (1940) a detailed account of seaweeds from Malvan coast, Maharashtra in the west coast of India. Biswas in 1932 published the algal flora of Chilika Lake, Odisha in east coast of India and a review of the seaweeds of the west coast of India in 1945. Anand (1940) published an account of the seaweeds from the Karachi coast, a part of the west coast (now in Pakistan). Since then, various researchers have explored the seaweed resources from different maritime states of India. Misra (1966) published the first monograph *Phaeophyceae of India* and included 93 species of brown seaweeds, belonging to 33 genera. Chennubhotla (1977) of Central Marine Fisheries Research Institute (CMFRI), Cochin published a note on the edible seaweeds in the Indian context. Srinivasan (1969, 1973) published two volumes of *Phycologia Indica*: *The Icons of Marine Indian Algae*, describing about 50 species of seaweeds from the Indian coast. Krishnamurthy & Joshi in 1970 published *A Checklist of Indian Marine Algae* that included records from Pakistan and Sri Lanka and listed 520 taxa of seaweeds. Subsequently, Untawale & al. (1983) published a list of marine algae of India in the form of memiography and recorded 624 species of seaweeds. Silva & al. (1996) published *The Catalogue of the Benthic Marine Algae of the Indian Ocean*, which is considered a monumental work for the Indian seaweeds. Desikachary & al., (1990, 1998) published the *Rhodophyta* (red seaweeds) of India in two volumes. Sahoo & al. (2001), published a checklist on the *Seaweeds of Indian Coast* and recorded 770 species including 184 species of Chlorophyceae, 166 species of Phaeophyceae and 420 species of Rhodophyceae. Oza & Zaidi (2001) from Central Salt and Marine Chemicals Research Institute (CMFRI),

Bhavnagar published *A Revised Checklist of Indian Marine Algae* which included 844 seaweed species including forma and varieties from throughout the Indian coasts. Recently, a revised monograph on brown seaweeds *i.e. Phaeophyceae of India and Neighbourhood* (Volume I & II) has been published by Krishnamurthy & Baluswami (2010) and Krishnamurthy & Ezhili (2013) respectively. More recently, the Botanical Survey of India, Kolkata (Rao & Gupta, 2015) has published an updated checklist on the Indian marine algae, containing a report of 865 taxa of seaweeds which included 212 taxa of Chlorophyceae, 211 taxa of Phaeophyceae and 434 taxa of Rhodophyceae.

In the east coast of India, several works have been carried out from the coasts of Tamil Nadu (Thivy, 1964, 1966; Desai, 1967; Subharamaiah & al., 1979, Chennubhotla & al., 1988; Kaliaperumal & al., 1989; Kaliaperumal & Chennubhotla, 1997; Palanisamy, 1998; Krishnamurthy & Baluswami, 1984, 2010), Andhra Pradesh (Rao & Sriramulu, 1964, 1968, 1970; Rao, 1969, 1970, 1973; Rama Rao, 1969, 1977, 1982, 1992), Odisha (Mitra, 1946; & Sahu, 1992; Chennubhotla & al., 1992; Adhikary & Sahoo, 1992; Rath & Adhikary, 2005a&b, 2006; Sahoo & al., 2001, 2003) and West Bengal (Mukhopadhyay & Pal 2002; Mukhopadhyay & al., 2003; Satpati & al., 2012). Similarly, in the west coast also, preliminary survey and exploration of seaweeds have been done by various workers. The coastline of Gujarat, which is the longest one in India, has been explored extensively (Desai, 1967; Chauhan & Krishnamurthy, 1968; Chauhan & Mairah, 1978). Recently, Jha & al. (2009) published the preliminary account of seaweeds of Gujarat entitled *Seaweeds of India: The diversity and distribution of Seaweeds in Gujarat Coast* and recorded 198 seaweed taxa belonging to 101 genera. The seaweed resources of Maharashtra have been dealt by various workers. Boergesen published a series of articles from the coast of Bombay between 1930–1935. Later, several other workers (Chauhan, 1978; Untawale & al., 1977; Dhargalkar & al., 1980) also have made valuable contribution. Very recently, Sonali Piwalatkar (2010) of Botanical Survey of India, Western Regional Centre, Pune carried out taxonomic study on seaweeds of this coast and recorded a total of total of 240 taxa. The seaweed resources of the shoreline of Goa has been worked by several researchers like Dhargalkar (1981), Agadi & Untawale (1978), Agadi, (1983), Pereira & Almeida (2014). The coastline of Kerala has been studied by various workers like Koshy & John (1948), Nair & al. (1982, 1986), Chennubhotla & al. (1988, 1990), Mathew (1991), Anilkumar & Panikkar (1992, 1994, 1997), Panikkar & Ampili (1993), Anilkumar & al. (1995), Nettar & Panikkar (2004, 2009), Sulekha & Panikkar (2006, 2007), Panikkar & Ampili (2011), Palanisamy & al. (2013, 2014, 2015a&b), Yadav & al. (2015a&b).

Besides the Indian mainland coastlines, the shorelines of the islands of Andaman & Nicobar in the Bay of Bengal have been surveyed sporadically by various workers (Gopinathan & Panigrahy 1983; Awasthi, 1989; Muthuvelan, 1994; Rao & Tigga, 1998, 2000 a & b; Palanisamy, 2012; Karthick & al., 2013). The seaweeds resources of the Lakshadweep islands in the Arabian Sea have been studied by Subbaramaih & al. (1979), Jagtap (1983, 1987), Kaliaperumal & al.

(1989) and Koya (2000). Besides, the estuaries and the backwater ecosystems such as Vellar estuary (Kannan & Krishnamurthy, 1978; Krishnamurthy & Jayaseelan, 1984) and Thirumullaivasal and Cuddalore estuaries (Palanisamy, 1998) in Tamil Nadu, Godavari estuary in Andhra pradesh (Rao, 1987), Zuari and Mandovi estuaries in Goa (Jagtap & Untawale, 1980; Jagtap, 1986) and Ashtamudi estuary in Kerala (Nair & al., 1982) also support the seaweed vegetation.

SEAWEED RESEARCH IN KARNATAKA

A perusal of literature pertaining to Karnataka coast revealed that the study on the algal flora, particularly marine macro algae (seaweeds) is intermittent. Agadi (1985, 1986) made the first attempt to study the distribution of marine macro algae from the littoral zones of Karnataka coast and reported 43 species of seaweeds. He also reported the poor seaweed vegetation due to the lack of wide intertidal expanse and strong wave action along the coast. Untawale & al. (1989) reported the presence of 65 species of seaweeds belonging to 42 genera from the northern Karnataka coast. Ambiye & Untawale (1992) studied the deep water algal flora of the submerged banks in the Lakshadweep islands and correlated the study from the seaweed diversity in Karnataka coast. NAAS (2003) and Venkataraman & Wafar (2005) reported only 39 species of seaweeds belonging to 52 genera and 28 families from the coastline of Karnataka. Rao & Mantri (2006) in a review article on Indian seaweeds also quoted only 43 species of seaweeds from Karnataka coast. Kaladharan & al. (2011) published an assessment studied on the coastal and marine floral diversity of Karnataka and documented 78 species of seaweeds and species of seagrasses from the entire Karnataka coast.

Besides, there are some reports by various workers (Yashovarma, 1985; Sukumaran, 2002; Rajeshwari & Krishnaswamya, 2006; Shekhar 2008; Hosmani, 2013; Krishnamurthy, 2015; Ambika & Krishnamurthy, 2016) on the fresh water algae and phytoplanktons from various parts of Karnataka

The extensive scrutiny of upto date literature pertaining to the study area revealed that the coastline of Karnataka has not been explored intensively and only sporadic reports in the form of checklist or brief notes are available. Considering the above facts, the present taxonomic study on seaweeds of Karnataka coast has been undertaken with the following objectives:

OBJECTIVES

- Survey and collection of seaweeds of Karnataka coast.
- Herbarium preparation and documentation of collected seaweeds.
- Identification and Enumeration of seaweeds.
- Listing of endemic and economically important seaweeds.
- The compilation of taxonomically described seaweeds in the form of “SEAWEED FLORA OF KARNATAKA COAST WITH ECOLOGICAL ASPECTS”.

MATERIALS AND METHODS

The present taxonomic study on seaweeds of Karnataka coast is primarily based on the fresh collection of seaweeds, consultation of seaweed herbarium and scrutiny of the relevant literature pertaining to Karnataka coast and other states of India.

Marine Macro Algal Collection

Extensive surveys were undertaken (6 field tours) to all three coastal districts *i.e.* Dakshina Kannada, Udupi and Uttara Kannada of Karnataka coast during April, 2014 to March, 2017 for Marine Macro Alage (seaweeds) collection (Plate 11). All the important field materials such as camera, field books, note book, polythene bags (zipped), standard plastic containers, buckets, trays, mounting boards, blotting papers, newspapers, forceps, needles, brushes, markers, soft cotton cloth, iron mess frames, ropes, fevicol (SH), reference books, scales and preservatives (ethyl alcohol and formalin) were carried during field tours. Before commencing the field tour, tide tables were collected from the Meteorological department website to select the suitable days and time for the collection of seaweeds. The seaweeds were randomly collected from rocks, artificial cement boulders, molluscus shells and coastal wastes like nets, plastics, cloths etc during low tides (Plates 12, 13). Small and delicate or coralline algae were collected with much care to avoid any damage of the specimen. The collected samples were kept in the zipped plastic covers and containers of various sizes. During the collection, 74 localities (Table I) were selected from the entire coast and **1595** field numbers of seaweeds samples were collected in duplicate. While surveying, important field details such as nature of the coast, dominance, pattern of seaweed vegetation such as monospecific or mixed vegetation (Plates 14, 15, 16, 17) habit, habitats, GPS coordinates of collection locality and vegetation pattern etc. were noted in field notebook. Photographs were taken using digital as well as underwater cameras.

Preservation of Samples

All the collected seaweed samples were washed thoroughly with sea water, followed by using fresh water. Attached sand particles, sediments and debris were removed carefully without damaging the specimens. Later, they were preserved by adopting two methods.

1. Wet Preservation
2. Dry Preservation

Table I: LIST OF COLLECTION LOCATIONS WITH GPS COORDINATES.

Sl. No.	Seaweed collection locations	Latitudes	Longitudes
	1. DAKSHINA KANNADA DISTRICT		
1	Uchila	12° 47' 24" N	74° 51' 17" E
2	Peribail	12° 47' 58" N	74° 51' 22" E
3	Someshwar coast	12° 47' 47" N	74° 50' 37" E
4	Ullal	12° 49' 48" N	74° 50' 16" E
5	Mangalore Harbour area	12° 50' 41" N	74° 49' 64" E
6	Mangalore fishing Area (old port)	12° 57′ 47″ N	74° 48′ 01" E
7	Panambur beach	12° 55' 57" N	74° 43' 41" E
8	Surathkal	13° 00'11" N	74° 47' 40" E
	2. UDUPI DISTRICT		
9	Mulki coast	13° 00' 00 '' N	74° 47' 43" E
10	Hejmadi coast	13° 06' 56" N	74° 46' 01" E
11	Padubidri	13° 08' 53" N	74° 45' 56" E
12	Yermal	13° 10' 56" N	74° 44'48" E
13	Sai Radha beach	13° 11' 44" N	74° 44' 59" E
14	Uchila	13° 11' 23" N	74° 44' 58" E
15	Charuvetti	13° 11' 57" N	74° 44' 26" E
16	Kaup beach	13° 13' 28" N	74° 44' 27" E
17	Yadu	13° 14' 49" N	74° 44' 01" E
18	Katpaadi back water area	13° 15' 40" N	74° 43'59" E
19	Padukarai	13° 17' 32" N	74° 44' 26" E
20	Palm Beach	13° 20' 58" N	74° 44' 18" E
21	Malpe Beach	13° 20' 58" N	74° 44' 56" E
22	St Mary's Island	13° 22' 56" N	74° 44' 56" E
23	Gujjarpet	13° 23' 49" N	74° 41' 57" E
24	Kaliampura	13° 24 20" N	74° 44' 13" E
25	Hoda	13° 24' 51" N	74° 41' 54" E
26	Kodibengre	13° 25' 57" N	74° 41' 44" E
27	Kalta	13° 30' 59" N	74° 41' 15" E
28	Beejady	13° 34 59" N	74° 40' 46 E
29	Kundapur	13° 37' 58" N	74° 40'19" E
30	Gangolli fisheri harbour	13° 38' 11" N	74° 40' 14" E
31	Gangolli coast	13° 39' 59" N	74° 39' 48" E
32	Madibengre	13° 39' 57" N	74° 39' 46" E
33	Maravanthe	13° 44. 35" N	74° 33'20" E
34	Upanndar	13° 49' 57" N	74° 37' 56" E
35	Someshwar Temple area	13° 55' 55" N	74° 44' 53" E
36	Yedama vinahole	13° 79' 32" N	74° 44' 26"E
37	Shiroor	13° 54' 28" N	74° 35' 50" E
	3. UTTARA KANNADA DISTRICT		
38	Gorte South	13° 55' 55" N	074° 34' 57" E
39	Gorte coast	13° 56' 09" N	74° 34' 57" E
40	Mundoli	13° 57' 54" N	074° 32' 43" E
41	Mundoli back water	13° 58' 13" N	074° 32' 18" E
42	Talgode	13° 58' 45" N	074° 31' 58" E

43	Jali	13° 59’ 59” N	074° 30’ 52” E
44	Onnagatta	14° 00’ 17” N	74° 30’ 57” E
45	Tenkanakodi	14° 01’ 57” N	74° 30’ 21” E
46	Alikode	14° 01’ 72” N	74° 30’ 04” E
47	Murudeshwar	14° 05’ 53” N	74° 29’ 13” E
48	Bailur	14° 07’ 33” N	74° 28 56”’ E
49	Bailur Rocky coast (Madiangire)	14° 08’ 50” N	74° 28’ 67” E
50	Apsaragonda beach	14° 13’ 50” N	74° 26’ 59” E
51	Honnavar Eco beach	14° 15’ 56” N	74° 25’ 57” E
52	Honnavar fishery harbor	14° 16’ 57” N	74° 26’ 14” E
53	Tonga- Honnavar	14° 16’ 48” N	74° 25’ 56” E
54	Pawankura	14° 18’ 57” N	74° 24’ 43” E
55	Ramangindy coast	14° 21’ 52” N	74° 24’ 34” E
56	Vanaali	14° 25’ 57” N	74° 23’ 11” E
57	Godiyengri –Kumta coast	14° 27’ 33” N	74° 22’ 42” E
58	Hegde	14° 28’ 52” N	74° 21’ 22” E
59	Tadri	14° 31’ 23” N	74° 20’ 48” E
60	Paradise beach	14° 31’ 08” N	74° 20’ 22” E
61	Om Beach	14°’ 31’15” N	74° 19’ 17” E
62	Gokarna	14° 32’ 44” N	74° 18’ 55” E
63	Belamber Beach	14° 37’ 57” N	74° 17’ 06” E
64	Shedikuli beach	14° 39’ 16” N	74° 16’ 16” E
65	Shedikuli Racky area	14° 39’ 22” N	74° 16’ 49” E
66	Belekeri	14° 42’ 37” N	74° 15’ 57” E
67	Belekeri coast	14° 42’ 26” N	74° 15’ 46” E
68	Ukursia Island, Harwada	14° 42’ 57” N	74° 14’ 24” E
69	Harwada-Tarangamett	14° 44’ 23” N	74° 15’ 08” E
70	Amadeli coast	14° 44’ 56” N	74° 13’ 58” E
71	Bithkol	14° 48’ 40” N	74° 06’ 59” E
72	Karwar	14° 49’03”N	74° 7’ 57” E
73	Devbagh	14° 51’ 58” N	74° 7’ 51” E
74	Majali (Near Goa border)	14° 53’ 56” N	74° 05’ 49” E

Wet Preservation

The specimens were preserved in a solution made of 4% formalin and 1% ethyl alcohol and seawater in different size plastic containers (50 ml, 100 ml, 250 ml, 500 ml and 1000 ml). All the containers were labeled properly, showing name of the species, their respective field number, collector/s name, date and place of collection and brought to the laboratory for further study.

Dry Preservation

Under dry method, the seaweed specimens were preserved in the form of herbarium sheets. For each field number, minimum two herbarium sheets were prepared adopting the standard herbarium techniques (Srinivasan, 1969; Dhargalkar & Kavlekar, 2004). The following steps were followed for the preparation of herbarium sheets:

- The collected specimens were segregated into three groups *viz*., red, brown and green.
- The samples were floated in water filled trey and standard herbarium sheet (28 × 42 cm) was immersed in between trey and specimens and gently lefted the herbarium sheet with spreaded specimens.
- The mounted samples were covered with piece of white cotton cloths to avoid any damage of the specimens because the algal samples are very delegate.
- Each herbarium sheet was numbered with specific field number and was pasted on left side of the sheet.
- The mounted sheets were kept in between the blotting papers.
- All the sheets were piled up one above the other and placed in between iron presser and tied properly with the help of cotton ropes.
- The tied bundles containing the herbarium sheets were kept under sunlight for 2–6 days for proper drying of specimens. During this period, blotting papers and white cloths were periodically changed every day for 2–3 times for avoiding conatmination.
- All the dried herbarium sheets were labeled appropriately with standard label slip (8 × 12 cm), containing various details such as institution, region name, botanical name, family, local name, locality, GPS coordinates, distribution, abundance, associated plants, notes, field number, date of collection, Photography status, collectors' name and identifying author/s name.
- All the preserved (wet and dry) specimens are deposited at the Madras Herbarium (MH), Botanical Survey of India, Southern Regional Centre, Coimbatore for future reference.

Herbarium Consultation

Consultation tours were undertaken to the Central Marine Fisheries Research Institute (CMFRI) and Central Salt and Marine Chemicals Research Institute (CSMCRI), Mandapam Camp, Ramnathapuram, Tamil Nadu. Important herbarium specimens, literature and research theses pertaining to seaweeds were consulted. In addition, various online resources like Algaebase (www.algaebase.org), Macroalgal Herbarium Portal (http://macroalgae.org/), Seaweed Site: Information on marine algae (http://www.seaweed.ie/), Phycological Society of India (http://phykosindia.com/), The Phycology.Net (http://www.phycology.net/), Trinity College, Dublin (http://www.tcd.ie/botany/herbarium) were also referred.

Microscopic Studies

Microscopic study of seaweeds plays an important role in the identification of seaweeds. Many of the species are morphologically looking very similar and create confusion in identification. In such cases, anatomical characters stand useful in confirming the identity of the species. For anatomical study, sections were made

following the standard techniques (Prasad & Krishna Prasad, 1986). The best sections were selected after observing them using stereo microscope (OLYMPUS SZ51). The sections were examined using optical microscopes (NIKON SMZ1500 & NIKON ECLIPSE 50*i*) coupled with computer attached digital sight *DS–Fi* camera to study the general morphology and anatomical characters.

Description

Based on the field observation and study of morphological and anatomical characters of the specimens, a list of characters was prepared in the form of a data sheet and it was followed consistently while making the description of every taxon to maintain uniformity. All the taxa enumerated from Karnataka coast have been arranged systematically following the classification proposed by Fritsch (1935, 1944) with slight modification as per Papenfuss (1951, 1955) and Silva & al. (1996). Seaweeds have been classified into 3 classes, followed by orders under each class, families under each order and genera under each family. For each genus, the diagnostic characters, number of species in world, India and Karnataka have been provided, followed by key to species and all of them are arranged alphabetically and serially numbered. Keys for the families, genera and species have been prepared based on the most relevant characters, following the bracketed keys. For each taxon, the currently accepted botanical name has been given in boldface, followed by author/s and original citation, while basionym and important synonyms, if any, were provided in italic. Nomenclature has been updated following the recent International Code of Nomenclature for Algae, Fungi and Plants (McNeill & al., 2012). The names of authors of plant names are after *Authors of Plant Names* by Brummitt & Powell (1992) whereas he standard abbreviations of the titles of the books, periodicals and journals were based on *Taxonomic Literature* ed. 2 (Stafleu & Cowan, 1976–1988) and its supplements (Stafleu & Mennega, 1992–2000), *Botanico–Peridico–Huntianum* or *BPH* (Lawrence & al., 1968) and its supplements (Bridson & Smith, 1991) and other online resources such as Biological Journals and Abbreviations (http://home.ncifcrf.gov) and Algaebase (http://www.algaebase.org). All the measurements used in description are given in metric units. At last, seasonal occurrence and distribution of each taxa in Karnataka and India in alphabetical order, and notes and uses, wherever necessary have been provided.

Identification

The specimens were identified after making a complete description based on the morphological and anatomical study of specimens. The following references were used to confirm the identity: *Phaeophyceae in India* (Misra, 1966); *Phycologia Indica: The Icons of Indian Seaweeds* (Srinivasan, 1969, 1973); *Rhodophyta* (Desikachary & al., 1990, 1998); *Catalogue of the Benthic Marine Algae of the Indian Ocean* (Silva & al., 1996); *Algae of India and Neighboring Countries I. Chlorophycota* (Krishnamurthy, 2000); *Phaeophyceae of India and Neighbourhood* (Krishnamurthy & Baluswamy, 2010); *Algae of Australia: Green and Brown Algae* (Kraft, 2007; Huisman, 2015) and other online resources such as

Algaebase, (www.algaebase.org), WoRMS (www.marinespecies.org), Macroalgal Herbarium Portal (macroalgae.org), Seaweed Site: Information on marine algae (www.seaweed.ie/), Seaweed Research and Utilisation (www.seaweedindia.net/), Marine Biological Association of the UK (www.mba.ac.uk/), Iris Seaweed Research Group (www.irishseaweedresearch.com/), International Phycological Society (www.intphycsoc.org/), Phycological Society of America (/www.psaalgae.org/) etc.

RESULTS AND DISCUSSION

ECOLOGICAL ASPECTS

The occurenec and distribution of seaweeds mainly depend on the ecological aspects such as Tidal nature, Rainfall, Temperature, Coastal Topography, Salinity, pH, DO etc. of the particular area.

Tidal Nature

Tidal nature is one of the most important natural facrors that affect the seaweed vegetation pattern of the coast. Tidal waves are the regularly occurring phenomena in the sea and depend on the gravitational interaction among the Sun, Moon and Earth. During the study period, the low tide range was recored as -0.1-0.4 m during October 2014 at Talgode coast whereas high tide range was recored as 1.4-2.3 m during September 2015 at Karwar (Majali). Low tide time is considered as most suitable time for seaweed collection. High tidal waves make submergence of the rocks and thus support seaweed vegetation on exposed rocks.

Rainfall and Temperature

Rainfall is also one of the important ecological facrors determining the seaweed vegetation at any palce. During the study period, highest annual rainfall (4009 mm) was recored at Malpe, south Udupi district and the lowest annual rainfall (137 mm) was recorded in North of Udupi district. Rainfall causes the influx of fresh water into Sea and increases the nutrients and essential components which lead to support high diversity of seaweeds. Therefore, during the post-monsoon season we recored the highest number of seaweeds particularly Chlorophyceae (green seaweeds) as compared to the other season. In contrary, during summer season when the atmospheric temperature is high, we recored the lowest diversity of seaweeds, particularly red seaweeds (Rhodophyceae).

Coastal Topography

The pattern of the natural and artificial features of the coastline is important factor for influenceing seaweed vegetation. Natural rocks, bed rocks, dead corals, Pebbles, bivalve shells and men made constractions are the main substrata for seaweed growth. In Karnataka, only 3 districts i.e. Dakshina Kannada, Udupi and Uttara Kannada are coastal in nature. In southern parts of the state, major parts of the coastlien is sandy in natue and interrupted with small patches of natural rocks at places like Peribail, Uchila, Kaup beach, Surathkal, Someshwar, Ullal, Mangalore, Mulki etc. However, in northern Karnataka, most parts of the coastline are rocky and endowed with medium to big size natural rocks at places like St. Mary's island, Vannali, Tadri, Honnavar, Talgode, Someshwar (temple area), Serikuli, Gokarna, Om beach, Mundoli, Madiyengri, Gorte, Gangolli, Belekeri Karwar, Harwada-Tarangamett, Majali etc. Therefore, the highest diversity of seaweeds are recoreded in Norther Karnataka compared to southern Karnataka.

Salinity

Salinity is the concentration of salt content in sea water. During the study period, the lowest salinity (26.7 ‰) was recorded in monsoon season whereas the high salinity (35.9‰) was recorded during the summer season. The low saline water support to grow the more number of seaweeds, particularly Chlorophyceae.

pH

The pH value below 7 indicates the acidity and above 7 indicates the alkalinity of the water. The pH value of sea water was range of fluctuation during the study period. The high value (8.4) was recorded during the summer season and the low (7.2) value during the monsoon season. Low pH value increases the growth of seaweeds.

DO

The Dissolved Oxygen (DO) value is the amount of Oxygen dissolved in the water and indicates the quality and quantity of the life forms in the aquatic ecosystems. During the present study, the highest DO value was measured as 29.4 mg/l during monsoon season whereas the lowest as 1.3 mg/l during the summer. The high DO value represents the presence of high biomass in the area.

FLORISTIC ANALYSIS

The present taxonomical study is an encompassing attempt made to carry out the diversity and distribution pattern of the marine macro algae of Karnataka coast. During the study period, 74 stations / localities from the entire costal zones of Karnataka were surveyed and a total of 1595 field numbers of seaweeds were collected during different seasons and preserved in the form of herbarium specimens. Vital studies (morphology & anatomy) were carried out, along with consultation of herbarium specimens at various institutions and study of the various scrutinized literature pertinent for the accurate identification. The significant results of the present study are summarized and given below under different headings.

The present wide-ranging study on the seaweeds of Karnataka fetch out the presence of 108 taxa (including varieties and forma) belonging to 54 genera, 31 families and 20 orders (Tables II & III). The class Chlorophyceae contains 6 orders, 11 families and 16 genera, Phaeophyceae with 5 orders, 5 families and 13 genera and Rhodophyceae with 9 orders, 15 families and 24 genera (Graph I, II). Among classes, Rhodophyceae is dominant with 42 species (39%) followed by Chlorophyceae with 36 species (33%) and Phaeophyceae with 30 species (28%) as shown in Chart I. The present study records the highest diversity of seaweeds as compared to those reported by previous workers like Agadi (1985, 1986), Untawale (1989), Ambiye & Untawale (1992), NAAS (2003) and Venkataraman & Wafar (2005), and Kaladharan & al. (2011).

Besides, we aslo collected two species of seagrasses i.e. *Halophila ovalis* (R. Br.) Hook.f. and *Halophila ovata* Gaud. (Family Hydrocharitaceae) from Karwar,

Tonga and Alikodi backwater area and one species of Blue Green Algae (BGA) *Lyngbya majuscula* Harv. ex Gomont from Karnataka.

Table II. LIST OF THE SEAWEED TAXA RECORDED FROM KARNATAKA COAST, INDIA

Sl. No.	Order	Family	Genus	Species name
		CHLOROPHYCEAE (GREEN SEAWEEDS)		
1	**ULOTRICHALES**	**TROMATACEAE**	**Monostroma (1)**	**Monostroma latissimum** Wittr.
2	**ULVALES**	**ULVACEAE**	**Ulva (10)**	**Ulva clathrata** (Roth) C. Agardh
3				**Ulva compressa** L.
4				**Ulva flexuosa** Wulfen
5				**Ulva intestinalis** L.
6				**Ulva linza** L.
7				**Ulva prolifera** O.F. Muell.
8				**Ulva fasciata** Delile
9				**Ulva lactuca** L.
10				**Ulva reticulata** Forssk.
11				**Ulva rigida** C. Agardh
12	**ACROSIPHONIALES**	**ACROSIPHONIACEAE**	**Acrosiphonia (1)**	**Acrosiphonia orientalis** (J. Agardh) P.C. Silva
13	**CLADOPHORALES**	**CLADOPHORACEAE**	**Chaetomorpha (5)**	**Chaetomorpha aerea** (Dillwyn) Kuetz.
14				**Chaetomorpha antennina** (Bory) Kuetz. (**Chaetomorpha media** (C. Agardh) Kuetz.)
15				**Chaetomorpha crassa** (C. Agardh) Kuetz.
16				**Chaetomorph linum** (O.F. Muell.) Kuetz.
17				**Chaetomorpha spiralis** Okamura
18			**Cladophora (2)**	**Cladophora vagabunda** (L.) C. Hoek
19				**Cladophora sp.**
20		**ANADYOMENACEAE**	**Microdictyon (1)**	**Microdictyon tenuis** J.E. Gray
21	**SIPHONOCLADALES**	**SIPHONOCLADACEAE**	**Cladophoropsis (1)**	**Cladophoropsis sundanensis** Reinbold
22			**Struvea (1)**	**Struvea anastomosans** (Harv.) Picc. & Grunow ex Picc.
23		**VALONIACEAE**	**Ernodesmis (1)**	**Ernodesmis verticiliata** (Kuetz) Boergesen
24			**Valoniopsis (1)**	**Valoniopsis pachynema** (G. Martens) Boergesen
25	**BRYOPSIDALES**	**BRYOPSIDACEAE**	**Bryopsis (2)**	**Bryopsis hypnoides** J.V. Lamour.

26				**Bryopsis plumosa** (Huds.) C. Agardh
27		**CAULERPACEAE**	**Caulerpa (6)**	**Caulerpa peltata** J.V. Lamour.
28				**Caulerpa prolifera** (Forssk.) J.V. Lamour.
29				**Caulerpa racemosa** (Forssk.) J. Agardh
30				**Caulerpa scalpelliformis** (R. Br. ex Turner) C. Agardh
31				**Caulerpa sertularioides** (S.G. Gmel.) M. Howe
32				**Caulerpa taxifolia** (Vahl) C. Agardh
33		**UDOTIACEAE**	**Chlorodesmis (1)**	**Chlorodesmis hildebrandtii**
34			**Arvaivillea (1)**	**Arvainvillea amadelpha** (Mont.) A. Gepp & E.S. Gepp
35		**CODIACEAE**	**Codium (2)**	**Codium dwarkense** Boergesen
36				**Codium decarticatum**
		PHAEOPHYCEAE (BROWN SEAWEEDS)		
37	**ECTOCARPALES**	**ECTOCARPACEAE**	**Ectocarpus (1)**	**Ectocarpus siliculosus** (Dillwyn) Lyngb.)
38			**Hincksia (1)**	**Hincksia mitchelliae** (Harv.) P.C. Silva
39			**Iyengaria (1)**	**Iyengaria stellata** (Boergesen) Boergesen
40	**SPHACELARIALES**	**SPHACELARIACEAE**	**Sphacelaria (1)**	**Sphacelaria rigidula** Kuetz.
41	**DICTYOTALES**	**DICTYOTACEAE**	**Dictyopteris (2)**	**Dictyopteris australis** (Sond.) Askenasy
42				**Dictyopteris woodwardii** (R. Br. ex Turner) C. Agardh
43				**Dictyopteris delicatula** J.V. Lamour.
44			**Dictyota (7)**	**Dictyota bartayresii** J.V. Lamour.
45				**Dictyota cervicornis** Kuetz.
46				**Dictyota ceylanica** Kuetz.
47				**Dictyota ciliolata** Kuetz.
48				**Dictyota delicatula** J.V. Lamour.
49				**Dictyota dichotoma** (Huds.) J.V. Lamour.
50				**Dictyota pinnatifida** Kuetz.
51			**Lobophora (1)**	**Lobophora variegata** (J.V. Lamour.) Womersley ex E.C. Oliveira
52			**Padina (4)**	**Padina boergesenii** Allender & Kraft
53				**Padina boryana** Thivy

54				**Padina pavonica** (L.) Thivy
55				**Padina tetrastromatica** Hauck
56			**Spatoglossum (1)**	**Spatoglossum asperum** J. Agardh
57			**Stoechospermum (1)**	**Stoechospermum marginatum** (C.Agardh) Kuetz.
58	**SCYTOSIPHONALES**	**SCYTOSIPHONACEAE**	**Colpomenia (1)**	**Colpomenia sinusa** (G. Mertens ex Roth) Derbes & Solier
59	**FUCALES**	**SARGASSACEAE**	**Sargassum (7)**	**Sargassum cinctum** J. Agardh
60				**Sargassum cinereum** J. Agardh
61				**Sargassum cristaefolium** C. Agardh
62				**Sargassum polycystum** C. Agardh
63				**Sargassum swartzii** C. Agardh
64				**Sargassum tenerrimum** J. Agardh
65				**Sargassum wightii** Grev.
66			**Turbinaria (1)**	**Turbinaria ornata** (Turner) J. Agardh
		RHODOPHYCEAE (RED SEAWEEDS)		
67	**BANGIALES**	**BANGIACEAE**	**Porphyra (2)**	**Porphyra kanyakumariensis** V. Krishnam. & Baluswami
68				**Porphyra vietnamensis** Tak. Tanaka & P.H. Ho
69	**AHNFELTIALES**	**AHNFELTIACEAE**	**Ahnfeltia (1)**	**Ahnfeltia plicata** (Huds.) Fr.
70	**GELIDIALES**	**GELIDIACEAE**	**Gelidium (2)**	**Gelidium micropterum** Kuetz.
71				**Gelidium pusillum** (Stackh.) Le Jolis
72		**GELIDIELLACEAE**	**Gelidiella (1)**	**Gelidiella acerosa** (Forssk.) J. Feldmann & G. Hamel
73	**GRACILARIALES**	**GRACILARIACEAE**	**Gracilaria (6)**	**Gracilaria corticata** (J. Agardh) J. Agardh
74				**Gracilaria corticata** (J. Agardh) J. Agardh var. **cylindrica** M.U. Rao
75				**Gracilaria edulis** (Gmelin) Silva
76				**Gracilaria foliifera** (Forssk.) Boergesen
77				**Gracilaria salicornia** (C. Agardh) E.Y. Dawson
78				**Gracilaria verrucosa** (Huds.) Papenf.
79	**CRYPTOMANIALES**	**HALYMENIACEAE**	**Grateloupia (3)**	**Grateloupia filicina** (J.V. Lamour.) C.Agardh

80				**Grateloupia indica** Boergesen
81				**Grateloupia lithophila** Boergesen
82	**CORALLINALES**	**CORALLINACEAE**	**Amphiroa (2)**	**Amphiroa fragilissima** (L.) J.V. Lamour.
83				**Amphiroa anceps** (Lamark) Decaigne
84			**Cheilosporum (1)**	**Cheilosporum spectabile** Harv. ex Grunov
85			**Jania (1)**	**Jania rubens** (L.) J.V. Lamour.
86			**Corallina (1)**	**Corallina officinalis** L.
87	**GIGARTINALES**	**CAULACANTHACEAE**	**Catenella (1)**	**Catenella impudica** (Mont.) J. Agardh
88		**GIGARTINACEAE**	**Chondracanthus (1)**	**Chondracanthus acicularis** (Roth) Fredericq
89		**HYPNEACEAE**	**Hypnea (5)**	**Hypnea esperi** Bory
90				**Hypnea flagelliformis** Grev. ex J.Agardh
91				**Hypnea musciformis** (Wulfen) J.V. Lamour.
92				**Hypnea spinella** (C.Agardh) Kuetz.
93				**Hypnea valentiae** (Turner) Mont.
94	**RHODYMENIALES**	**CHAMPIACEAE**	**Champia (2)**	**Champia compressa** Harv.
95				**Champia parvula** (C.Agardh) Harv
96		**RHODYMENIACEAE**	**Gelidiopsis (2)**	**Gelidiopsis repens** (Kuetz.) Weber-Van Bory
97				**Gelidiopsis variabilis** (J. Agardh) F. Schmitz
98	**CERAMIALES**	**CERAMIACEAE**	**Centroceras (1)**	**Centroceras clavulatum** (C. Agardh) Mont.
99			**Ceramium (1)**	**Ceramium flaccidum** (Kuetz.) Ardiss.
100			**Chondria (2)**	**Chondria armata** (Kuetz.) Okamura
101				**Chondria cornuta** Boergesen
102		**DELESSERIACEAE**	**Caloglossa (1)**	**Caloglossa leprieurii** (Mont.) G. Martens
103			**Martensia (1)**	**Martensia fragilis** Harv.
104		**RHODOMELACEAE**	**Acanthophora (1)**	**Acanthophora spicifera** (Vahl) Boergesen
105			**Bostrychia (1)**	**Bostrychia tenella** (J.V. Lamour.) J. Agardh
106			**Laurencia (2)**	**Laurencia obtusa** (Huds.) J.V. Lanour.
107				**Laurencia papillosa** (C. Agardh) Grev.
108			**Polysiphonia (1)**	**Polysiphonia platycarpa** (Dillwyn) Grev. ex Harvey

Table III. summary of seaweed diversity in Karnataka coast

S. No.	Class	Orders	Families	Genera	Species
1	Chlorophyceae	6	11	15	36
2	Phaeophyceae	5	5	13	30
3	Rhodophyceae	9	15	24	42
4	**Total**	**20**	**31**	**53**	**108**

An analysis of the taxa recorded in the present study reveals that family Dictyotaceae shows the highest diversity with 6 genera and 17 species, followed by Ulvaceae with 1 genus and 10 species and Sargassaceae with 2 genera and 8 species. Similarly, *Dictyota* and *Sargassum* are most dominant genera with 7 species each. Top 5 dominant families and genera are represented in Table IV and V.

Table IV. Dominant families of Seaweeds in Karnataka coast.

Sl. No.	Family	Genera	Species
1	DICTYOTACEAE	6	17
2	ULVACEAE	1	10
3	SARGASSACEAE	2	8
4	CLADOPHORACEAE	2	7
5	CAULERPACEAE	1	6

Table V. Dominant genera of Seaweeds in Karnataka coast.

Sl. No.	Genera	Species
1	*Ulva*	10
2	*Dictyota*	7
3	*Sargassum*	7
4	*Caulerpa*	6
5	*Gracilaria*	6

New additions

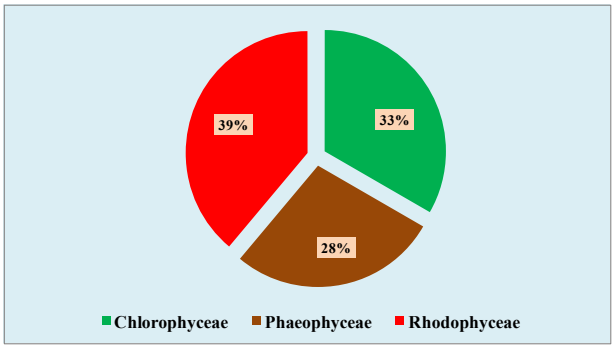
During the present floristic study, 20 taxa (Table VI, Plates 18, 19) are recored as new to the state. Therefore, these are additions to the seaweed flora of Karnataka coast.

Table VI. List of new additions to seaweed flora of Karnataka coast

Sl. No.	Class	Family	Name of the species
1	**Chlorophyceae**	Ulvaceae	**Ulva linza** L.
2		Acrosiphoniaceae	**Acrosiphonia orientalis** (J. Agardh) P.C. Silva
3		Cladophoraceae	**Chaetomorpha aerea** (Dillwyn) Kuetz.
4			**Chaetomorpha crassa** (C. Agardh) Kuetz.
5			**Chaetomorpha spiralis** Okamura

6		Siphonocladaceae	**Cladophoropsis sundanensis** Reinbold
7		Bryopsidaceae	**Bryopsis hypnoides** J.V. Lamour.
8		Codiaceae	**Codium dwarkense** Boergesen
9	**Phaeophyceae**	Ectocarpaceae	**Iyengaria stellata** (Boergesen) Boergesen
10	**Rhodophyceae**	Bangiaceae	**Porphyra kanyakumariensis** V. Krishnam. & Baluswami
11		Gelidiaceae	**Gelidium micropterum** Kuetz.
12		Gracilariaceae	**Gracilaria corticata** (J. Agardh) J. Agardh var. **cylindrica** M.U. Rao
13		Halymeniaceae	**Grateloupia indica** Boergesen
14		Gigartinaceae	**Chondracanthus acicularis** (Roth) Fredericq
15		Champiaceae	**Champia compressa** Harv.
16		Rhodymeniaceae	**Gelidiopsis repens** (Kuetz.) Weber-Van Bory
17		Rhodomelaceae	**Chondria cornuta** Boergesen
18		Delesseriaceae	**Caloglossa leprieurii** (Mont.) G. Martens
19			**Martensia fragilis** Harv.
20		Rhodomelaceae	**Bostrychia tenella** (J.V. Lamour.) J. Agardh

Chart 1. Percentage distribution of seaweed classes in Karnataka coast.



ENDEMIC SEAWEEDS

Identification and determination of endemic seaweeds is one of the difficult tasks in the field of seaweed research. The report on the endemic status of seaweeds in the world as well as in India is very meagre. In India, Oza & Zaidy (2001) made the first attempt to determine the endemic seaweeds of India and provided a provisional list of 125 endemic taxa of seaweeds, consisting of 73 Rhodophyceae, 32 Phaeophyceae and 20 Chlorophyceae members. Based on the review of this reference, the authors could found 3 taxa of Rhodophyceae i.e. *Porphyra kanyakumariensis* V. Krishnam. & Baluswami, *Grateloupia indica* Boergesen and *Hypnea flagelliformis* Grev. ex J.Agardh, which are endemic to Karnataka coast.

ECONOMICALLY IMPORTANT SEAWEEDS

Seaweeds are economically one of the most important marine natural resourses and used by the human beings since times immemorial. In many of the south East Asian countries like Japan, Philippines, China, Thailand, Korea etc. seaweeds are used as food on large scale. With the advancement in technology and research, the economical aspects of seaweeds has also increased and now apart from food and fodder, they are also used as raw materials in many industries such as biochemical industries (agar-agar, align, alginates etc.), textiles, pharmaceuticals, food industry, cosmetics, biofertilizers (SLF), paper industries etc. Presently, 221 economically important seaweeds are reported from worldwide, of which 125 are from India (Sahoo, 2000). Base on the above reference and the taxa enumerated in the present study, 43 species (Table VII) of seaweeds, consisting of 20 chlorophyceae, 7 phaeophyceae and 16 rhodophyceae are recognized as economically important in Karnataka. The economical utilization of these seaweeds is, however not known to the local people. Theferore, awareness should be created among them towards the economical importance of seaweeds so that they can move towards the artificial cultivation of these seaweeds which many lead to the establishment of seaweed based industries and finally an alternative source of income to them.

Table VII. List of the economically important Seaweeds in Karnataka coast

Sl. No.	Class	Order / Family	Species name
1	**CHLOROPHYCEAE**	**ULOTRICHALES / MONOSTROMATACEAE**	**Monostroma latissimum** Wittr.
2		**ULVALES / ULVACEAE**	**Ulva compressa** L.
3			**Ulva flexuosa** Wulfen
4			**Ulva intestinalis** L.
5			**Ulva linza** L.
6			**Ulva prolifera** O.F. Muell.

7			**Ulva fasciata** Delile
8			**Ulva lactuca** L.
9			**Ulva reticulata** Forssk.
10			**Ulva rigida** C. Agardh
11		**ACROSIPHONIALES / ACROSIPHONIACEAE**	**Acrosiphonia orientalis** (J. Agardh) P.C. Silva
12		**CLADOPHORALES / CLADOPHORACEAE**	**Chaetomorpha antennina** (Bory) Kuetz.
13			**Chaetomorpha crassa** (C. Agardh) Kuetz.
14			**Chaetomorpha spiralis** Okamura
15			**Cladophora vagabunda** (L.) C. Hoek
16		**BRYOPSIDALES / BRYOPSIDACEAE**	**Bryopsis plumosa** (Huds.) C. Agardh
17		**CAULERPACEAE**	**Caulerpa peltata** J.V. Lamour.
18			**Caulerpa racemosa** (Forssk.) J. Agardh
19			**Caulerpa sertularioides** (S.G. Gmel.) M. Howe
20			**Caulerpa taxifolia** (Vahl) C. Agardh
21	**PHAEOPHYCEAE**	**DICTYOTALES / DICTYOTACEAE**	**Dictyota bartayresii** J.V. Lamour.
22			**Lobophora variegata** (J.V. Lamour.) Womersley ex E.C. Oliveira
23			**Padina boergesenii** Allender & Kraft
24			**Padina tetrastromatica** Hauck
25		**FUCALES / SARGASSACEAE**	**Sargassum tenerrimum** J. Agardh
26			**Sargassum wightii** Grev.
27			**Turbinaria ornata** (Turner) J. Agardh
28	**RHODOPHYCEAE**	**BANGIALES / BANGIACEAE**	**Porphyra kanyakumariensis** V. Krishnam. & Baluswami

29	**GELIDIALES / GELIDIACEAE**	**Gelidium micropterum** Kuetz.
30		**Gelidium pusillum** (Stackh.) Le Jolis
31	**GELIDIELLACEAE**	**Gelidiella acerosa** (Forssk.) J. Feldmann & G. Hamel
32	**GRACILARIALES / GRACILARIACEAE**	**Gracilaria corticata** (J. Agardh) J. Agardh
33		**Gracilaria corticata** (J. Agardh) J. Agardh var. **cylindrica** M.U. Rao
34		**Gracilaria edulis** (Gmelin) Silva
35		**Gracilaria foliifera** (Forssk.) Boergesen
36		**Gracilaria salicornia** (C. Agardh) E.Y. Dawson
37		**Gracilaria verrucosa** (Huds.) Papenf.
38	**CRYPTOMANIALES / HALYMENIACEAE**	**Grateloupia filicina** (J.V. Lamour.) C.Agardh
39	**HYPNEACEAE**	**Hypnea flagelliformis** Grev. ex J.Agardh
40		**Hypnea musciformis** (Wulfen) J.V. Lamour.
41		**Hypnea valentiae** (Turner) Mont.
42	**RHODOMELACEAE**	**Acanthophora spicifera** (Vahl) Boergesen
43		**Laurencia papillosa** (C. Agardh) Grev.

An analysis of the abundance of the seaweeds recorded from Karnataka coast reveals variation in pattern of seaweed distribution. Species like *Acrosiphonia orientalis, Caulerpa taxifolia, Centrocersa clavulatum, Chaetomorpha antennina, Cladophora vagabunda, Enteromorpha compressa, E. flexuosa, Gelidium micropterum, Gracilaria corticata, Grateloupita filicina, G. lithophila, Padina tetrastromatica, Hypnea nmusciformis, Sargassum cinereum, Ulva fasciata* etc. are common and distributed widely. Species like *Ahnfeltia plicata*, *Acanthophora spicifera*, *Amphiroa fragilissima, Bryopsis plumosa, Caulerpa peltata*, *C. racemosa, Chondracanthus acicularis, Dictyota dichotoma, Gelidium pusillum, Padina boergesenii, Padina boryana* etc. were moderately distributed at most of the places. Whereas species like *Bostrychia tenella, Bryopsis hypnoides, Chaetomorpha spiralis, Champia compressa, Caulerpa scalpelliformis, C.*

sertularioides, Dictyota cervicornis, D. ciliolata, Dictyopteris delicatula, Enteromorpha linza, Hypnea spinell, H. Valentiae, Struvea anastomosans, Ulva rigida etc. were found meagerly distributed.

During the study, we identified some important seaweed rich localities *i.e.* Gorte, St. Mary's island, Surathkal, Om beach, Talgode, Tadri, Honnavar, Vannali, Uchila, Karwar, Majali, sherikuli etc. This finding will be useful for the local villegers to inhance their livelihood practicing collection and artificially cultivation of seaweeds for commercial uses.

SYSTEMATIC TREATMENT

The seaweed taxa enumerated from the Karnataka coast have been classified after Fristch (1935, 1944) with slight modifications according to Papenfuss (1951) and Silva & al. (1996) and bracketed keys have been provided for easy identification.

KEY TO CLASSES

1a. Thallus green; chlorophyll b present; zoospores flagellate **1. CHLOROPHYCEAE**
1b. Thallus brown or red; chlorophyll b absent; zoospores flagellate or eflagellate **2**

2a. Thallus brown; chlorophyll a & c present; reserve food mannitol and laminarin zoospores always flagellate **2. PHAEOPHYCEAE**
2b. Thallus red; chlorophyll a & d present; reserve food floridean starch; zoospores always aflagellate **3. RHODOPHYCEAE**

CLASS: CHLOROPHYCEAE

Under the class Chlorophyceae, 7 orders which are exclusively marine or both marine and freshwater in nature, are represented in India (Oza & Zaidi, 2001), of which 6 are available in Karnataka coast. Therefore, keys to the orders, which are represented in Karnataka coast are given below.

KEY TO ORDERS

1a. Thallus filamentous, simple or branched; cells usually cylindrical to barrel shaped, multinucleate **2**
1b. Thallus not filamentous; cells variable in shape, uni- or multinucleate **3**

2a. Thallus intertwined, forming mat like structure **Acrosiphoniales**
2b. Thallus freely branched, not forming mat like structure **Cladophorales**

3a. Thallus usually foliose, flat, ribbon shaped or tubular **4**
3b. Thallus usually siphonous, spongy or feather like, rarely foliose, multinucleate **5**

4a. Thallus foliose, small, up to 30 cm long **Ulotrichales**
4a. Thallus foliose, tubular or ribbon shaped, up to 2 m long **Ulvales**

5a. Thallus spongy, cup like or matted with clavate to cylindrical vesicles; holdfast rhizoidal or tenaculam type **Siphonocladales**
5b. Thallus feathery to grape like or foliaceous **Bryopsidales**

1. ULOTRICHALES

MONOSTROMATACEAE

Thallus green in colour, membranous, foliose or tubular, up to 30 cm in length. Anatomically, cells usually isodiametric, uninucleate, chloroplast with one to several pyrenoids.

This family is represented by 2 genera in India as well as in Karnataka (Krishnamurthy, 2000).

1. Monostroma Thur.

Thallus membranous, foliose, forming a saccate shape in young stage, variable in length. Anatomically, cells usually isodiametric, monostromatic. Presently, 28 taxa in world (Guiry & Guiry, 2017), 2 in India (Rao & Gupta, 2015) and 1 species in Karnataka.

Monostroma latissimum Wittr. Monogr. Monostroma. 33, pl. 1, fig. 4. 1866; Untawale & al., *Mahasagar – Bull. Natl. Inst. Ocenogr.* Goa, 13 (2): 180. 1979; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 147. 2001; Jha & al., Seaweeds Gujarat: 7. 2009; P.S.N. Rao & Gupta, Algae India 3: 1. 2015.

Thallus light-dark green, small, foliose, membranous, usually 1-3 cm in length, tufted, lithophilic, grows as patches and forming thick mat on surface. Holdfast minute, discoid, firmly attached on substratum. Stipe tubular in young stage and flattened at maturity, small. Fronds foliose, membranous, margins crispy to slightly undulate. Anatomically cells monostromatic (consists of single layer), cells oval-spherical, 9.05 × 12.8 µm across, thick walled, uninucleate, chloroplast laminate with one to many pyrenoids. **(Plate 20. a)**

Occurrence: Usually post-monsoon seasons. Rare (scanty).

Distribution: **Karnataka**: Uttara Kannda district. **India:** Goa and Gujarat.

Notes: This species is mostly found growing in monospecific condition and forms a thick mat like surface on substratum. In young stage, it shows morphological similarities with *Ulva* and causes confusion in identification.

Uses: This species is recognized as edible seaweed and is used for human consumption (as delicacy in soyabean milk soup) in many south East Asian countries like China, Japan (Jha & al., 2009).

Specimen Examined: - Karnataka: Madiyengri, *Palanisamy* 133270, 21.09.2015; Someshwar beach, *Palanisamy & Yadav* 131117, 13.10.2014; Shiroor coast, *Palanisamy & Yadav* 131146, 14.10.2014.

2. ULVALES

ULVACEAE

Thallus green in colour, membranous, tubular to foliose, variable in size, up to 2 meters long, usually epilithic. Fronds often linear to elongate, ribbon shaped or variable, margins entire to proliferate. Anatomically, thallus mono- or distromatic; cells rectangular, quadrate or polygonal in surface view; chloroplast reticulate to peripheral with one to several pyrenoids.

This family is represented by 2 genera in India as well as in Karnataka.

Note: Hayden (2003) based on the molecular study opined that the two genera *Ulva* and *Enteromorpha* are paraphyletic in origin and transferred *Enteromorpha* into *Ulva*. Although, the morphological and anatomical characters (like tubular, membranous, foliose thallus, number of layer(s) of cells such as mono- or dia-

stromatic nature etc.) support very good characters for distinguishing *Enteromorpha* and *Ulva.* However, the result of the molecular studies states that both genera have similar molecular orientation (Hayden, 2003). Therefore, genus *Enteromorpha* has been merged under genus *Ulva* and the same has been followed here.

1. Ulva L.

Thallus light-dark green in colour, foliose, mono -distromatic, membranous to foliose, simple, and lobed or branched. Cells in surface view quadrate to polygonal; in cross section, cells palisade like, arranged in mucilaginous sheath; chloroplast single, plate like with one to several pyrenoid(s).

Presently, 149 taxa in world (Guiry & Guiry, 2022), 31 in India (Rao & Gupta, 2015) and 10 in Karnataka.

Key to Species

1a.	Thallus lettuce, flat, distromatic	**2**
1b.	Thallus cylindrical or tubular, monostromatic	**7**
2a.	Fronds simple, foliose, flat to slightly tubular	**3**
2b.	Fronds simple or branched, tubular; stipe usually short	**4**
3a.	Fronds almost uniformly flattened, contorted, intestine like coiled, up to 6 mm Wide	**4. U. intestinalis**
3b.	Fronds broadly flattened towards apex, straight or slightly twisted, up to 2 cm Wide	**5. U. linza**
4a.	Thallus small, up to 6 cm long, fronds tapering below and gradually expanded Above	**2. U. compressa**
4b.	Thallus large, up to 20 cm long, fronds hairy, almost uniform throughout	**5**
5a.	Fronds usually simple, flexuous or twisted, inflated	**3. U. flexuosa**
5b.	Fronds filiform, regularly branched, straight, not flexuous	**6**
6a.	Thallus large, up to 35 cm long; fronds sparsely branched, surface cells polygonal	**6. U. prolifera**
6b.	Thallus small, up to 12 cm long; fronds profusely branched throughout, surface cells elongate	**1. U. clathrata**
7a.	Fronds reticulate or net like, fronds profusely perforated	**9. U. reticulata**
7b.	Fronds not reticulate, margins entire to minutely perforated	**8**
8a.	Fronds ribbon like, up to 1.5 m long, simple of lobed; lobes linear, usually uniformly flattened, up to 5 cm wide; margins entire to undulate	**7. U. fasciata**
8b.	Fronds not ribbon like, rounded, obovate to lanceolate or slightly lobed	**9**
9a.	Thallus small, up to 10 cm long and 15 cm broad, rounded to obovate or irregularly proliferated into small lobes, delicate to transparent	**8. U. lactuca**
9b.	Thallus large, up to 15 cm long, usually ovate-round in young stage and becomes orbicular to slightly lobed, rigid, thick, tufted	**10. U. rigida**

1. Ulva clathrata (Roth) C. Agardh, Disp. algar.2:23.1811; P.S.N. Rao & Gupta, Algae India 3: 1. 2015. *Enteromorpha clathrata* (Roth) Grev., Alg. Brit. 16: 181. 1830; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 89. 2000; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 72. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 147. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Palanisamy & al. in Rajendran & Aravindhan (eds.), Biodiver. Conserv. Asp. Prosp. 34. 2015. *Conferva clathrata* Roth, Cat. Bot. Fasc. 3: 175. 1806.

Thallus light-yellowish green, usually 2-10 cm long, tubular, hair like, tufted, profusely branched throughout main axis, lithophilic. Holdfast minute, discoid, firmly attached on substratum. Stipe tubular, small, up to 1.5 mm long. Fronds cylindrical or tubular at base, 0.5-3 mm in diameter, margins entire, apex obtuse or acute. *Microscopic*: Cells in surface view elongate, large, irregularly arranged, 20-38 × 10-15 µm, thin walled; cells in cross section squarish, 10-18 µm across, sheath 1.4-2 µm thick; uninucleate; chloroplast plate-like, arranged towards cell wall, pyrenoids one to two. **(Plate 20. b)**

Occurrence: During post-monsoon seasons. Rare.

Distribution: **Karnataka**: Uttara Kannda district (Madiyengri). **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: - Karnataka: Madiyengri, *Palanisamy & Yadav* 136233, 26.11.2016.

2. Ulva compressa L., Sp. Pl. 2: 1163. 1753; P.S.N. Rao & Gupta, Algae India 3: 2. 2015. *Enteromorpha compressa* (L.) Nees, Horae Phys. Berol. Index 2: 123. 1820; K.S. Sriniv., Phycol. Ind.: 2: 51. Pl. 51. 1973; Untawale & al., List Mar. Alg. India: 8. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 729. 1996; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 90. 2000; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 147. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011.

Thallus light-yellowish green in colour, 2-10 cm long, hollow, profusely branched, lithophilic. Holdfast minute, discoid, attached firmly on rocky substrata in intertidal region. Stipe tubular, up to 1.5 mm long, simple or branched in the upper portion. Fronds many, tubular at base and gradually expanded and compressed towards apex, 1-8 × 0.2-1.2 mm, surface smooth, margins entire, apex obtuse to round, slightly transparent. *Microscopic*: Cells in surface view squarish-elongate or irregular, 15-30 µm across, 8-17 µm across in basal region, irregularly arranged, cell wall thin; cells in cross section 15-30 × 10-12 µm, sheath with equal thickness, up to 2 µm thick; uninucleate; chloroplast plate like with single pyrenoid. **(Plate 20. c)**

Occurrence: Throughout the year. Common.

Distribution: Throughout Karnataka coast. **India**: Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra, Odisha and Tamil Nadu.

Notes: This is one of the most common species and is mostly found growing in association with other species of *Ulva* and *Chaetomorpha.*

Specimen Examined: Karnataka: Surathkal beach, *Palanisamy & Yadav* 131040, 09.10.2014; Thudiya (Uchila) coast, *Palanisamy & Yadav* 131082, 11.10.2014; Someshwar beach, *Palanisamy & Yadav* 131119, 13.10.2014.

3. Ulva flexuosa Wulfen, Crypt. Aquat. 3: 1. 1803. *Enteromorpha flexuosa* (Wulfen) J. Agardh, Algern. Syst. 3: 126. 1883; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 127. 1970; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 731. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 148. 2001; Jha & al., Seaweeds Gujarat: 9. 2009; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 1. 2015.

Thallus yellowish green in colour, up to 28 cm long and 2.4-10 mm broad, tubular, hollow, lithophilic. Holdfast small, discoid, attached firmly on rocks as well as waste materials like nets, cloths, ropes in intertidal and subtidal regions. Stipe small, tubular, 4-6 µm long. Fronds hairy in young stage and becoming somewhat flat at maturity, 5-20 cm long and 5-8 µm wide, tubular at base and gradually becoming flexuous towards apex, margins entire, apex obtuse to round. *Microscopic*: Cells in surface view usually polygonal to rectangular, 10-22 µm across; arranged in linear series towards base and irregularly towards apex; cells in cross section thallus 20-24 µm thick, cells usually rectangular, 16-25 × 14-20 µm wide; uninucleate; chloroplast completely filling almost entire cell, pyrenoids 4-5, spherical. **(Plate 20. d)**

Occurrence: Throughout the year. Common.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra, Odisha and Tamil Nadu.

Notes: This is one of the common species and grows luxuriantly during the monsoon season especially where the influx of fresh water is found.

Uses: The dry seaweed powder is used in instant cup noodles in Japan and also as garnishing agent in snack foods. Further, it is reported that this species contains nourishing agents such as polysaturated fatty acids, minerals, vitamins, antioxidants and proteins (Jha & al., 2009).

Specimen Examined: - Karnataka: Mangalore F.H. area, *Palanisamy & Yadav* 131009 & 131011, 09.10.2014; Surathkal beach, *Palanisamy & Yadav* 131019 & 131021, 09.10.2014; Mulki coast, *Palanisamy & Yadav* 131051, 10.10.2014.

4. **Ulva intestinalis** L., Sp. Pl. 2: 1163. 1753; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014. *Enteromorpha intestinalis* (L.) Nees, Horae Phys. Berol. Index: 2.1820; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 3.1970; Untawale & al., List Mar. Alg. India: 8. 1983; P.C. Silva & al., Cat. Benth. Mar.

Alg. Ind. Ocean: 733. 1996; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Palanisamy & al. in Rajendran & Aravindhan (eds.), Biodiver. Conserv.: Asp. Prosp.: 28. 2015.

Thallus light-yellowish green in colour, long, up to 22 cm long and 2-5 mm wide, tubular, contorted, mature filaments intestine like, lithophilic. Holdfast minute, discoid, attached loosely to the substratum but later free floating; Stipe simple, small, up to 2 cm long. Fronds usually simple, mature thallus sometimes proliferated, thin, cylindrical below and becoming inflated and irregularly constricted above, lumen inflated with air bubbles, becoming free floating on water surface, margins entire to undulate. *Microscopic*: Cells in surface view rounded to polygonal, thin walled, 8-20 µm across, irregularly arranged; in cross section 10-20 × 9-15 µm, sheath with equal thickness, 4-8 µm thick; uninucleate; chloroplast cup shaped, ulmost complete, with 2-4 pyrenoids. **(Plate 20. e)**

Occurrence: During monsoon and post-monsoon seasons. Moderate.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra, Odisha, Puducherry, Tamil Nadu and West Bengal.

Notes: This species is mostly found growing gregariously in monospecific condition and occasionally inn association with other species of *Enteromorpha*.

Uses: This species along with other species of green seaweeds is used in preparing seaweed meal as poultry feed in south East Asian countries like Japan (Jha & al., 2009).

Specimen Examined: - Karnataka: Hejmadi coast, *Palanisamy & Yadav* 131050, 10.10.2014; Hejmadi coast, *Palanisamy & Yadav* 131056, 11.10.2014; Karwar beach, *Palanisamy & Yadav* 131220, 18.10.2014.

5. Ulva linza L., Sp. Pl. 2: 1163. 1753. *Enteromorpha linza* (L.) J. Agardh, Algern. Syst. 3: 134. 1883; Untawale & al., List Mar. Alg. India: 8. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 736. 1996; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 94. 2000; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 151. 2001; Palanisamy & al. in Seaweed Res. Utiln. 35(1&2): 24. 2013; P.S.N. Rao & Gupta, Algae India 3: 2. 2015.

Thallus light-dark green in colour, foliaceous, flattened to slightly tubular, 5-16 cm long, epilithic. Holdfast small, discoid, loosely attached to substratum, sometimes free floating. Stipe tubular, gradually flattened upwards, up to 1 cm long. Fronds simple, flattened, linear to lanceolate, tubular below and gradually flattened upwards, 0.4-1.8 cm wide in middle, margins entire to undulate or proliferated, apex irregular. *Microscopic*: Cells in surface view polygonal to elongate, thin walled, irregularly arranged; in cross section usually rectangular, 9-11.8 × 15-18.2 µm wide, sheath 2 µm thick; uninucleate; chloroplast concentrated in half part or irregular, pyrenoid single. **(Plate 20. f)**

Occurrence: Monsoon and post-monsoon seasons. Rare.

Distribution: **Karnataka**: Uttara Kannda (Gokarna, Harwada- Tarangamett and Madiyendri) and Uttara Kannda (Surathkal and Peribail) districts. **India:** Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Use: The seaweed powder is used as aquafeed and livestock feed in several countries (Jha & al., 2009).

Specimen Examined: - Karnataka: Peribail, *Palanisamy & Yadav* 135219, 24.08.2016; Gokarna, *Palanisamy & Yadav* 135774, 31.08.2016; Surathkal beach, *Palanisamy & Yadav* 131039, 09.10.2014;

6. **Ulva prolifera** O.F. Muell., Fl. Dan. 5(13): 7, pl. 763 (1). 1778. *Enteromorpha prolifera* (O.F. Muell.) J. Agardh, Algern. Syst. 3: 129. 1883; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 3.1970; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 749. 1996; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 94. 2000; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 151. 2001; Palanisamy & al. in Rajendran & Aravindhan (eds.), Biodiver. Conserv. Asp. Prosp. 33. 2015. *Enteromorpha polyclados* (Kuetz.) Kuetz. Tab. Phycol. 6: 13. 1856.

Thallus dark-yellowish green in colour, up to 30 cm long and 0.5-1.7 cm broad, proliferated, growing in densely intricated masses, regularly tubular at base and compressed above; holdfast small. Stipe slender, small, simple or branched; fronds tubular, prominently proliferated from main axis forming several secondary proliferations, side branches up to 1 mm in width, margins entire, apex obtuse. Cells in surface view usually polygonal, thin walled, 10-16.5 µm across, linear to irregularly arranged; in cross section oblong, 10-25 × 6-10.8 µm wide, sheath up to 4 µm thick; uninucleate; chloroplast complete, filling almost entire cell, pyrenoids one to many. **(Plate 21. a)**

Occurrence: Throughout the years. Common.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Gujarat, Kerala, Lakshadweep Islands, Maharashtra, Tamil Nadu and West Bengal.

Use: This is one of the edible species and is cultivated in Japan and several other countries of the world (Jha & al., 2009).

Specimen Examined: - Karnataka: Mulki coast, *Palanisamy & Yadav* 131049, 10.10.2014; Hejmadi coast, *Palanisamy & Yadav* 131057, 11.10.2014; Uppandar, *Palanisamy* 133203, 19.09.2015.

7. Ulva fasciata Delile, Fl. Egypt. Expl. Pl. 2: 297, Pl. 58. Fig. 5. 1813; Untawale & al., List Mar. Alg. India.,7. 1983; P.C. Silva & al., Cat. Benth. Mar.

Alg. Ind. Ocean: 743. 1996; Kaliap. & al. in Seaweed Res. Utiln. 20(1&2): 141. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 152. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 3. 2015.

Thallus dark-light green in colour, up to 50 (-120) cm long but can grow even up to 2 m long, leafy, ribbon shaped, mostly gregarious, tufted, lithophilic. Holdfast small, rhizoidal, tufted, firmly attached. Stipe small, foliaceous, simple or branched, up to 2.6 cm long and 1.2 cm wide. Fronds leafy, deeply divided into several linear blades; blades 1.5-5 cm wide, almost uniformly flattened in middle portion, surface smooth, membranous, irregularly lobed, gradually tapering towards apex; margins entire to frequently undulate; apex acute to obtuse. *Microscopic*: Cells in surface view polygonal - squarish, 12-20 µm across, irregularly arranged; in cross section thallus surface 90-115 µm thick towards base and 70-100 µm towards apex; cells palisade like, distromatic, compactly arranged, 34-40 × 8-12 µm; separated with 8-15 µm thick middle layer, uninucleate, chloroplast plate like, concentrated mainly towards cell wall, inner parts somewhat hyaline or transparent, pyrenoids 2 in each cell. **(Plate 21. b)**

Occurrence: Throughout the year. Common.

Distribution: Throughot Karnataka coast. **India:** Andaman & Nicobar Islands; Andhra Pradesh; Goa; Gujarat; Kerala; Lakshadweep Islands; Maharashtra; Puducherry; Tamil Nadu.

Notes: This is one of the most common species and found growing luxuriantly during the monsoon and post-monsoon seasons.

Uses: It is also used as food in the form of salad and soups in some parts of the world, especially in Hawaii, USA and south-east Asian countries. The seaweed meal is also used as feed for aquaculture and paultry animals (Jha & al., 2009).

Specimen Examined: - Karnataka: Someshwar coast, *Palanisamy & Yadav* 131235, 04.06.2015; Uchil coast, *Palanisamy & Yadav* 131002, 09.10.2014; Uchila coast, *Palanisamy & Yadav* 131070, 10.10.2014.

8. Ulva lactuca L., Sp. Pl. 2: 1163. 1753; M.O.P. Iyengar in Bull. Madras Govt. Mus. Ser. Nat. Hist. Sect.1(1): 187. 1927; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 745. 1996; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 100. 2000; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 3. 2015.

Thallus light-dak green in colour, up to 10 cm long, leafy, tufted, translucent, membranous, rosette like, lithophilic. Holdfast minute, discoid, attached firmly on rocky substratum, sometimes epiphytic on mollusc shells. Stipe small, simple or branched. Fronds foliaceous, surface smooth, thin, delicate, much broader and

obovate in young stage, rounded, lanceolate to irregularly proliferated into several small lobes at maturity; margins undulated, wavy or ruffled; apex acute to obtuse. *Microscopic*: Cells in surface view usually polygonal, 7-15 µm across, thick walled, irregularly arranged; in cross section cells usually rectangular, uninucleate; chloroplast cup shaped, with one or two pyrenoids. **(Plate 21. c)**

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: **Karnataka**: Dakshina Kannda (Someshwar, Surathkal and Kapu) and Uttara Kannada (Golte, Belekeri, Tadri and Majali) districts. **India:** Andaman & Nicobar Islands; Andhra Pradesh; Goa; Gujarat; Kerala; Lakshadweep Islands; Maharashtra; Odisha, Tamil Nadu and West Bengal.

Uses: It is an edible species and used by cooking with meats and fish and also in salads and soups. The dry powder of this species is used as a component in paultry feed (Jha & al., 2009).

Specimen Examined: - Karnataka: Someshwar coast, *Palanisamy & Yadav* 131234, 04.06.2015; surathkal, *Palanisamy & Yadav* 131241, 05.06.2015; kapu beach, *Palanisamy & Yadav* 131265, 05.06.2015.

9. Ulva reticulata Forssk. Fl. Aegypt.-Arab. 187. 1775; K.S. Sriniv., Phycol. Ind. 1: 50. Pl. 50. 1969; Dhargalkar & al. in Indian J. Mar. Sci. 9: 297. 1980; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 736. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 155. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 3. 2015.

Thallus light-dark green in colour, up to 20 cm long, leafy, profusely perforated, net like or reticulate, membranous, often convoluted, lithophilic. Holdfast minute, sometimes unrecognisable, attached lightly on rocky and muddy substrata, sometimes free floating in the intertidal pools and backwater areas with domestic sewage outlets. Stipe foliaceous, divided into several distinct laciniae with microscopic serration. Fronds leafy, lamina prominently perforated with a number of laciniae (holes); lacinae usually oval, circular or rectangular, sometimes exceeding the blade network, margins entire or sometimes with microscopic teeth around; lamina margins entire to wavy; apex acute to obtuse. *Microscopic*: Cells in surface view mostly polygonal to rectangular, thick walled, 6-18 µm across; in cross section cells elongate, 18-28× 10-19 µm, compact, middle layer up to 6 µm thick; cell cuticle 3-5 µm thick; uninucleate; chloroplast plate like, with 1or 2 pyrenoids. **(Plate 21. d)**

Occurrence: Monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

10. Ulva rigida C. Agardh, Spec. Alg. 1(2): 410. 1823; Untawale & al., List Mar. Alg. India:7 1983; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 750. 1996; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 94. 2000; Oza

& Zaidi, Rev. Checkl. Ind. Mar. Alg.: 155. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 3. 2015. *Ulva lactuca* L. var. *rigida* (C. Agardh) Le Jol. in Mem. Soc. Imp. Sci. Nat. 10: 38. 1893.

Thallus dark light-yellowish green, up to 18 cm long, leafy, leathery, ovate in young stage, later becomes broadly orbicular to deeply lobed, forming small rosette like structure, lithophilic. Holdfast minute, discoid, distinct, attached firmly on rocky substratum. Stipe small, foliaceous, solid, tapering towards base. Fronds foliaceous, ovate, orbicular to slightly lobed, tufted, up to 5 cm wide; margins entire, undulated or slightly serrate; apex obtuse or acute. *Microscopic*: Cells in surface view usually polygonal, thick walled, 6.5-18 µm across, irregularly arranged; in cross section, cells palisade like or elongate, 20-45 × 10-20 µm, compactly arranged, separated by 4-8 µm thick middle layer; cell cuticle upto 4 µm thick; uninucleate; chloroplast cup shaped with 1, rarely 2 pyrenoids.

(Plate 21. e)

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: - Karnataka: Shiroor coast, *Palanisamy & Yadav* 131151, 14.10.2014; Golte coast, *Palanisamy & Yadav* 131162, 14.10.2014; charuvetti, *Palanisamy* 132571, 18.09.2015.

2. ACROSIPHONIALES

ACROSIPHONIACEAE

Thallus dark green in colour, filamentous, profusely branched, up to 10 cm long, bushy, often caespitose, epilithic. Cells uniseriately arranged, cylindrical to barrel shaped, elongate, and multinucleate.

This family is represented by 1 genus in India as well as in Karnataka.

Acrosiphonia J. Agardh

Generic characters are similar to family characters.

Presently, 13 taxa in world (Guiry & Guiry, 2017), 2 In India (Rao & Gupta, 2015) and 1 in Karnataka.

Acrosiphonia orientalis (J.Agardh) P.C.Silva, in P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 754. 1996; K.S. Sriniv. in Bull. Bot. Surv. India 7: 204. 1965; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 36.1970; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 4. 2015.

Anadema orientalis J. Agardh, Ofvers Kongl. Vetensk.-Akad. Forh. 3: 103. 1846.

Thallus dark-muddy green in colour, up to 8 cm long, caespitose, remiform, bushy, growing gregariously, profusely branched, corymbose, lithophilic. Holdfast small, discoid, attached firmly on calcareous bedrocks in intertidal zones. Stipe up to 2 cm long, stalked, tufted, profusely branched. Fronds repeatedly branched, cylindrical, uniseriate, filamentous, 2-5 cm long and up to 1.6 mm in diameter; branching pseudo-dichotomous or trichotomous sometimes alternate, margins entire, apex acute. *Microscopic*: Cells in surface view cylindrical or elongated, basal and middle cells 0.8-2.6 mm long, 110-310 µm broad, apical cells 200-980 × 90-250 µm, uniseriately arranged; in cross section cell wall up to 40 µm thick; multinucleate, chloroplast reticulate with numerous pyrenoids. **(Plate 21. f)**

Occurrence: Usually Monsoon and post - Monsoon seasons. Rare.

Distribution: **Karnataka**: Udupi (St. Mary's island) and Uttara Kannda (Golte, Madiyendri, Majali and Mundoli) districts. **India:** Andhra Pradesh, Gujarat, Kerala, Islands, Maharashtra and Tamil Nadu.

Note: It is usually found growing mainly on bedrocks in association with other species of seaweeds.

Use: Manilal & al. (2009) reported that the polysaccharide extracted from this species shows antiviral activity against the shrimp pathogen White Spot Sundrome Virus (WPSV). Thus it can be utilised as a prophylactic drug in shrimp disease management.

Specimen Examined: Karnataka: Majali coast, Karwar, *Palanisamy & Yadav* 131223, 18.10.2014; Madiyengri, *Palanisamy* 132464, 09.06.2015; Mundoli coast, *Palanisamy & Yadav* 136295, 27.11.2016.

3. CLADOPHORALES

Key to families

1a. Thallus simple or branched; branches free **1. Cladophoraceae**
1b. Thallus always branched; branches not freen, usually adhering laterally or forming net like structure **2. Anadyomenaceae**

1. CLADOPHORACEAE

Thallus light to dark green in colour, filamentous, epilithic. Holdfast rhizoidal or discoid, rarely free floating. Stipe usually cylindrical or elongate, simple or branched. Fronds filamentous, uniseriately arranged, occasionally coiled, simple or profusely or irregularly branched. Cells usually cylindrical, barrel shaped, multinucleate; chloroplast one to many, usually reticulate with one to several pyrenoids.

This family is represented by 7 genera in India and 2 in Karnataka.

Key to genera

1a. Thallus filamentous, unbranched, erect or irregularly coiled **1. Chaetomorpha**
1b. Thallus with branched, filaments erect, never coiled **2. Cladophora**

1. **Chaetomorpha** Kuetz.

Thallus light to dark green in colour, filamentous, unbranched, up to 20 cm long, usually epilithic. Cells uniseriately arranged, cylindrical or barrel shaped, variable in sizes, cell multinucleate, usually thick walled; chloroplast usually reticulate to parietal with one to several pyrenoids.

Presently, 65 taxa in world (Guiry & Guiry, 2017), 14 in India (Rao & Gupta, 2015) and 5 in Karnataka.

Key to species

1a. Thallus straight, firmly attached on substrata; **2**
1b. Thallus irregularly coiled and forming a loose mass, usually free floating or loosely entangled with substrata **3**

2a. Thallus yellowish green in colour up to 10 cm long, cells cylindrical, cell wall up to 45 µm thick **1. C. aerea**
2b. Thallus dark green in colour, up to 15 cm long; cells cylindrical - barrel shaped, cell wall up to 100 µm thick **2. C. antennina**

3b. Thallus spirally twisted or curled in apical region, cells rectangular-squarish or moniliform, up to 700 µm long **5. C. spiralis**
3b. Thallus spirally zig-zag, or curled, usually entangles with other masses, cells cylindrical - quadrangular or moniliform, up to 700 µm long **4**

4a. Filaments dark green in colour, spirally curled, thick; cells cylindrical to barrel shaped, more than 300 µm in diameter **3. C. crassa**
4b. Filaments usually dark green in colour; cells cylindrical to rectangular or squarish, 65-200 µm in diameter, slightly constricted at nodes **4. C. linum**

1. Chaetomorpha aerea (Dillwyn) Kuetz. in Sp.Al.,379. 1849;V. Krishnam. & H.V.Joshi, Checkl. Ind. mar. alg., 3.1970; M.U. Rao in Bull. Centr.Mar. Fish. Res. Inst., 9: 37. 1969; Untawale & al., List mar. alg. India,9. 1983; Kaliap.et al. in Seaweed Res. Utiln.,14: 106. 1992;P. C. Silva & al., Cat. benth. mar. alg. Ind. Ocean, 759. 1996; Oza & Zaidi, Rev. Checkl. Ind. mar. alg., 157. 2001.

Conferva aerea **Dillwyn, Brit. Conferv. Fasc., 80. 1806.**

Thallus yellowish to bright green in colour, up to 15 (-30) cm long, subclavate basal cell which has a disklike base lobed or fimriate at the margins; basal cell 130-150µ diam. At the top, 7.5-10.5 diameters long, and about 2.5-4.2 times as long as the suprabasal cell; filaments slender towardes the base, above to 150-350µ diam., stiff and straight, the cells to 1-2 diameters long, little constricted at the septa; zoospores formed in the upper cells of the filament, which become cask - shaped to subglobose.**(Plate 22. a)**

Occurrence: During post-monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district (Shiroor). **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Karnataka, Lakshadweep Islands, Maharashtra, Odisha and Tamil Nadu.

Specimen Examined: - Karnataka: Shiroor coast, *Palanisamy & Yadav* 131141 & 131152, 14.10.2014.

2. Chaetomorpha antennina (Bory) Kuetz. in Bot. Zeitung 5: 166. 1847; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 3. 1970; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 736. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 157. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India, 3: 4. 2015.

Conferva antennina Bory, Voy. Iles Afrique, I: 381. 1804.

Chaetomorpha media (C. Agardh) Kuetz., Sp. Alg. 380.1849.

Thallus dark green in colour, up to 12 cm long, filamentous, brush like, caespitose, tufted, erect, gregarious, lithophilic. Holdfast small, rhizoidal, irregularly branched, attached tightly on rocky and muddy substrata in the tidal or intertidal zones. Stipe and fronds undifferentiated, filamentous, differentiated into nodes and internodes, unbranched, uniseriate, cylindrical or barrel shaped with regular nodes and internodes; basal cells long, usually barrel shaped with narrow base; apical cell with acute apices. *Microscopic*: Basal cells elongate, up to 4 mm long and 150-200 µm wide, narrowly tapering towards base; cell wall 50-90 µm thick; chloroplast reticulate with several pyrenoids. **(Plate 22. b)**

Occurrence: Throughout the year. Common.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra, Odisha and Tamil Nadu.

Notes: This is one of the most common and widely distributed species in Indian coast and usually found growing luxuriantly during monsoon and post-monsoon seasons.

Use: It is used as raw material for paper manufacturing industries in some countries (Jha & al., 2009).

Specimen Examined: - Karnataka: Someshwar coast, *Palanisamy & Yadav* 131006, 09.10.2014; Ullal (Muccachery), *Palanisamy & Yadav* 131007, 09.10.2014; Shiroor coast, *Palanisamy & Yadav* 131139, 14.10.2014.

3. Chaetomorpha crassa (C. Agardh) Kuetz., Phycol. Germ. 204. 1845; V. Krishnam. & L. Kannan in Seaweed Res. Utiln. 5(1): 34. 1982; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 762. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 159. 2001; Yadav & al. in Rajendran & Aravindhan (eds.), Biodiv. Cons. - Asp. Prosp.: 56. 2015; P.S.N. Rao & Gupta, Algae India, 3: 4. 2015.

Conferva crassa C. Agardh, Syst. Alg.: 99. 1824.

Thallus dark green in colour, up to 10 cm long, unbranched, coiled, forming loose clumps or entangled, tufted. Holdfast small, discoid, entangled tightly with other seaweeds and waste fishing nets, cloths etc. in the intertidal regions, sometimes free floating. Stipe and fronds undifferentiated, filamentous, divided

into nodes and internodes, unbranched, prominently coiled, tapering towards apex. *Microscopic*: Cells cylindrical to barrel shaped, slightly swollen in central part and constricted near nodes, 310-600 × 250-400 µm; cell wall 30-95 µm thick; chloroplast reticulately arranged with several pyrenoids.**(Plate 22. c)**

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: Karnataka: Dakshina Kannada (Surathkal) and Udupi (St. Mary's island) districts. **India:** Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: This species is usually found entangled with the species of *Enteromorpha*, *Chaetomorpha* and *Ulva* in intertidal regions and occasionally seen offshore.

Specimen Examined: - Karnataka: Surathkal, *Palanisamy* 132547, 17.09.2015; St. Mary Island, Malpe, *Palanisamy* 134910, 20.02.2016.

4. Chaetomorpha linum (O.F. Muell.) Kuetz., Phycol. Germ: 204. 1845; Untawale & al., List Mar. Alg. India: 9.1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 736. 1996; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 117. 2000; Oza & Zaidi, Rev.Checkl. Ind. Mar. Alg.: 159.2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 5. 2015. *Conferva linum* O.F. Muell., Fl. Dan. 5(13): 7. 1778.

Thallus bright light-dark green in colour, filamentous, unbranched, up to 20 cm long, wiry, stiff, usually free floating. Stipe and fronds undifferentiated, divided into nodes and internodes, unbranched, often loosely entangled mass, margin entire with acute apices. *Microscopic*: Cells usually cylindrical, rectangular-squarish with regular nodes and internodes, slightly swollen in internodal regions, 60-190 × 70-170 µm; cell wall up to 18 µm thick, mucilagenous; chloroplast reticulatey arranged, pyrenoids several. **(Plate 22. d)**

Occurrence: Usually during post - Monsoon season. Rare.

Distribution: Karnataka: Dakshina Kannada (Surathkal, Ullal) and Uttara Kannda (Mundoli, Talgode, Honnavar, Manki andVannali) districts. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Kerala, Lakshadweep Islands, Maharashtra, Tamil Nadu and West Bengal.

Specimen Examined: Karnataka: Mundoli, *Palanisamy* 133232, 21.09.2015; Ullal, *Palanisamy & Yadav* 135245, 24.08.2016; Honnavar Manki, *Palanisamy & Yadav* 136223, 26.11.2016

5. Chaetomorpha spiralis Okamura in Alg. Jap. Exs. 94: 131. 1903; Untawale & al., List Mar. Alg. India: 9. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 767. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 160. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014; Yadav & al. in Rajendran & Aravindhan (eds.), Biodiv. Cons. - Asp. Prosp.: 56. 2015; P.S.N. Rao & Gupta, Algae India 3: 5. 2015.

Thallus usually dark green in colour, becomes light green to white towards apex in mature thallus, usually 2-6 (-10) cm long, filamentous, straight towards base and spirally twisted or coiled upwards, stiff, gregarious, lithophilic. Holdfast small, discoid, loosely attached on rocky substrata in the low intertidal pools. Stipe small with cylindrical cells. Fronds filamentous, unbranched, cylindrical below and moniliform towards apex, loosely entangled, margin entire to undulate; apex usually obtuse. *Microscopic*: Basal cells distinctly cylindrical, 480-750 µm long; other cells usually rectangular-squarish, spherical or moniliform in appearance, isodiametric, slightly constricted in nodal regions, 250-710 × 300-430 µm; cell wall 50-90 µm thick; chloroplast elongate, densely arranged; pyrenoids several

(Plate 22. e)

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: Throughout Karnataka coast. **India**: Goa, Gujarat, Karnataka and Tamil Nadu.

Specimen Examined: - Karnataka: Uchila coast, *Palanisamy & Yadav* 131053, 10.10.2014; Golte coast, *Palanisamy & Yadav* 131171, 14.10.2014; Oyingi beach, *Palanisamy & Yadav* 131182, 15.10.2014.

2. Cladophora Kuetz.

Thallus light-dark green in colour, filamentous, up to 25 cm long, branched; filaments with cylindrical cells, apical cell obtuse; branching lateral; holdfast rhizoidal in nature, long, arising from the basal cell. Cells with thick walled, cells multinucleate, chloroplast usually reticulate with one-sevaral pyrenoids.

Presently, 207 taxa in world (Guiry & Guiry, 2017, 28 in India (Rao & Gupta, 2015) and only 2 in Karnataka.

1. Cladophora vagabunda (L.) C. Hoek, Rev. Eur. *Cladophora*: 144. 1963; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 782. 1996; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 137. 2000; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 164. 2001; Jha & al., Seaweeds Gujarat: 23.2009; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014; P.S.N. Rao & Gupta, Algae India 3: 7. 2015.

Conferva vagabunda L., Sp. Pl. 2: 1167. 1753.

Cladophora fascicularis (Mert. ex C. Agardh) Kuetz.: Phycol. Germ.: 268. 1843; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011.

Thallus light-olive green in colour, filamentous, up to 20 cm long, tufted, non caespitose, usually sparingly branched below and densely fasciculated above, epilithic. Holdfast small, rhizoidal, firmly attached on rocky substrata in tidal or intertidal zones. Stipe stalked, filamentous, simple or branched. Fronds densely fasciculated, flexible; branching usually pseudodichotomous-irregular or alternate below and fasciculated above, ultimate branches usually unilateral with slightly curved and acute apices. *Microscopic*: Cells of the main axis large cylindrical, elongate, 560-1450 × 160-300 µm; cells of the seconsary branches almost similar

to main axis, 240-1100 × 110-180 µm; cells of the ultimate branches cylindrical and slightly curved, 110-490 × 35-100 µm. **(Plate 22. f)**

Occurrence: Monsoon and post-monsoon seasons. Common.

Distribution: Throughout Karnataka coast. **India:** Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: This is one of the most common species and is found growing in association with the species of *Bryopsis*, *Chaetomorpha, Enteromorpha, Gracilaria, Grateloupia* and *Ulva* in shallow intertidal regions.

Specimen Examined: - Karnataka: Someshwar coast, *Palanisamy & Yadav* 131014, 09.10.2014; Maravanthe beach, *Palanisamy & Yadav* 131112, 13.10.2014; Madikkal (Uppanad), *Palanisamy & Yadav* 131114, 13.10.2014.

2. Cladophora sp.

Thallus dark green in colour, filamentous, up to 15 cm long, tufted, epilithic. Holdfast rhizoidal or discoid, firmly attached. Stipe stalked, up to 2 cm long. Fronds usuallu 6-15 cm long, flexible, profusely branched throughout; branches 0.5-2 cm long, repeatedly branched and forming thick mat like appearance.

Occurrence: Post-monsoon and summer seasons. Moderate.

Distribution: Karnataka coast (St. Mary's island).

Notes: This species is usually foind growing in water poor area in monospecific form and gives dark greenish appearance.

Specimen Examined: - Karnataka: St. Mary's island, *Palanisamy* 134911, 20.2.2016.

2. ANADYOMENACEAE

Thallus dark green in colour, filamentous, branched, forming a foliose or net like structure; rhizoids thick walled, interwoven occasionally.

This family is represented by 2 genera in India and 1 genus in Karnataka.

MICRODICTYON

Microdictyon tenuis J.E. Gray in J. Bot. (London) 4: 69. 1866; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 154. 2000; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 4. 2015.

Thallus dark green in colour, foliose, up to 10 cm long, tufted, 5-8 cm broad, epilithic. Holdfast small, rhizoidal, firmly attached on rocky substrata in tidal or intertidal zones. Fronds forming a net like structure, ultimate branches unicellular and usually connected with tenacula.

Occurrence: Monsoon season. Rare.

Distribution: **India:** Tamil Nadu & Karnataka coast.

Note: This species has been included here based on the report by Kaladharan & al. (2011). However, in our consequent surveys, it could not be collected freshly.

4. SIPHONOCLADALES

Key to families

1a. Thallus often matted with branched, clavate to subcylindrical or filiform vesicles; primary vesicle forms elongated stipe; holdfast usually rhizoidal **1. Siphonocladaceae**

1b. Fronds simple or spongy; vesicles simple or branched with lenticular segments; primary vesicle often expands or form a branch or tenaculam which serves as holdfast **2. Valoniaceae**

1. SIPHONOCLADACEAE

Thallus light-dark green in colour, clustered, tufted or matted, up to 10 cm long, epilithic. Stipe elongate, subcylindrical, simple or branched, usually with annular constrictions. Frond clustered, vesicles profusely branched upwards giving a cup like or globose appearance. Cells multinucleate; chloroplasts reticulate with usually several pyrenoids.

This family is represented by 7 genera in India and 1 genus in Karnataka.

1. **Cladophoropsis** Boergesen

Thallus light to dark green in colour, filaments usually densely aggregated, matted, tufted, usually epilithic, attached with rhizoidal holdfast. Fronds alternate, opposite or irregularly branched, usually differentiated into longer and shorter segments; branches united by a distinct tenacula.

Presently, 12 taxa in world (Guiry & Guiry, 2017), 2 in India (Oza & Zaidi, 2001) and 1 in Karnataka.

Cladophoropsis sundanensis Reinbold in Naova Notarisia 16: 147. 1905; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 8. 1970; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 793. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.:167. 2001; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 166. 2000; P.S.N. Rao & Gupta, Algae India 3: 8. 2015.

Thallus light-medium green in colour, filamentous, forming spongy and moss like small clumps, up to 7 cm across, epilithic. Holdfast rhizoidal, hapteroid, firmly attached on rocky substrata in intertidal regions. Fronds filamentous, irregularly branched; lateral branches mostly unilateral; ultimate branches straight or slightly curved, up to 5 mm long and terminates into round to obtuse apices. *Microscopic*: Cells of the main axis cylindrical, elongate, 40-110 (-140) µm in diameter; cell wall conspicuous.

*Occurrence***:** Usually Post-monsoon season. Rare.

Distribution: Karnataka: Udupi (St. Mary's island) and Uttara Kannda (Gorte, Tadri and Karwar) districts. **India:** Goa, Gujarat, Kerala and Maharashtra.

Specimen Examined: - Karnataka: Gorte coast, *Palanisamy & Yadav* 136323, 27.11.2016.

2. Struvea Sond.

Thallus green in colour, net like, up to 6 cm long; stipe long, aseptate, showing annular constrictions at base, attached by rhizoidal holdfast. Fronds profusely branched, forming net like loosely entangled globular structure, branches curved, one to many celled.

Currently 5 taxa in world (Guiry & Guiry, 2017), 2 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Struvea anastomosans (Harv.) Picc. & Grunov ex Picc., Crociera Corsaro Alg., 20. 1884; V. Krishnam. & H.V.Joshi, Checkl. Ind. Mar. Alg.: 8.1970; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 798. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 168. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Gupta, Algae India 2: 254. 2012. *Cladophora anastomosans* Harv., Phycol. Austral., 2: pl. CL, 1859. *Struvea deliculata* Kuetz., Tab. Phycol. 16. Pl. 2, 1886.

Thallus bright-dark green in colour, small, branched interconnected, forming net like like globular structure. Holdfast well developed, rhizoidal, multicellular, dichotomously branched, septate or not, firmly attached to rocky substrata. Stipe cylindrical, unbranched, up to 1 cm long, annular constrictions at base. Fronds profusely branched, forming net like loosely entangled globular to circular structure, up to 5 cm long, sparsely branched below and profusely branched above, fan shaped, branches usually tri-tetra -pinnate, upwardly curved, lateral branches formed of 2 to several cells, cells interconnected with distinct structures called tenacula. *Microscopic*: Cells of the main axis 350-1460 × 140-200 µm, secondary branches 200-1150 × 80-150 µm; Cell wall thin, transparent in apical region, chloroplast numerous, reticulate, pyrenoid single in each chloroplast (Plate:).

*Occurrence***:** Usually during Monsoon and post-monsoon seasons. Rare.

Distribution: Karnataka: Uttara Kannda district. **India:** Andhra Pradesh, Gujarat, Kerala, Lakshadweep Island, Maharashtra and Tamil Nadu.

2. VALONIACEAE

Thallus light to dark green in colour, globose, spongy to cushioned or discoid, up to 20 cm in diameter, consists of intricately interwoven vesicles, epilithic, occasionally free floating. Vesicles cylindrical or oblong, simple or irregularly branched, usually forming lenticular segments inside the wall.

This family is represented by only 3 genera in India and 2 genera in Karnataka.

1. Ernodesmis Boergesen

Thallus cushion like, composed of intricately woven filiform cells to form spongy mat like structure, 1-6 cm thick and 3-15 cm in diameter. Holdfast rhizoidal well developed, firmly attached on rocky substratum. Fronds consist of cylindrical vesicles, clustered and curved downwards in apical region.

Presently, 2 taxa in world (Guiry & Guiry, 2017), 1 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Ernodesmis verticillata (Kuetz) Boergesen, Bot. Tidssk. 32: 259, figs. 10-12. 1912; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 8. 2015.

Thallus dark – olive green in colour, up to 10 cm long, loosely entangled, forming stiff and spong shapes, epilithic. Holdfast usually rhizoidal. Fronds irregularly interwoven and forming a spongy mass, branched, branches pinnate, lateral branches formed of 2 to several cells, cells interconnected with distinct structures called tenacula. *Microscopic*: Cells of the main axis usually cylindrical, chloroplast numerous, reticulately arranged.

Occurrence: Monsoon and post-monsoon seasons. Rare.

Distribution: **India:** Kerala, Maharashtra and Tamil Nadu.

Note: This species has been included here based on the report by Kaladharan & al. (2011). However, in our consequent surveys, it could not be collected freshly.

2. Valoniopsis Boergesen

Thallus cushion like, composed of intricately woven filiform cells to form spongy mat like structure, up to 6 cm thick and 15 (-20) cm in diameter. Fronds consist of cylindrical vesicles, clustered, curved downwards in apical region.

Presently, 2 taxa in world (Guiry & Guiry, 2016), 1 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Valoniopsis pachynema (G. Martens) Boergesen, Biol. Meddel. Kongel Danske Vidensk.Selsk. 11(6): 10. 1934; K.S. Sriniv., Phycol. Ind.: 2: 26. 1973; Ambiye & Untawale in Desai (ed.), Oceanogr. Indian Ocean 249. 1991; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 170. 2001; P.S.N. Rao & Gupta, Algae India 3: 8. 2015.

Bryopsis pachynema G. Martens, Die Exped. Amtli. Bot. Theil. Berlin: 24, 62. 1868.

Thallus dark green in colour, spongy, up to 8 cm thick and 10 (-15) cm in diameter, dense, firmly entangled, forming stiff, hemispherical to flattened or elongate cushioned mats. Holdfast rhizoidal irregularly branched with septate hapteroids, loosely attached. Stipe small, cylindrical, stiff. Fronds irregularly interwoven, cushioned, spongy, irregularly ramified or clustered; branches cylindrical, coenocytic, curved, up to 1 cm long; ramuli unilateral, umbellate or clumped, up to 3 mm long and 200-500 µm in diameter, erect with obtuse apex; *Microscopic*: Cells cylindrical, cell wall thin, transparent in apical region, chloroplast numerous, discoid to polygonal, pyrenoid single in each chloroplast.**(Plate 23. a)**

Occurrence: usually post-monsoon seasons. Rare.

Distribution: **Karnataka**: Dakshina Kannada (Near Mangalore coast). **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

5. BRYOPSIDALES

Key to families

1a. Thallus foliose of feather like, usually bearing specialised assimilators or rhizomes **2**
1b. Thales not foliose, usually spongy, cylindrical, dichotomously branched **3**

2a. Thallus feather like, without assimilators; erect axes pinnately or one sided branched;terminal branches hairy with acute or obtuse ápices. **1. Bryopsidaceae**
2b. Thallus feather or grape like, with assimilators, erect axis radially verticillately branched; terminal branches with assimilators of variable shapes **2. Caulerpaceae**

3a. Thallus spongy, cylindrical, dichotomously or irregularly branched **3. Codiaceae**
3b. Thallus cylindrical, repeatedly branched and forming a staked into the lower portion and flabellate into the upper region **4. Udotiaceae**

1. BRYOPSIDACEAE

Thallus light-dark green in colour, feathery, epilithic. Fronds simple or pinnately, radially or irregularly branched; branches usually determinate, with basal constrictions. Cells coenocytic, chloroplast numerous, each usually with single pyrenoids.

This family is represented by 3 genera in India and 1 in Karnataka.

Bryopsis J.V. Lamour.

Thallus light-dark green in colour, up to 40 cm long, feather like, soft, consists of an erect and a prostrate system. Fronds with a distinct midrib and pinnate, pyramidal or laterally arranged branchlets. Cells coenocytic, siphonous, not traversed internally by travaculate network, multinucleate.

Presently, 56 taxa in world (Guiry & Guiry, 2016), 7 in India (Rao & Gupta, 2015) and 2 in Karnataka.

Key to species

1b. Thallus light-olive green in colour, main axis pinnately or distichously branched; pinnules gradually or irregularly becoming shorter upwards, distinctly constricted at base **2. B. plumosa**
2a. Thallus light-dark green in colour, main axis radially branched; plumules almost uniformly cylindrical, without any constriction at base **1. B. hypnoides**

1. Bryopsis hypnoides J.V. Lamour. in Nouv. Bull. Sci. Soc. Philom. Paris 1: 333. 1809; Untawale & al., List Mar. Alg. India: 11. 1983; P. C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 805. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 170. 2001; Jha & al., Seaweeds Gujarat: 34. 2009; P.S.N. Rao & Gupta, Algae India 3: 9. 2015.

Thallus light-pale or dark green in colour, tubular, remiform with radially ranged branches, up to 10 cm long, gregarious, siphonous, tufted, epilithic. Holdfast rhizoidal, firmly attached. Stipe stalked cylindrical, 100-200 µm in

diameter. Fronds tubular, cylindrical-terete, main axis up to 250 µm in diameter, progressively tapering towards apex, branches usually naked or with scars in basal portion and dense and radially arranged in middle and apical portion; pinnules almost uniformly cylindrical or linear-lanceolate, facing upwards and gradually or sometimes irregularly becoming shorter, ultimate branches usually terminate into a long and round to acute apex. *Microscopic*: Pinnules 300-850 × 45-140 µm; cells of the main axis and branches siphonous, usually transparent towards apex, multinucleate, with numerous lecnticular plastids. *Occurrence*: Usually post - Monsoon season. Rare.

Distribution: Throughout Karnataka coast. **India**: Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: - Karnataka: Madiyengri, *Palanisamy & Yadav* 136231, 26.11.2016.

2. Bryopsis plumosa (Huds.) C. Agardh, Spec. Alg. 1(2): 448.1823; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 5.1970; Untawale & al., List Mar. Alg. India: 64. 1983; P.C. Silva & al.,Cat. Benth. Mar. Alg. Ind. Ocean: 808. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 171. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 9. 2015.

Ulva plumosa Huds., Fl.Angl. 2: 571. 1778.

Thallus light to olive green in colour, tubular with sparingly branches, feathery, small, up to 12 cm long, siphonous, epilithic. Holdfast small, rhizoidal, stoloniferous, firmly attached. Stipe stalked, tubular or cylindrical, 140-310 µm in diameter. Fronds numerous and directly arise from the holdfast, tubular with feathery appearance, main axis cylindrical to terete, 140-420 µm in diameter, erect, irregularly tapering towards apex, sparingly branched; branches erect, naked below and regularly plumose above, usually distichous; pinnules cylindrical, linear-lanceolate, distinctly constricted at base, gradually or irregularly becoming shorter with round apices. *Microscopic*: Pinnules short, 50-650 × 45-90 µm; cells of the main axis and branches siphonous, multinucleate, with numerous plastids. **(Plate 23. b)**

Occurrence: Usually post - Monsoon season. Moderate.

Distribution: Throughout Karnataka coast. **India**: Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: - Karnataka: St. Mary's Island, Malpe, *Palanisamy & Yadav* 136366, 29.11.2016.

2. CAULERPACEAE

Thallus light to dark or grey green in colour, foliose to highly variable, stoloniferous, prominently differentiated into rhizoidal stolons and erect photosynthetic assimilators of various shapes and sizes; ramuli highly variable, usually vesiculate, turbinate, peltate, spinous to flattened; stolons creeping, up to 60 cm long; assimilators usually up to 15 cm long. Cells coenocytic with numerous chloroplasts and with or without pyrenoids .

It is usually a monogeneric family with the genus *Caulerpa* in India as wall as in Karnataka.

Caulerpa J.V. Lamour.

Generic characters are similar to family characters.

Presently, 97 taxa in world (Guiry & Guiry, 2016), 45 in India (Rao & Gupta, 2015) and 6 in Karnataka.

Key to species

1a. Assimilators cylindrical-terete; ramuli usually radially arranged, peltate, discoid, spherical, clavate, turbinate or oval **2**
1b. Assimilators foliose, flattened; ramuli compressed, linear, scalpilliform-sickle shaped **3**

2a. Thallus up to 15 cm long; assimilators 2-6 cm long, ramuli peltate to discoid, 2-5 mm in diameter, radially arranged **3. C. peltata**
2b. Thallus up to 20 cm long; assimilators 2-8 cm long, ramuli highly variable, spherical, pear shaped, grapes like, turbinate, 2-5 mm in diameter, racemosely arranged **4. C. racemosa**

3a. Thallus foliose, flattened, up to 10 cm long **2. C. prolifera**
3b. Thallus foliose to modified into various forms, up to 25 cm long; ramuli linear, scalpelliform, needle or sickle shaped, incurved **4**

4a. Assimilators leafy, much flattened, up to 2 cm broad; ramuli scalpelliform to linear and curved upward, tufted **5. C. scalpelliformis**
4b. Assimilators leafy or feathery, flattened up to 1.2 cm; ramuli linear, sickle or needle shaped, flexible or curved upward **7**

5a. Assimilators feathery; ramuli linear, needle like, flexible, densely packed and conical at apex **7. C. sertularioides**
5b. Assimilators leafy, flattened or slightly feathery; ramuli linear to sickle shaped and curved upward, tufted, densely packed and usually forked at apex **8. C. taxifolia**

1. Caulerpa peltata J.V. Lamour. in Nouv. Bull. Sci. Soc. Philom, Paris, 1: 332. 1809; K.S. Sriniv., Phycol. Ind.: 2: 41.1973; Untawale & al., List Mar. Alg. India:, 12. 1983; Duraiswami in Seaweed Res. Utiln. 13(1): 32, figs. 2 A-I; 10 D. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 828. 1996; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 11. 2015.

Caulerpa laetevirens Mont., Prodr. Gen. Sp. Phyc. Nov.: 13. 1842.

Thallus dark-bright green in colour, rhizomatous, up to 15 cm long, tufted, growing as patches, prostrate, stoloniferous, epilithic. Holdfast rhizoidal, colourless, stout, variable in length, often loosely attached. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender to terete, up to 2 mm in diameter, colourless to blackish green in older regions, tufted, branched. Assimilators usually arranged at intervals of 1-5 cm long, cylindrical, up to 5 (-8)

cm long; ramuli radially arranged, peltate, disc like, smooth, entire, 1.5-5 mm in diameter; rachis 1-2 × 0.4-1 mm. *Microscopic*: In cross section, thallus siphonous, coenocytic, traversed internally by a network of trabeculae; rhizoidal cell wall 20-58 µm thick, moderately lamellated, trabaculae 6-15 µm in diameter, thicker in basal region and gradually tapering towards apex. **(Plate 23. c)**

Occurrence: Throughout the year. Moderate.

Distribution: **Karnataka**: Udupi (St. Mary's island) and Uttara Kannda districts (Mundoli, Madibengre and Gorte). **India**: Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: This species is usually found growing as green patches in association with species of *Bryopsis*, *Cladophora*, *Caulerpa*, *Padina*, *Sargassum* etc. in shallow and intertidal regions.

Uses: It is one of the economically important seaweeds and is used as food, fodder and as raw materials for manure.

Specimens Examined: - Karnataka: goolte, *Palanisamy & Yadav* 131281, 07.06.2015; onna gatta, *Palanisamy* 132438, 08.06.2015; St. Mary Island, Malpe, *Palanisamy* 134915, 20.02.2016.

2. Caulerpa prolifera (Forssk.) J.V. Lamour. in Nouv. Bull. Sci. Soc. Philom. Paris 1: 332. 1809; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 831. 1996; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011.

Fucus prolifer Forssk., Fl. Aegypt.-Arab. 32:193. 1775.

Thallus dark green in colour, rhizomatous, up to 10 cm long, flattened foliose, stoloniferous, epilithic. Holdfast rhizoidal, colourless, stout, firmly attached on substrata. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender to terete, up to 2 mm in diameter, colourless to blackish green in older regions, tufted, branched. Assimilators arranged at intervals of 1.6 cm long, slightly flattened.

Occurrence: During post-monsoon seasons. Rare.

Distribution: **India**: Tamil Nadu & Karnataka

Note: This species has been included here based on the report by Ambiye & Untawale (1991). However, it was not collected freshly during our survey.

3. Caulerpa racemosa (Forssk.) J. Agardh, Algern. Syst. 9 (8): 35. 1873; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 6.1970; Duraiswami in Seaweed Res. Utiln. 13(1): 49, figs. 6 A-H; 9 A. 1990; Ambiye & Untawale in Desai (ed.), Oceanogr. Indian Ocean 249. 1991; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 832. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 177. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 11. 2015.

Fucus racemosus Forssk. Fl. Aegypt.-Arab. 32: 191. 1775.

Thallus dark-pale green in colour, rhizomatous, up to 10 (-20) cm long, tufted, growing as patches, prostrate, stoloniferous, epilithic. Holdfast rhizoidal, numerous, colourless, prostrate, loosely attached on rocky and calcareous substrata. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender to terete, up to 10 cm long and 2 mm in diameter, colourless, stout and branched. Assimilators usually upright, spreading and arranged at intervals of 1-5 cm long, simple, cylindrical-terete, up to 8 (-10) cm long with densely and racemosely arranged ramuli; ramuli spherical, pear or grapes shaped, entire, 1.2- 4 mm in diameter; rachis short, up to 2 cm long, bearing several stipitate branchlets. *Microscopic*: In cross section, thallus siphonous, coenocytic, traversed internally by a network of trabeculae; rhizoidal cell wall 20-30 µm thick, lightly lamellated, trabaculae thin, 3- 8 µm in diameter. **(Plate 23. d)**

Occurrence: During post-monsoon season. Moderate.

Distribution: **Karnataka**: Udupi (St. Mary's island) and Uttara Kannda (Talgode, Gorte) districts. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimens Examined: - Karnataka: Talgode, *Palanisamy* 135019, 23.02.2016; St. Mary Island, Malpe, *Palanisamy* 134914, 20.02.2016; Gorte, *Palanisamy* 134972, 22.02.2016.

4. Caulerpa scalpelliformis (R. Br. ex Turner) C. Agardh, Syn. Alg. Scand. 22. 1817; M.O.P. Iyengar in Bull. Madras Govt. Mus. Ser. Nat. Hist. Sect.1(1): 187. 1927; K.S. Sriniv., Phycol. Ind.: 1: 46. 1969; Untawale & al., List Mar. Alg. India: 12. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 180. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 12. 2015.

Fucus scalppelliformis R. Br. ex Turner in Fuci. 3: 95, pl. 174. 1809.

Thallus pale-dark green in colour, rhizomatous, up to 15 (-25) cm long, prostrate, stoloniferous, epilithic. Holdfast rhizoidal, numerous, colourless. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender, 1-3 mm in diameter, colourless, tufted. Assimilators usually arranged at intervals of 0.8-3 cm long, foliose, flat, usually up to 20 cm long and 0.8-2 cm broad, usually with marginally lobed ramuli; ramuli compressed, scalpelliform, linear and slightly curved upward with an acute to spinous apex, densely arranged, entire, 1.5-4.2 × 0.5-2 mm. *Microscopic*: In cross section, thallus siphonous, coenocytic, traversed internally by a network of trabeculae.

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Karnataka: Uttara Kannda districts. **India:** Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Note: This species has been included here based on the report by Kaladharan & al. 2011. However, during the present study, it could not be traced and collected freshly.

5. Caulerpa sertularioides (S.G. Gmel.) M. Howe in Bull. Torrey Bot. Club 32: 576. 1905; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 6. 1970; Untawale & al.,List Mar. Alg. India: 12. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 844. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 182. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; P.S.N. Rao & Gupta, Algae India 3: 12. 2015.

Fucus sertularioides S.G. Gmel., Hist. Fuc. 151. 1768.

Thallus bright-yellow green in colour, rhizomatous, up to 15 cm long, prostrate, growing as patches, stoloniferous, epilithic. Holdfast rhizoidal, numerous, colourless, loosely anchored on rocky substrata with fine sediments in intertidal regions. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender, 0.5-2 mm in diameter, colourless, tufted, bearing several upring assimilatos. Assimilators usually arranged at intervals of up to 3 cm long, feathery or foliose to slightly flattened, 2-10 cm long, simple or occasionally branched with marginally lobed ramuli; ramuli compressed, linear, needle like and slightly curved upward with an acute to mucronate apex, opposite–distichous and densely arranged, entire, 0.5-2.5 × 0.3-1 mm, densely packed and conical at apex. *Microscopic*: In cross section, thallus siphonous, coenocytic, traversed internally by a network of trabeculae.

Occurrence: During Monsoon and post-monsoon seasons. Moderate.

Distribution: Throughout Karnataka coast. **India:** Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: This species shows morphologically wide range of variations and forms. In India, 3 varieties/forms have been recognized (Oza & Zaidi, 2001).

Specimen Examined: - Karnataka: Golte coast, *Palanisamy & Yadav* 131156, 14.10.2014; surathkal, *Palanisamy & Yadav* 131240, 05.06.2015; St. Mary's Island, Malpe, *Palanisamy & Yadav* 136360, 29.11.2016.

6. Caulerpa taxifolia (Vahl) C. Agardh, Syn. Alg. Scand. 23. 1817; K.S. Sriniv., Phycol. Ind.: 2: 44. 1973; P.C.Silva & al.,Cat. Benth. Mar. Alg. Ind. Ocean: 845. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 182. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 13. 2015.

Fucus taxifolius Vahl in Skr. Naturhist.-Selsk. 5(2): 36. 1802.

Thallus yellow-dark green in colour, rhizomatous, up to 15 (- 20) cm long, tufted, growing as patches and forming thick mat like structures, prostrate, stoloniferous, epilithic. Holdfast rhizoidal, colourless, stout, often loosely attached on rocky substrata. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender, 0.5-2 mm in diameter, colourless to light green in older regions, tufted, branched. Assimilators usually arranged at intervals of 0.5-3 cm long, foliose to slightly feathery, compressed, 4-12 (-20) cm long and up to 1.4

cm broad, simple or branched with densely arranged ramuli; ramuli linear to sickle shaped, flexible, slightly curved upward, usually longest in middle portion, opposite-distichous and densely arranged, entire, 0.5-4.5 × 0.2-0.5 mm, ramuli at apex usually dense and forked. *Microscopic*: In cross section, thallus siphonous, coenocytic, traversed internally by a network of trabeculae; rhizoids up to 7 mm long; cell wall lightly lamellated, trabaculae thin, filamentous, 2-5 µm in diameter. **(Plate 23. e)**

Occurrence: Post monsoon season. Common.

Distribution: Throughout Karnataka coast. **India**: Andaman & Nicobar Islands, Andhra Pradesh, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Species Examined: - Karnataka: Surathkal beach, *Palanisamy & Yadav* 131035, 09.10.2014; Uchila coast, *Palanisamy & Yadav* 131069, 10.10.2014; St. Mary Island, Malpe, *Palanisamy & Yadav* 131098, 12.10.2014.

3. UDOTIACEAE

Thallus light to yellowish green in colour, stout, filamentous, tubular, dichotomously or irregularly branched.

It family is represented by 6 genera in India and 2 genera in Karnataka.

Key to species

1a.	Thallus stout, distinguished into cylindrical rhizoidal portion and flabellate assimilatory portion	**1. Arvainvillea**
1b.	Thallus filamentous, tubular, dichotomously and freely branched	**2. Chlorodesmis**

1. Arvaivillea Decne.

Thallus usually dark green in colour, stout, up to 30 cm long, flabellate in the upper portion, solitary, unbranched, often monifiform due to constriction, blades composed of non-septate siphons.

Presently, 30 taxa in world (Guiry & Guiry, 2017), 4 in India (Oza & Zaidi, 2011) and 1 in Karnataka.

Arvainvillea amadelpha (Mont.) A. Gepp & E.S. Gepp in Trans. Linn. Soc. London, 3: 55. 1797; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 875. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 189. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011;P.S.N. Rao & Gupta, Algae India 3: 15. 2015.

Thallus dark-grey green in colour, up to 6 cm long, wedge shaped, erect, epilithic. Holdfast rhizoidal, conspicuous, firmly attached with the substratum. Stipe up to 2 cm long, stout. Fronds flattened, siphonous, asymmetrical, surface rough, margins entire to lacerated. *Microscopic*: fronds siphonous; siphons cylindrical. up to 12 µm in diameter. **(Plate 23. f)**

Occurrence: Throughout the year. Rare.

Distribution: Karnataka: Uttara Kannda district (Gorte). **India:** Tamil Nadu.

Species Examined: - Karnataka: Gorte coast, *Palanisamy & Yadav* 136319, 27.11.2016 & 134974, 22.02.2016.

1. Chlorodesmis W.H. Harvey & J.W. Bailey

Thallus usually green in colour, clumped or brush like forming a spongy structure, up to 20 cm long. Fronds several, non-septate, siphonous. Cells coenocytic, multinucleate. Presently, 11 taxa in world (Guiry & Guiry, 2017), 2 in India (Oza & Zaidi, 2011) and 1 in Karnataka.

Chlorodesmis hildebrandtii A. Gepp & E.S. Gepp, Siboga-Exped. Monogr. 62: 16, 137, pl. 8; figs. 74. 1911; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 879. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 189. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011;P.S.N. Rao & Gupta, Algae India 3: 15. 2015.

Thallus light to dark green in colour, loosely entangled, forming spongy structure, up to 15 (-20) cm long, epilithic. Holdfast conspicuous, variable in length. Fronds Fronds numerous, 2-8 (-15) cm long, non-septate, siphonous, loosely attached. *Microscopic*: Cells coenocytic, multinucleate.

Occurrence: During post-monsoon season. Rare.

Distribution: **India:** Tamil Nadu & Karnataka

Note: This species has been included here based on the report by Ambiye & Untawale (1991). However, this species was could not be traced.

3. CODIACEAE

Thallus light to dark or yellowish green in colour, simple or branched, occasionally globose or flattened, up to few meters long; surface smooth or rough, sometimes mucilaginous. Cells coenocytic, multinucleate, chloroplasts numerous, discoid, devoid of pyrenoids.

It is a monogeneric family, represented by genus *Codium* in India as well as in Kerala.

Codium Stackh.

Thallus light-dark green in colour, spongy, variable in size from 1 cm to few m, erect or prostrate, sometimes globose, membranous, slightly mucilaginous. Holdfast rhizoidal, siphonous, colourless, firmly attached to substratum. Stipe subcylindrical or flat, sometimes indistinct, simple or branched. Fronds simple or branched, cylindrical to flat, pulvinate, the surface layer composed of a special elongate structure called utricle. Cells coenocytic, multinucleate.

Presently, 143 taxa in world (Guiry & Guiry, 2016), 12 in India (Oza & Zaidi, 2011) and 2 in Karnataka.

Key to species

1a. Thallus large, up to 30 cm long, flattened throughout or atleast near dichotomies **1. C. decorticatum**

1b. Thallus small, up to 15 cm long, uniformly cylindrical, regularly dichotomously branched **2. C. dwarkense**

1. Codium decorticatum (Woodw.) Howe in Bull. Torrey Bot. Club 38: 494. 1911; V. Krishnam. & H.V.Joshi, Checkl. Ind. Mar. Alg.: 7. 1970; Untawale & al., List Mar. Alg. India, 13. 1983; P. C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean, 852. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 184. 2001; Jha & al., Seaweeds Ind.: Diver. Distrib. Seaweeds Gujarat, 52. 2009; P.S.N. Rao & Gupta, Algae India 3: 13. 2015.

Ulva decorticatum Woodw. in Trans. Linn. Soc. London, 3: 55. 1797.

Thallus dark green in colour, spongy, lobed, up to 20 (-30) cm long, bushy, proliferous and epilithic. Holdfast discoidal, conspicuous, attached firmly by basal discs. Stipe slender, stalked. Fronds regularly dichotomously branched, younger branches terete while older branches, frequently compressed and slightly expanded near the furcation; utricles cylindrical or clavate, 145-860 µm in diameter, apices rounded, truncate or depressed, hair scars variable, numerous.

Occurrence: Usually post-monsoon season. Rare.

Distribution: **India:** Andhra Pradesh, Gujarat, Maharashtra and Tamil Nadu.

Note: This species has been included here based on the report by Kaladharan & al. 2011. However, during the present study, it could not be traced and collected freshly.

2. Codium dwarkense Boergesen in J. Indian Bot. Soc. 16: 6, 8, figs. 3-5. 1947; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 7. 1970; K.S. Sriniv., Phycol.Ind. 2: 32, pl. 32. 1973; Untawale & al., List Mar. Alg. India: 13. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 184. 2001; Jha & al., Seaweeds Gujarat: 53. 2009; P.S.N. Rao & Gupta, Algae India 3: 13. 2015.

Thallus light to yellowish green in colour, occasionally colourless and becomes dark after drying, spongy, and cylindrical, up to 15 cm long, erect, epilithic. Holdfast discoidal, conspicuous, several rhizoidal axes deveop from the discoid base, firmly attached on rocky substrata in intertidal zones. Stipe cylindrical, narrow towards base, up to 6 mm in diameter. Fronds almost uniformly cylindrical to slightly terete, elongated, 3.5-6 mm in diameter, regularly dichotomously branched, dichotomies usually at intervals of up to 4 cm long; surface smooth, slightly mucilaginous in nature, often appears as spotted; margins entire; apex simple or dichotomously forked, round to obtuse or slightly acute, light to yellowish coloured. *Microscopic*: Utricles cylindrical to clavate, 500-1050 × 90-200 µm; utricular wall 1-3 µm thick.

Occurrence: During post-monsoon seasons. Moderate.

Distribution: Karnataka: Dakshina Kannada, Udupi and Uttara Kannda districts. **India:** Gujarat and Kerala.

Note: This species is recorded here as a new addition to seaweed flora of Karnataka coast.

Specimen Examined: - Karnataka: St. Mary's Island, Malpe, *Palanisamy & Yadav* 136385, 29.11.2016; New Mangalore port coast, *Palanisamy & Yadav* 136455, 01.12.2016.

CLASS: PHAEOPHYCEAE

Under the class Phaeophyceae, a total of 6 orders are represented in India (Oza & Zaidi, 2001), of which 5 are available in Karnataka coast. Therefore, keys to these 5 orders are given below.

Key to orders

1a.	Life cycle lacks alternation of generations, sporophytic phase absent, represented by only gametophyte phase	**Fucales**
1b.	Life cycle exhibits alternation of generations, represented by both sporophytic and gametophytic phases	**2**
2b.	Thallus shows apical growth	**3**
2b.	Thallus shows trichothalic growth	**4**
3a.	Thallus polysiphonous, grows with single prominent cell	**Sphacelariales**
3b.	Thallus not polysiphonous, grows with one to many apical cells, fronds flat, blade like, non heterotrichous	**Dictyotales**
4a.	Thallus heterotrichous, filamentous, rarely pseudoparenchymatous	**Ectocarpales**
4b.	Thallus non heterotrichous, hollow or sac like	**Scytosiphonales**

1. ECTOCARPALES

ECTOCARPACEAE

Thallus light to dark brown in colour, filamentous, epiphytic, epilithic, epizoic, occasionally endophytic, heterotrichous, and simple of branched, often forming a slippery mat. Growth sub-apical to trichothalic. Sporangia develop in terminal, lateral or intercalary position; oogamy absent. Cells with discoid to ribbon like plastids; pyrenoids sometimes absent.

This family is represented by 7 genera in India and 3 in Karnataka.

Key to genera

1a.	Thallus without a distinct and well dife\ined meristematic zones	**1. Ectocarpus**
1b.	Thallus consists of well defined meristematic zones	**3**
2a.	Thallus filamentous, produsely branched	**2. Hincksia**
2b.	Thallus sac like, delicate, multi lobed	**3. Iyengaria**

1. Ectocarpus Lyngb.

Thallus dark-light brown in colour, filamentous, heterotrichous, profusely branched, irregularly branched; erect filaments uniseriate, profusely branched.

Cells without any well-defined zones, apical cells acute to obtuse; chloroplasts variable, usually parietal, with or without pyrenoids.

Presently, 96 taxa in world (Guiry & Guiry, 2017), 6 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Ectocarpus siliculosus (Dillwyn) Lyngb., Tent. Hydrophytol. Dan.: 131, figs. 43B, C. 1819; Untawale & al., Natl. Inst. Ocenogr., Goa, 1-42. 1983; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 561. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 100. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 18. 2015.

Conferva siliculosus Dillwyn, Brit. Conferv.: 69, suppl. Pl. E. 1809.

Thallus light-dark to olive brown in colour, filamentous, up to 5 cm long, caespitose, heterotrichous, profusely branched forming a dense subglobose tuft, epilithic, occasionally epiphytic on other seawweeds. Holdfast minute, rhizoidal or discoid, firmly attached on rocky substrata in intertidal regions. Frond filamentous, alternate or irregularly branched; branches usually sparse below and profuse towards apex, tapering towards apex. *Microscopic*: cells filamentous, rectangular to cylindrical, 7-30 × 4-16 µm, basal cells comparatively large and gradually become shorter, uniseriately arranged, thin walled, uninucleate; chloroplast usually reticulate, pyrenoids several. Sporangia usually develop laterally on branches, plurilocular, sessile or sub-sessile, cylindrical to elongate, occasionally slightly curved at apex.

Occurrence: Throughout the year. Moderate.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Kerala and Maharashtra.

Illustration: Lyngb., *op. cit.*

Notes: This is the type species of the genus *Ectocarpus* and is usually found growing in shallow intertidal region. Morphologically, it shows similarities with the species of *Polysiphonia*, but it can be distinguished from the latter by having distinct plurilocular sporangia and uniseriate filamentous cells.

Specimen Examined: Serikuli, *Palanisamy* 135207, 25.02.2016.

2. Hincksia J.E. Gray

Thallus light-dark brown in colour, filamentous, heterotrichous, uniseriate and densely branched, mostly epilithic or epiphytic. Filaments of the erect system monopodially or irregularly branched with attenuated branchlets. Pseudohairs often absent. Growth of the filaments by meristematic zones, cells usually with numerous discoid or parietal plastids. Sporangia plurilocular as well as plurilocular; unilocular sporangia often round to ovoid; plurilocular sporangia highly variable, usually cylindrical, ovoid to fusiform or conical.

Presently, 31 taxa in world (Guiry & Guiry, 2017), 15 in India (Nettar & Panikkar, 2009; Rao & Gupta, 2015) and 1 in Karnataka.

Hincksia mitchelliae (Harv.) P.C. Silva, Smithsonian Contrib. Mar. Sci. 27: 130. 1987; Untawale & al., Natl. Inst. Ocenogr., Goa, 23. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 103. 2001; Nettar & Panikkar in Seaweed Res. Utiln. 31(1&2): 18, figs. 9-13. 2009; V. Krishnam & Baluswami, Phaeophyceae India Neighb. 1: 40, pl. 1, figs. 10, 11; figs. 65-70. 2010; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 19. 2015

Ectocarpus mitchelliae Harv., Smithsonian Contrib. Know. 3(4): 142, pl. 12G, 1852.

Giffordia mitchelliae (Harv.) Hamel in Bot. Not. 66. 1939; J.N. Misra, Phaeophyceae India, 91, fig. 4. 1966.

Thallus light-dark brown in colour, filamentous, usually 2.5 to 6 (-15) cm long, densely tufted, usually epilithic. Filaments heterotrichous, consists of a creeping prostrate (rhizoidal) and an erect systems; filaments of the erect system profusely branched, branches first monopodial, later becomes lateral and irregular, tapering towards apex. *Microscopic*: Cells of the rhizoidal filaments 35-40 × 20-24 µm, poor in cytolplasmic contents; growth of the filaments intercalary, meristematic zones conspicuous, found at the base of the branches, cells 30-45 × 29-42 µm. Cells of the erect filaments cylindrical, chromatophore numerous, discoidal. Sporangia plurilocular, produced laterally on erect filaments, long, cylindrical with obtuse apices, 80-165 × 20-30 µm, often sessile; plurangia identical in shape but variable in size.

Occurrence: Summer season. Rare.

Distribution: Karnataka: Uttara Kannda district. **India:** Andhra Pradesh, Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Illustration: Nettar & Panikkar, *op. cit.* & V. Krishnam. & Baluswami *op. cit.*

Note: This species has been included here based on the report by Kaladharan & al. 2011. However, during the present study, it could not be traced and collected freshly.

3. Iyengaria Boergesen

Iyengaria stellata (Boergesen) Boergesen in K. Joss. & R. Sparck, Dan. Sci. Inverst. Iran, I: 91. 1939; J.N. Misra, Phaeophyceae India, 118. 1966; V. Krishnam. & H.V.Joshi, Checkl. Ind. mar. alg., 12. 1970; Untawale & al., List mar. alg. India, 20. 1983; P. C. Silva & al., Cat. benth. mar. alg. Ind. Ocean, 631. 1996; Oza &Zaidi, Rev. Checkl. Ind. mar. alg., 121. 2001.

Rosenvingea stellata, Borgesen, Dansk Bot. Ark., 5 (6): 1.1928.

Thallus yellowish brown in colour, sack like, up to 8 cm long, spongy, delicate, usually epilithic, occasionally free floating. Fronds globular in outline, multilobed, 1-3 cm in length.

Occurrence: Summer season. Rare.

Distribution: Karnataka: Uttara Kannda district (Gorte). **India:** Tamil Nadu.

Specimen Examined: Karnataka: Gorte, *Palanisamy* 134966, 22.02.2016.

2. SPHACELARIACEAE

Thallus light to dark or olivaceous brown in colour, filamentous, cylindrical to terete, up to 10 cm long. polysiphonous, occasionally corticated, usually branched and clothed with numerous branchlets, subglobose or hemispherical tufts, usually heterotrichous, epilithic or epiphytic, rhizomatous. Growth by segmentation of a large apical cell. Sporangia unilocular; gametangia plurilocular, born on branchlets.

This family is represented by only 1 genus in India and as well as in Karnataka.

Sphacelaria Lyngb**.**

Generic characters are similar to family characters.

Presently, 42 taxa in world (Guiry & Guiry, 2017), 5 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Sphacelaria rigidula Kuetz., Phycol. General.: 292. 1843; Boergesen in J. Indian Bot. Soc. 16: 26. 1937; J.N. Misra, Phaeophyceae India: 129, fig. 65. 1966; Untawale & al., Natl. Inst. Ocenogr., Goa, 1-42. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 105. 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 78, pls. 3: 1-6, figs. 186-196. 2010; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 21. 2015

Sphacelaria furcigera Kuetz., Tab. Phycol.: 5: 27, pl. 90, fig. 2. 1868; Anilkumar & Panikkar in Seaweed Res. Utiln. 14(2): 129, figs. 1-9. 1992.

Thallus light to olive or dark brown in colour, filamentous, up to 3 cm long, tufted, heterotrichous, usually epiphytic. Holdfast minute, rhizoidal, multicellular. Stipe minute or undifferentiated. Fronds filamentous, cylindrical-terete, 20-50 µm in diameter, main axis irregularly and profusely branched towards apex, terminates into long colourless hairs; branches bilaterally arranged, segmented. *Microscopic*: Cells in surface view rectangular, 28-46 × 5-8 µm across; in transverse section, main axis with 7-10 cells; hairs 80-165 µm long and 10-15 µm in diameter. Propagules stalked, develop on either side of branches, Y shaped, biradiate, arms up to 350 µm long. Sporangia unilocular, globose, 50-70 µm in diameter.

Occurrence: Usually monsoon and post monsoon seasons. Rare.

Distribution: Karnataka: Uttara Kannda district. **India:** Kerala.

Note: This species has been included here based on the report by Kaladharan & al. 2011. However, during the present study, it could not be traced and collected freshly.

3. DICTYOTALES

DICTYOTACEAE

Thallus light to dark brown in colour, leafy or stupose, erect or prostrate, variable in length, epilithic. Holdfast distinct, rhizoidal or discoid, cushion like.

Fronds stupose to blade like, flat, usually lobed, expanded or fan shaped; margins entite to wavy or irregular. Growth by a single apical cell or a marginal row of apical initials.

This family is represented by 8 genera in India and 7 in Karnataka.

Key to genera

1a.	Thallus with rhizomatous holdfast	**2**
1b.	Thallus without rhizomatous holdfast	**4**
2a.	Fronds fan shaped, dichotomously branched	**4. Padina**
2b.	Fronds not fan shaped, di-trichotomously branched	**3**
3a.	Fronds without a distinct midrib, reproductive parts scattered over the thallus surface	**2. Dictyota**
3b.	Thallus with a prominent midrib, reproductive parts scattered parallel to the midrib	**1. Dictyopteris**
4a.	Thallus prostrate, thick, cartilaginous, circular in young stage	**3. Lobophora**
4b.	Thallus erect, flat, papery to transparent, foliaceous, elongate	**5**
5a.	Apical margins circinately inrolled, dichotomously branched towards apex	**6. Stoechospermum**
5b.	Apical margins not circinately inrolled, irregularly and palmately branched towards apex	**5. Spatoglossum**

1. Dictyopteris J.V. Lamour.

Thallus dark brown in colour, strap like, up to 15 (-20) cm long, erect or partially prostrate, attached by discoid holdfast. Fronds with prominent and thick midrib, surface hairy except midrib region, margins entire or winged, wings usually supports hair clusters and reproductive parts. In cross section, thallus many layered, midrib cells small, quadrate-rectangular, thick walled; wing cells large, almost quadrate, thin walled.

Currently 35 taxa in world (Guiry & Guiry, 2017), 6 in India (Krishnamurthy & Baluswami, 2010) and 2 in Karnataka.

Key to species

1a.	Thallus small, up to 5 cm long,	**2. D. delicatula**
1b.	Thallus large, up to 30 cm long	**2**
2a.	Midrib distinctly prominent, veins originating from midrib are well developed	**1. D. australis**
2b.	Midrib normally prominent, veins absent or indistinct	**3. D. woodwardii**

1. Dictyopteris australis (Sond.) Askenasy, Forsch. Botanik: 30. 1888; Untawale & al., Natl. Inst. Ocenogr., Goa, 31. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 580. 1996; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 21. 2015.

Thallus light – yellowish brown in colour, foliose, shaped, up to 30 cm long, epilithic. Holdfast minute, discoid, firmly attached on substrata. Stipe flat, up to

1.5 cm long. Fronds foliose, flat, irregularly branched; surface smooth; midrib distinctly prominent throughout, conspicuous, veins well developed; margins entire to slightly wavy; apex usually rounded to obtuse. *Microscopic*: Thallus multilayered; cells in basal midrib region multilayered layered, thick walled; cells in upper region of fronds 2-layered, large, squarish to rectangular.

Occurrence: Usually Post monsoon and summer seasons. Moderate.

Distribution: Karnataka: Udupi (St. Mary's island) and Uttara Kannda district (Majali and Tadri). **India:** Gujarat and Tamil Nadu.

Specimen Examined: Karnataka: Gorte, *Palanisamy* 134957, 22.02.2016.

2. Dictyopteris delicatula J.V. Lamour. in Nouv. Bull. Sci. Soc. Philom, Paris 1: 332. 1809; J.N. Misra, Phaeophyceae India: 146. 1966; Untawale & al., List Mar. Alg. India: 20. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 581. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 106. 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 97. 2010; P.S.N. Rao & Gupta, Algae India 3: 21. 2015.

Thallus light brown in colour, flat, strap shaped, usually 1-5 cm long, tufted, epilithic. Holdfast minute, discoid, firmly attached on substrata. Stipe flat, small, up to 1 cm long. Fronds strap shaped, uniformly flat, dichotomous or irregularly branched, branching usually at intervals of up to 1 cm; surface smooth; midrib prominent towards base, slightly raised; margins entire to slightly wavy; apex usually rounded to obtuse. *Microscopic*: Thallus multilayered; cells in basal midrib region usually 4-6-layered, small, squarish to rectangular, 8-26 µm across, thick walled, chromatophore content more; cells in upper region of fronds 2-layered, large, squarish to rectangular. Reproductive structures develop on both surfaces of the fronds, irregularly scattered, associated with hairs.

Occurrence: Usually Post monsoon and summer seasons. Moderate

Distribution: **Karnataka**: Uttara Kannda district (Majali, Madiyendri and Tadri). **India**: Kerala and Tamil Nadu.

Specimen Examined: Karnataka: Talgode, *Palanisamy* 135008, 23.02.2016.

3. Dictyopteris woodwardii (R. Br. ex Turner) C. Agardh, Syn. Alf Scand. 21 1817; J.N. Misra, Phaeophyceae India: 151. 1966; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 580. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 107. 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 99. 2010; P.S.N. Rao & Gupta, Algae India 3: 21. 2015.

Thallus light to yellowish brown in colour, flat, strap shaped, up to 30 cm long, tufted, epilithic. Holdfast discoid, tufted, firmly attached. Stipe cylindrical to slightly flattened upward, stiff, up to 1 cm long. Fronds foliose, flattened, repeatedly dichotomously branched, branching usually at intervals of up to 1.2 cm; midrib prominent, veins absent of indistinct; margins dentate to slightly undulate; apex usually bifid, acute to obtuse. *Microscopic*: Thallus multilayered; cells in basal midrib region usually 2-4-layered, squarish to rectangular. Reproductive structures

develop on both surfaces of the fronds, irregularly scattered, tetrasporangia sunken in the thallus.

Occurrence: Usually summer season. Rare.

Distribution: **Karnataka**: Uttara Kannda district (Gorte). **India**: Goa, Maharashtra, and Tamil Nadu.

Specimen Examined: Karnataka: Gorte, *Palanisamy* 134958, 22.02.2016.

2. Dictyota J.V. Lamour.

Thallus dark-light brown in colour, flat, narrowly ribbon like, up to 25 cm long, membranous, erect or partially prostrate, attached by rhizoidal or discoid holdfast; fronds usually branched, surface smooth or hairy, clustered hairs mainly concentrated along the middle of margins, midrib absent or indistinct, margins entire or with teeth, spines or proliferation, apices obtuse to round or acute. In cross section, thallus 3-layered consisting of 1-2 layers of cortex and 1-2 layers of medulla.

Currently 89 taxa in world (Guiry & Guiry, 2017), 16 in India (Krishnamurthy & Baluswami, 2010) and 8 in Karnataka.

Key to species

1a.	Frond margins serrate to dentate or proliferated	**3. D. ciliolata**
1b.	Frond margins entire	**2**
2a.	Thallus small, usually less than 10 cm long	**3**
2b.	Thallus large, usually more than 10 cm long	**4**
3a.	Thallus usually olive green in colour, 2-3cm long	**2. D. ceylanica**
3b.	Thallus dark-yellowish brown in colour, up to 10 cm long	**4. D. dichotoma**
4a.	Thallus irregularly dichotomous or alternately branched; apex rounded or obtuse	**6. D. pinnatifida**
4b.	Thallus regularly dichotomously branched; apex rounded to obtuse or acute	**5**
5a.	Thallus 10-20 cm long and 2-5 mm broad, uniformly flattened	**1. D. bartayresii**
5b.	Thallus 12-28 cm long and 1-2 mm wide, usually slightly twisted	**5. D. indica**

1. Dictyota bartayresii J.V. Lamour. in J. Bot. (Desv.) 2: 43. 1809; Panikkar & Ampili in J. Econ. Taxon. Bot. 17(3): 702. 1993; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 586. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 107. 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 89. 2010; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Dictyota bartayrensensis J.V. Lanour. in Nouv. Bull. Sci. Soc. Philom, Paris 1: 331. 1809.

Thallus llight-yellowish brown in colour, foliose, 6-15 (-20) cm long, ribbon or strap like, bushy, tufted, epilithic. Holdfast discoid, conspicuous, firmly attached on rocky substrata. Stipe flat, up to 2 cm long and 2-3 mm broad. Frond foliose, almost uniformly flattened, usually up to 15 (-20) cm long and 2-6 cm wide,

regularly dichotomously branched in upper region, angles of dichotomy usually narrow; surface membranous, smooth; margins entire; apices simple or equally to unequally forked, acute to occasionally obtuse. *Microscopic*: Cells in surface view usually rectangular, compact; in cross section, thallus consists of a single layered superficial cells enclosing the central medullary cells. Sporangia scattered over thallus surface, isolated or in groups or 2-5, round to spherical, 30-90 µm across; antheridia usually club shaped, oogonia spherical; tetrasporangia scattered on thallus surface, solitary or in groups.

Occurrence: Summer and post-monsoon seasons. Moderate.

Distribution: Karnataka: Udupi (St. Mary's island) and Uttara Kannda (Gorte, Mundoli and Talgode)) districts. **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: St. Mary Island, Malpe, *Palanisamy* 134903, 20.02.2016; Gorte, *Palanisamy* 134961, 22.02.2016; Mundoli beach (Bhatkal), *Palanisamy* 134986, 23.02.2016.

2. Dictyota cervicornis Kuetz. Tab. Phycol. 9(1): 11, Pl. 25, fig. 1. 1859; J.N. Misra, Phaeophyceae India: 139, fig. 72. 1966; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 587. 1996; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 86. 2010; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Thallus light to olive green in colour, frondose, 10-25 cm long, foliose, epilithic. Holdfast minute, rhizoid, loosely attached, occasionally free floating. Frond foliose, almost uniformly flattened, up to 1.5 cm wide, membranous, profusely branched in upper portion; margins entire to slightly undulate; apices broadly rounded to obtuse. *Microscopic*: Cells in surface view usually squarish or rectangular; in cross section, thallus consists of an outer layer of superficial cells and a central medullary layer. Sporangia usually born on upper surface of the branches, occasionally towards margins; antheridia and oogonia develop in sori. **(Plate 24. a)**

Occurrence: Summer and post-monsoon seasons. Rare.

Distribution: Karnataka: Udupi (St. Mary's island) district. **India:** Gujarat (Dwarka, Misra, 1966).

Specimen Examined: Karnataka: St. Mary Island, Malpe, *Palanisamy* 134901, 20.02.2016; St. Mary's Island, Malpe, *Palanisamy & Yadav* 136373, 29.11.2016.

3. Dictyota ceylanica Kuetz., Tab. Phycol. 9(1): 11, Pl. 25, fig. 1. 1859; J.N. Misra, Phaeophyceae India: 139, fig. 72. 1966; Panikkar & Ampili in J. Econ. Taxon. Bot. 17(3): 702. 1993; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 588. 1996; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 85. 2010; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Thallus light to olive green in colour, frondose, small, 2-3.5 cm long, tufted, epilithic. Holdfast minute, cuneately discoid, firmly attached. Frond foliose,

almost uniformly flattened, up to 1 mm wide, membranous, dichotomously branched in upper portion; margins entire; apices broadly rounded to obtuse. *Microscopic*: Cells in surface view usually squarish or rectangular, horizontally arranged; in cross section, thallus consists of an outer layer of superficial cells and a central medullary layer; superficial cells single layered, small, squarish, chromatophore content more; medullary cells single layered, large, squarish-rectangular, thick walled, chromatophore content less. Sporangia usually born as a rule along the central region of the branches, occasionally towards margins; antheridia and oogonia develop in sori; tetrasporangia solitary or in groups or 2-3, usually spherical.

Occurrence: Post-monsoon season. Rare.

Distribution: Karnataka: Udupi district (St. Mary's island). **India:** Gujarat (Dwarka, Misra, 1966) and Kerala.

Note: This taxon was originally reported by Kuetzing from Sri Lanka (Ceylon) in 1859. It has very restricted distribution around the Arabian sea. Recently, it has been reported with very scanty population from the Karachi coast, Pakistan (Abbas, 2010).

Specimen Examined: Karnataka: St. Mary's Island, Malpe, *Palanisamy & Yadav* 136375, 29.11.2016.

4. Dictyota ciliolata Kuetz., Tab. Phycol. 9: 27. 1859; J. N. Misra, Phaeophyceae India: 136. 1966; Untawale & al., List Mar. Alg. India: 25. 1983; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 588. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 108. 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 95, pl. 4: 9, fig. 240. 2010; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Dictyota ciliata J. Agardh in Linnaea 15(2): 5. 1841.

Thallus light-yellowish brown in colour, becomes dark brown after drying, 5-15 (-20) cm long and 0.3-1.2 cm wide, leafy, flat, ribbon like, bushy, tufted, epilithic. Holdfast minute, discoid, firmly attached on rocky substrata in surf-exposed areas. Stipe flat, up to 1.5 cm long and 2-10 mm broad. Fronds foliose, usually 5-12 cm long and up to 1.2 cm wide, width gradually increases from base towards apex, membranous, regularly dichotomously branched in upper portion, irregular towards apex, angles of dichotomy narrow; branches flat, lobed; margins entire in basal region and ciliate to irregularly dentate or proliferated towards apex; proliferations flat, strap like, sometimes branched; apices simple or dichotomously forked, rounded to obtuse or acute, occasionally truncate. *Microscopic*: Cells in surface view usually rectangular to polygonal, compactly arranged; in cross section thallus consists of a single layered superficial cells enclosing the central medullary cells; superficial cells small, thin walled, usually rectangular, chromatophore contents more; medullary cells large, rectangular to elongate or squarish, thick walled, hyaline chromatophore contents less. Sporangia develop on both surfaces of the fronds, round to spherical, 50-120 µm across, usually found in

group, occasionally isolated, mostly concentrated in middle and subapical parts, occasionally towards the margins, non involucrate. **(Plate 24. b)**

Occurrence: Post-monsoon season. Moderate.

Distribution: Throughout Karnataka coast. **India:** Gujarat, Kerala and Tamil Nadu.

Illustration: V. Krishnam. & Baluswami, *op. cit.*

Notes: Agardh (1882) opined that *Dictyota ciliata* and *D. ciliolata* are conspecific. However, he wrongly retained *D. ciliata*, a latter homonym of *D. ciliata* J.V. Lamour. which is an illegitimate new name for *Fucus pseudociliatus* J.V. Lamour. Therefore, *Dictyota ciliata* J. Agardh is an illegitimate name (Silva & al., 1996).

Specimen Examined: Karnataka: Uchila coast, *Palanisamy & Yadav* 131067, 10.10.2014; Ukursia Island, Harwada, *Palanisamy & Yadav* 131213, 18.10.2014; uchila udupi district, *Palanisamy* 133381, 19.02.2016.

5. Dictyota delicatula J.V. Lamour. J.V. Lamour. in J. Bot. (Desvaux) 2: 42. 1809; J.N. Misra, Phaeophyceae India: 132, fig. 66, 1966; Untawale & al., List Mar. Alg. India: 21. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 589. 1996; 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 86. 2010; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Ulva dichotoma Huds., Fl. Angl. 476. 1762.

Thallus dark-yellowish brown in colour, up to 10 cm long, leafy to frondose or ribbon like, bushy, tufted, epilithic. Holdfast minute, discoid, firmly attached on rocky substrata in surf-exposed areas in intertidal region. Stipe foliose to stalked, up to 2 cm long. Fronds foliose, up to 8 cm long, membranous, regularly dichotomously branched, angles of dichotomy less than 90^0; branches profuse towards apex, flat, uniform, slightly broader at base; margins entire; apices dichotomously forked, rounded to obtuse, occasionally acute. *Microscopic*: Cells in surface view mostly squarish and sparsely arranged, 8-20 µm across; in cross section, thallus consists of an outer layer of superficial cells and a central medulla layer; superficial cells single layered, small, usually rectangular to squarish, 8-25 µm across, thin walled, compact, chromatophore content more; medullary cells single layered, comparatively large, squarish to rectangular, 32-80 µm across, thick walled, compact, chromatophore content less. Sporangia develop in sori on surface, usually associated with clusters of paraphyses; antheridial sori (sporangia) whitish, antheridia cylindrical-clavate; oogonial sori dark brown; oogonia club shaped; tetrasporangia single or grouped, spherical, occasionally associated with paraphyses.

Occurrence: Summer season. Rare.

Distribution: Karnataka: Uttara Kannda district (Gorte). **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Gorte, *Palanisamy* 134959, 22.02.2016; Talgode, *Palanisamy* 135008, 23.02.2016

6. Dictyota dichotoma (Huds.) J.V. Lamour. in J. Bot. (Desvaux) 2: 42. 1809; J.N. Misra, Phaeophyceae India: 132, fig. 66, 1966; Untawale & al., List Mar. Alg. India: 21. 1983; Untawale & al., Natl. Inst. Ocenogr., Goa, 581. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 589. 1996; 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 86. 2010; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Ulva dichotoma Huds., Fl. Angl. 476. 1762.

Thallus dark-yellowish brown in colour, up to 10 cm long, leafy to frondose or ribbon like, bushy, tufted, epilithic. Holdfast minute, discoid, firmly attached on rocky substrata in surf-exposed areas in intertidal region. Stipe foliose to stalked, 0.5-1.6 (-2) cm long. Fronds foliose, up to 8 cm long, membranous, regularly dichotomously branched, angles of dichotomy less than 90^0; branches profuse towards apex, flat, uniform, slightly broader at base; margins entire; apices dichotomously forked, rounded to obtuse, occasionally acute. *Microscopic*: Cells in surface view mostly squarish and sparsely arranged, 8-20 µm across; in cross section, thallus consists of an outer layer of superficial cells and a central medulla layer; superficial cells single layered, small, usually rectangular to squarish, 6-25 µm across, thin walled, compact, chromatophore content more; medullary cells single layered, comparatively large, squarish to rectangular, 30-84 µm across, thick walled, compact, chromatophore content less. Sporangia develop in sori on surface, usually associated with clusters of paraphyses; antheridial sori (sporangia) whitish, antheridia cylindrical-clavate; oogonial sori dark brown; oogonia club shaped; tetrasporangia single or grouped, spherical, occasionally associated with paraphyses.

Occurrence: Throughout the year. Moderate.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: This is the type species of the genus *Dictyota* and is found growing mainly on rock poolls in low intertidal regions in association with the species of *Dictyota*, *Gracilaria Hypnea* and *Padina*.

Specimen Examined: Karnataka: Gorte, *Palanisamy* 133216, 20.09.2015; Oyingi beach, *Palanisamy & Yadav* 131186, 15.10.2014; Uchila Udupi district, *Palanisamy & Yadav* 131258, 05.06.2015.

7. Dictyota pinnatifida Kuetz. in Tab. Phycol. 16: Pl. 39, fig. 1. 1859; J.N. Misra, Phaeophyceae India: 140. 1966; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 11.1970; Untawale & al., Natl. Inst. Ocenogr., Goa, 596. 1983; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 596. 1996; V. Krishnam. & Baluswami,

Phaeophyceae India Neighb. 1: 88. 2010; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Thallus yellowish or greenish brown in colour, frondose, usually 4 - 12 cm long, tufted, epilithic. Holdfast minute, discoid, firmly attached on rocky substrata. Frond foliose, almost ribbon like, irregularly flattened, 1-3 mm wide, internodal segments 1-4 cm long, regularly dichotomously branched, branches erect, flat, usually slightly twisted; margins entire; apices rounded or obtuse. *Microscopic*: Cells in surface view elongated to squarish or rounded, horizontally arranged; in cross section, thallus consists of an outer layer of superficial cells and a central medullary layer. Tetrasporangia develop in scattered sori on thallus surfaces

Occurrence: Usually monsoon and post-monsoon seasons. Rare.

Distribution: *Distribution*: Karnataka: Udupi district (St. Mary's island). **India:** Maharashtra.

Specimen Examined: Karnataka: St. Mary Island, Malpe, *Palanisamy* 134902, 20.02.2016; Madi- Bengre, *Palanisamy* 134929, 21.02.2016.

3. Lobophora J. Agardh

Thallus dark to yellowish brown in colour, up to 15 cm long and 10 cm wide, flat, decumbent or erect, rigid, crustose. In cross section, thallus multilayered, consists of an outer single layered epidermis, 2 to several layered cortex and a single layered medulla. Reproductive structures develop in sori on surface of the fronds. sporangia sessile with 4-8 spores.

Currently 21 taxa in world (Guiry & Guiry, 2017), 3 in India (Krishnamurthy & Baluswami, 2010) and 1 in Karnataka.

Lobophora variegata (J.V. Lamour.) Womersley ex E.C. Oliveira, Alg. Mar. Brasil 217. 1977; Untawale & al., Natl. Inst. Ocenogr., Goa, 1-42. 1983; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 114. 2010; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Manisseri & al., Comm. Seaw. Seagr. India 1: 25. 2012; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Dictyota variegata J.V. Lamour. in J. Bot. (Desvaux) 2: 40. 1809.

Thallus light-dark brown in colour, up to 15 cm long and 10 cm wide, crustose, circular to fan shaped or rosette, prostrate, tufted, epilithic. Holdfast small, rhizoidal or discoid, anchored tightly on calcareous bedrocks in intertidal zones. Stipe stalked or sessile, rigid, 0.5 to 3 cm ling. Fronds leafy, fan shaped, irregularly lobed to overlapped in upper portion, sub-marginal rows of cells; surface rough, rigid; base often cuneate; margins entire to wavy; apex usually obtuse, apical margins involute, thick, light- brown in colour. *Microscopic*: Thallus consists of an outer single superficial layer, middle 3-4-layered cortex and single layered medulla; cells of the superficial layer small, usually elongate or palisade like, thin walled, vertically arranged; cells of the cortex squarish or rectangular, thick walled, compact; cells of medullary layer comparatively large, almost rectangular, thin walled, compact. Reproductive structures scattered on both sides of fronds,

sori lack paraphyses; young sori indusiate; oogonia usually single, sometimes in groups, spherical to pear shaped, sessile; tetrasporangia usually spherical, 40-60 μm across.

Occurrence: Usually post-monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Lakshadweep Islands, Kerala, Maharashtra and Tamil Nadu.

Note: This species has been included here based on the report by Kaladharan & al. (2011). However, in our consequent surveys, it could not be collected freshly.

4. Padina Adans.

Thallus light-dark brown in colour, up to 20 cm long, foliaceous, usually fan shaped, flat, membranous, complanate, flabellate, epilithic. Holdfast rhizoidal or discoid, firmly attached on rocky substrata. Fronds leafy, surface rough with concentric lines of microscopic hairs; apical margins curled ventrally. In cross section, thallus multilayered, consisting of single layer of surface cells on either side and 2 to several layered central medullary cells. Reproductive parts develop in indusiate or non indusiate sori.

Currently 52 taxa in world (Guiry & Guiry, 2017), 9 in India (Krishnamurthy & Baluswami, 2010) and 4 in Karnataka.

Key to species

1a.	Thallus surface prominently calcified	**2**
1b.	Thallus surface moderately or uncalcified	**3**
2a.	Calcification thin and uniform on both surfaces; mature thallus 2-3-layered	**2. P. boryana**
2b.	Calcification heavy on lower surface and light on upper surface; mature thallus always more than 3-layered	**3. P. pavonica**
3a.	Thallus with 3 layers of cells in mature portion	**1. P. boergesenii**
3b.	Thallus with 3-6 layers of cells in mature portion	**4. P. tetrastromatica**

1. Padina boergesenii Allender & Kraft in Brunonia 6: 87, figs. 6C, H, I, 7C, D. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 601. 1996; M. S. Balakr. & V. Krishnam. in Seaweed Res. Utiln. 20(1&2): 115. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 111. 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 111. 2010; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 55. 2015. Misapplied name: *Padina gymnospora* (Kuetz.) Vickers vide: Krishnamurthy & Baluswami, 2010.

Thallus dark brown in colour, frondose, circular to fan shaped, 5-12 × 4-10 cm, usually without calcification, moderately calcified in ventral surface, epilithic. Holdfast small, thick, rhizomatous, several small proliferations or young branches develop from the disc, firmly attached on rocky substrata in intertidal regions.

Stipe flat to slightly stalked, 2-6 × 0.2-0.6 cm wide. Fronds leafy, circular to fan shaped, surface membranous, alternate rows of microscopic hairs (piliferous zones) and glabrous surface, irregularly cleft into several broad lobes; lobes reaching up to half or even more in young stage; base cuneate; margins entire to slightly wavy; apex obtuse or acute with involute margins. *Microscopic*: Thallus 75-150 µm thick, 2-3-layered, usually 2-layered in upper portion and 3-layered in lower portion of the fronds; cells of the upper superficial layer small, rectangular, 20-55 × 15-40 µm across, thin walled, chromatophore content more; cells in the centre and lower region large, rectangular, 40-75 × 20-40 µm across, thick walled, chromatophore content less. Thallus dioecious, reproductive structures develop on frond surface, forming alternate concentric bands of wider and narrow rows; sporangia in sori, non-indusiate, associated with hair bands (paraphyses).
(Plate 24. c)

Occurrence: Monsoon and post-monsoon season. Rare.

Distribution: Karnataka: Dakshina Kannada (Uchila) and Udupi (St. Mary's island) districts. **India:** Kerala, Gujarat and Tamil Nadu.

Notes: This species was traditionally referred to as *Padina gymnospora* (Kuetz.) Sond. Allender & Kraft (1983) described this species from the Lord Howe Island, Australia and pointed that this species is similar to *P. gymnospora* but differs from the latter in having 2-3-layered thallus rather than 4-8-layered one. Besides, they also suggested that many of the records of *P. gymnospora* from the Indo-Pacific regions are likely to be referred to *P. boergesenii*.

Specimen Examined: Karnataka: Uchila coast, *Palanisamy & Yadav* 131068, 10.10.2014; St. Mary Island, Malpe, *Palanisamy & Yadav* 131095, 12.10.2014

2. Padina boryana Thivy in W.R. Taylor (ed.), Pacific Sci. 20: 355, fig. 2. 1966; Untawale & al., List Mar. Alg. India: 23. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 602. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 111. 2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 104. 2010; P.S.N. Rao & Gupta, Algae India 3: 23. 2015. *Padina commersonii* Bory, Voy. Coquille: 144, pl. 21, fig. 2-J. 1828; J.N. Misra, Phaeophyceae India: 155. 1966.

Thallus light to dark brown in colour, frondose, circular to fan shaped, 3-8 × 2-5 cm broad, lightly calcified on both surfaces of thallus, whitish with occasional blue tinge, epilithic. Holdfast small, thick, rhizomatous or bulbous, 2-6 mm across, attached firmly on rocky substrata in intertidal zones. Stipe stalked, narrowly flat. Fronds leafy, spreading, circular or fan shaped, usually dichotomously branched, surface membranous, younger fronds usually entire, mature fronds irregularly cleft into several lobes; usually incised up to half, rarely more; lobes narrow, up to 8 cm long and 2-5 cm broad; base cuneate; margins entire to slightly undulate; apex obtuse to circular with involute margins. *Microscopic*: Thallus 70-120 µm thick, usually 2(-3)-layered; cells of the upper superficial layer small, rectangular, 25-50 × 25-38 µm, thin walled, chromatophore content more; cells in lower region large, rectangular, 30-70 × 20-36 µm, thick walled, chromatophore content less.

Thallus dioecious, reproductive structures develop on frond surface, forming alternate rows with microscopic hair bands; sporangia develop in sori on ventral surface, non-indusiate, associated with hair bands; tetrasporangia develop above the microscopic hair rows, globular to spherical. **(Plate 24. d)**

Occurrence: Throughout the year. Moderate.

Distribution: Throughout Karnataka coast. **India:** Kerala, Gujarat and Tamil Nadu.

Specimen Examined: Karnataka: Oyingi beach, *Palanisamy & Yadav* 131178, 15.10.2014; Mundoli beach (Bhatkal), *Palanisamy* 132403, 08.06.2015; Madiyengri, *Palanisamy & Yadav* 136247, 26.11.2016.

3. **Padina pavonica** (L.) Thivy in W.R. Taylor, Mar. Alg. East. Trop. Americas: 234. 1960; J.N. Misra, Phaeophyceae India: 154, fig. 81. 1966; Untawale & al., List Mar. Alg. India: 21.1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 113.2001; V. Krishnam. & Baluswami, Phaeophyceae India Neighb. 1: 107, fig. 257. 2010; P.S.N. Rao & Gupta, Algae India 3: 23. 2015.

Fucus pavonicus L., Sp. Pl. 2: 1162. 1753.

Thallus light to dark brown in colour, circular to fan shaped, 4-8 × 2-6 cm broad, heavily calcified on lower surface and light on upper surface of mature thallus, whitish, tufted, epilithic. Holdfast small, bulbous or discoid, 2-5 mm across, attached firmly on rocky substrata in intertidal zones. Stipe small, stalked, narrow to gradually flat upwards, up to 1.4 cm long and 2-6 mm wide. Fronds leafy, spreading, forming fan shaped structure, surface membranous, younger fronds usually simple, mature fronds usually dichotomously cleft down up to half or sometimes up to the base into several lobes; lobes flat, circular to fan shaped, occasionally mature lobes further divided into several irregular parts; surface membranous, with alternate rows of microscopic hairs (piliferous zones) and glabrous surface, base cuneate; margins entire to slightly undulate; apex obtuse to circular with involute margins. *Microscopic*: Thallus 75-146 µm thick, usually 2 (-3)-layered towards apex and 4-layered in basal region; cells of the upper superficial layer small, rectangular or polygonal, 20-46 × 15-25 µm, thin walled, 2-6 µm thick, chromatophore content more; cells in lower region large, rectangular to squarish. Reproductive structures develop mainly near piliferous zones on dorsal surface of frond; sporangia develop in sori forming a narrow band of up to 0.5 mm width commonly on upper surface or sometimes on both surfaces. **(Plate 24. e)**

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Andaman Karnataka: Udupi and Uttara Kannda districts. **India:** Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: It is the type species of the genus *Padina* and is mostly found growing in rock-pools and heavy surf-exposed areas.

Specimen Examined: Karnataka: goolte, *Palanisamy & Yadav* 131277, 07.06.2015; onnahalli, *Palanisamy* 135051, 24.02.2016;

4. Padina tetrastromatica Hauck in Hedwigia 26: 43. 1887; J.N. Misra, Phaeophyceae India: 158, fig. 84. 1966; Untawale & al., List Mar. Alg. India: 21. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 113. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Palanisamy & al. in Seaweed Res. Utiln. 36 (1&2): 4. 2014; P.S.N. Rao & Gupta, Algae India 3: 23. 2015.

Thallus light to yellowish brown in colour, frondose, circular to fan shaped, 4.5-15 × 2-9 not calcified, tufted, epilithic. Holdfast small, thick, rhizomatous to bulbous, up to 6 mm across. Stipe stalked or flat, up to 3 cm long and 5 mm in diameter. Fronds fan or club shaped, fragile, surface membranous with alternate rows of microscopic hairs (piliferous zones) and glabrous surface, irregularly cleft into several broad lobes; lobes narrow in young stage, later become wide and divide up to base, individual lobes usually 2.5-8 cm long and 2-5 cm wide towards apex; base cuneate; margins entire to slightly wavy; apex usually obtuse with involute margins. *Microscopic*: Thallus usually 3-4-layered in upper region and 4-6-layered in basal region; cells of the superficial layer small, usually rectangular; cells in the centre comparatively large, rectangular to squarish, 40-90 µm across, thick walled, chromatophore content less. Thallus dioecious, reproductive bodies found in transverse rows on thallus surface, associated with paraphyses, compactly arranged; tetrasporangia develop in sori on both sides of piliferous zones of thallus, campact, spherical.**(Plate 24. f)**

Occurrence: Throughour the year. Common.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: uchila udupi district, *Palanisamy* 133377, 19.02.2016; St. Mary Island, Malpe, *Palanisamy* 133398, 20.02.2016; Madi-Bengre, *Palanisamy* 134934, 21.02.2016.

5. Spatoglossum Kuetz.

Thallus light-dark brown in colour, up to 30 cm long, foliaceous, irregularly branched, epilithic. Fronds leafy, without any midrib and veins, irregularly or pinnately branched, margins entire to slightly dentate. In cross section, thallus consists of single layered cortex and multilayered medulla. Reproductive parts associated with hairs, scattered over the surface; oogonia embedded, solitary, rarely in clusters; antheridia forming small sori, embedded across the frond margins.

Currently 20 taxa in world (Guiry & Guiry, 2017), 3 in India (Krishnamurthy & Baluswami, 2010) and 1 in Karnataka.

Spatoglossum asperum J. Agardh, Anal. Cont. 29(9): 36. 1894; J.N. Misra, Phaeophyceae India: 160. 1966; Untawale & al., Natl. Inst. Ocenogr., Goa, 40. 1983; K.S. Sriniv., Phycol. Ind.: 1: 33. 1969; Dhargalkar & al., Indian J. Mar. Sci.

9: 297. 1980; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 608. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 114. 2001; Nettar & Panikkar in J. Econ. Taxon. Bot. 28(1&2): 377. 2004; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 23. 2015.

Thallus light to dark brown in colour, up to 30 cm and 2.5 cm broad, frondose, flattened to ribbon shaped, epilithic. Holdfast small, rhizomatous, attached tightly on substratum. Stipe flat to foliose, sometimes stalked, margins slightly spinous. Fronds foliaceous, thin, usually 5-25 cm long, irregularly dichotomously branched or sub-divided into several broad lobes; surface usually glabrous, shining; base attenuate; margins entire to wavy or slightly dentate with several small proliferations; apical margins undulate or irregularly forked, irregular, young proliferations with obtuse dichotomy. *Microscopic*: Cryptostomata absent on thallus surface; cells in surface view usually rectangular or elongate; in cross section, mature thallus usually 200-300 µm thick in centre and up to 650 µm in basal region, multilayered, consisting of single superficial layer enclosing 3-5-layered medulla; superficial cells usually elongate or palisade like, 65-105 × 30-70 µm, thin walled, chromatophore content more; medullary cells large, tetra-hexa angular, isodiametric or elongate, scattered hair pits base originates in medullary region. Reproductive bodies scattered on both sides of the thallus surface, sterile towards margins; tetrasporangia usually globular to polygonal, solitary, embedded, 60-120 µm across. **(Plate 25. a)**

Occurrence: Throughout the year. Moderate.

Distribution: Karnataka: Udupi and Uttara Kannda districts. **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Mundoli beach (Bhatkal), *Palanisamy* 132401, 08.06.2015; Madi- Bengre, *Palanisamy* 134931, 21.02.2016; Shiroor coast, *Palanisamy & Yadav* 131129, 14.10.2014.

6. Stoechospermum Kuetz.

Thallus dark-yellowish brown in colour, up to 25 cm long, foliaceous, dichotomously branched, tufted, epilithic. Holdfast rhizomatous. Stipe stalked or narrowly frondose. Fronds foliaceous, surface rough with microscopic hairs, lateral margins entire-slightly undulate, upper margins involute. In cross section, thallus consists of two superficial cortical layers and multilayered medulla. Reproductive parts develop parallel to the margins, sporangia formed in longitudinal marginal sori.

Currently only 1 taxon in world (Guiry & Guiry, 2016), 1 in India (Krishnamurthy & Baluswami, 2010) and 1 in Karnataka.

Stoechospermum marginatum (C. Agardh) Kuetz., Phycol. General. 339. 1843; Untawale & al., Natl. Inst. Ocenogr., Goa, 40. 1983; K.S. Sriniv., Phycol. Ind.: 1: 32. 1969; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 11.1970; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 610. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 115. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 23. 2015.

Zonaria marginata C. Agardh, Syst. Alg.: 266. 1824.

Stoechospermum maculatum (J. Agardh) J. Agardh, Spec. Gen. Ord. Alg. 1: 99. 1848.

Thallus light to yellowish brown in colour, up to 15 (-20) cm and 1-4 cm broad, foliaceous, frondose, ribbon shaped, epilithic. Holdfast small, rhizomatous, attached firmly on calcareous rocks in shallow and intertidal zones. Stipe stalked, slightly flat, rough. Fronds foliose, flat, 5-15 cm long, regularly dichotomously branched into several broad lobes; lobes uniformly broad, strap like; surface rough, provided with microscopic hairs; margins entire to slightly undulate towards base; apex with median notch and regular dichotomy, obtuse, margins distinctly involute. *Microscopic*: Cells in surface view rectangular to squarish or elongate, irregularly arranged. In cross section, mature thallus multilayered, consisting of 2 superficial layers and 4-6 medullary layers; superficial cells small, usually rectangular-circular, thin walled; medullary cells large, rectangular. Reproductive bodies develop in sori parallelly along thallus margins, associated with paraphyses; antheridia cylindrical; oogonia club shaped or spathulate, 40-70 × 10-33 µm wide, covered with thick indusium; tetrasporangia subspherical. **(Plate 25. b)**

Occurrence: Usually Post-monsoon and summer seasons. Moderate.

Distribution: Karnataka: Udupi and Uttara Kannda districts. **India:** Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Notes: This is the type species of the genus *Stoechospermum* and is mainly found growing in heavy surf exposed areas in association with the species of *Padina* and *Sargassum*.

Specimen Examined: Karnataka: uchila udupi district, *Palanisamy* 133379, 19.02.2016; St. Mary Island, Malpe, *Palanisamy* 134904, 20.02.2016; Vannali beach, *Palanisamy & Yadav* 136207, 25.11.2016.

4. SCYTOSIPHONALES

SCYTOSIPHONACEAE

Colpomenia (Endl.) Derbes & Solier

Thallus yellowish brown in colour, up to 15 cm long, erect or prostrate, sac like, lithophilic. Holdfast usually discoid. Fronds spongy, globose, hollow.

Currently 13 taxa in world (Guiry & Guiry, 2016), 1 in India (Krishnamurthy & Baluswami, 2010) and 1 in Karnataka.

Colpomenia sinusa (G. Mertens ex Roth) Derbes & Solier, Castagne Suppl. Catal. 95. 1851; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 25. 2015.

Thallus yellowish brown in colour, up to 10 cm long, globular, hollow, irregularly lobed, surface rough, irregular. Holdfast small, discoid, loosely attached, occasionally free floating. Fronds spongy, composed of pibmented layers

of epidermis; apex acute or obtuse or irregular. *Microscopic*: Thallus multilayered, 5-6 layered. Reproductive bodies develop develop on epidermis; usually associated with paraphyses. **(Plate 25. c)**

Occurrence: Post-monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district (Tadri). **India:** Goa, Gujarat, Maharashtra, Nicobar Islands and Tamil Nadu.

Specimen Examined: Karnataka: Someshwar coast, *Palanisamy & Yadav* 136330, 28.11.2016.

5. FUCALES

SARGASSACEAE

Thallus light to dark brown in colour, variable in length, bushy, foliaceous, lithophilic, usually perennial. Holdfast rhizoidal to discoid or stoloniferous. Stipe stalked, hard, simple or branched. Fronds foliaceous with a cartilaginous or stalked main axis; branches cylindrical to terete or slightly compressed; Leaves usually elongate, midrib prominent, margins entire to serrate or dentate; air vesicles present, variable in shape and sizes; receptacles prominent, branched, monoecious or dioecious.

This family is represented by 2 genera in India as well as in Karnataka.

Key to genera

1a. Thallus large, primary axis profusely branched; leaves well developed with prominent midrib; vesicles distinct; receptacles found in the axil of leaves or vesicles **1. Sargassum**

1b. Thallus small, primary axis not profusely branched; leaves truncate or turbinate; vesicles indistinct, enclosed by leaves; receptacles found on the adaxial segments **2. Turbinaria**

1. **Sargassum** C. Agardh

Thallus light-dark brown in colour, up to 1 m long, perennial, bushy, tufted, foliaceous, erect or prostrate, lithophilic. Holdfast discoid or stoloniferous. Fronds bushy, consists of a main axis and several secondary branches; main axis long, cylindrical, terete, angular or slightly compressed, bearing radially or distichously arranged leaves; secondary branches small, variable in sizes, bears compressed to terete ramuli; leaves simple or various, midrib prominent, margins entire to wavy or dentate; air vesicles (bladders) present, variable in shape and sizes; monoecious or dioecious.

Currently *ca* 400 taxa in world (Yosida, 1988; Guiry & Guiry, 2017), 83 in India (Rao & Gupta, 2015) and 7 in Karnataka.

Key to species

1a. Leaves wedge shaped or ovate to slightly elongate; receptacles racemosely branched **2. S. cinereum**

1b. Leaves not wedge shaped, usually elongate, linear to lanceolate or variable; receptacles furcated or irregularly branched **2**

2a. Leaves turbinoid-spathulate; receptacles cymosely or irregularly clustered **3. S. cristaefolium**
2b. Leaves not turbinoid-spathulate; receptacles variously clustered **3**

3a. Leaves with entire or wavy-slightly serrate margins; vesicles spherical-ellipsoidal **4**
3b. Leaves with crenate to prominently dentate margins; vesicles round to oval or spherical **5**

4a. Leaves elongate or linear-lanceolate; margins wavy to lightly serrate; vesicles elliptical **5. S. swartzii**
4b. Leaves narrowly oblong-linear or lanceolate; entire to wavy or sinuate; vesicle spherical to ellipsoidal **7. S. wightii**

5a. Leaves coriaceous, thick with prominent midrib; vesicles round to spherical, obtuse to slightly mucronate **6. S. tenerrimum**
5b. Leaves usually thin, transparent; midrib prominent or inconspicuous; vesicles usually spherical, non mucronate **6**

6a. Leaves linear- lanceolate or slightly ovate; margins serrate to sparsely dentate; vesicles few **1. S. cinctum**
6b. Leaves linear to narrowly lanceolate; margins dentate to broadly toothed; vesicles numerous, spherical to oval **4. S. polycystum**

1. Sargassum cinctum J. Agardh, Spec. Gen. Ord. Alg.1: 324. 1848; K.S. Sriniv. in Phykos 5: 137. 1969; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.:14.1970; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 663. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.:127. 2001; P.S.N. Rao & Gupta, Algae India 3: 27. 2015.

Carpacanthus cinctus (J. Agardh) Martens, Tange Ost-Asean: 78. 1866.

Thallus dark brown in colour, 6-25 (-50) cm long, foliose, bushy, tufted, erect, epilithic. Holdfast discoid, up to 2 cm in diameter, rigid, firmly attached on rocky substrata in intertidal zones. Stipe stalked, simple or branched, terete, cylindrical to terete, slightly compressed towards apex, 1-3 mm wide, margins smooth or rough. Fronds well developed, differentiated into several primary and secondary branches; primary axis usually 5-25 cm long and 0.5-4 mm wide, glabrous, cylindrical to terete, slightly compressed near nodes towards apex; secondary branches several, develop alternately on primary branches, rarely subopposite, much crowded towards apex; leaves develop on secondary branches, rarely on primary axis in basal areas, linear- lanceolate or slightly ovate, 0.5-4 × 0.5 -1.5 cm, usually basal leaves smaller, thin, transparent or translucent, stalked or subsessile; stalk up to 2.5 mm and 1.5 mm wide; base cuneate or gradually tapering; surface usually smooth; midrib prominent towards base; margins serrate to sparsely dentate; dentation upward, much crowded towards apex, 150-350 × 190-260 µm; apex narrowly obtuse to round. *Microscopic*: Cryptostomata minute, spherical or oval, ostiolate with microscopic hairs. Air vesicles (bladders) and receptacles develop on lateral branches; vesicles oval to spherical, up to 5 mm across; receptacles axillary, irregularly branched, rough; apical dichotomy 140-470 × 305-350 µm. **(Plate 25. d)**

Occurrence: Summer and monsoon seasons. Moderate.

Distribution: Throughout Karnataka coast. **India:** Goa, Gujarat, Kerala and Tamil Nadu.

Specimen Examined: Karnataka: Madi- Bengre, *Palanisamy* 134935, 21.02.2016; Gorte, *Palanisamy* 134967, 22.02.2016; Vannali, *Palanisamy* 135053, 24.02.2016.

2. Sargassum cinereum J. Agardh, Spec. Gen. Ord. Alg. 1: 305. 1848; J.N. Misra, Phaeophyceae India: 233. 1966; Untawale & al., Natl. Inst. Ocenogr. Goa, 41. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 664. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 127. 2001; Jha & al., Seaweeds Gujarat: 89. 2009; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 27. 2015.

Thallus light-dark brown in colour, up to 40 cm long, bushy, foliose, tufted, erect, epilithic. Holdfast usually discoid, attached tightly on rocky substrata in lower intertidal zones. Stipe stalked, dark, wiry to terete, tufted, variable in length. Fronds well developed, stout, richly differentiated into the primary and secondary branches; primary branches usually 5-12 cm long and 0.5-3 mm wide, cylindrical to terete, slightly flattened towards apex and near nodes, producing several secondary lateral branches, radially or alternately organized, up to 6 cm long, densely and much crowded towards apex; leaves usually develop on primary laterals or sparsely on lower portion of the main axis in mature thallus, simple, wedge shaped, ovate, mature leaves slightly elongate or lanceolate in apical region, stalked; stalk cylindrical to flat; base slightly curved, cuneate; surface membranous, smooth, transparent or translucent; midrib distinct towards base and gradually disappearing towards apex; margins dentate to broadly serrate; apex round to broadly obtuse. *Microscopic*: Cryptostomata minute, irregularly scattered on both surfaces of leaves, spherical, ostiolate. Air vesicles (bladders) and receptacles always develop on lateral branches; vesicles spherical, 2-5 mm across, stalked, slightly mucronate; receptacles axillary, develop on lateral branches in the axil of leaves, cylindrical to slightly flat, racemosely and richly branched, rough; apical dichotomy 100-460 × 245-360 µm; apex usually round to obtuse.

(Plate 25. e)

Occurrence: Usually post-monsoon and summer seasons. Moderate.

Distribution: Karnataka: Udupi and Uttara Kannda districts. **India:** Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Om beach, *Palanisamy & Yadav* 135862, 24.11.2016; Paradise beach, *Palanisamy & Yadav* 135887, 24.11.2016; Talgode coast, *Palanisamy & Yadav* 136261, 26.11.2016.

3. Sargassum cristaefolium C. Agardh, Syst. Alg.: 1 (1): 13. 1820; J. N. Misra, Phaeophyceae India: 179. 1966; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 665. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 128. 2001; Panikkar

& Ampili in Seaweed Res. Utiln. 33(1&2): 15. 2011; P.S.N. Rao & Gupta, Algae India 3: 28. 2015.

Sargassum duplicatum Bory, Voy. Conquille: 127. 1828.

Sargassum ilicifolium (Turner) var. *duplicatum* J. Agardh, Spec. Gen. Ord. Alg. 1: 318. 1848.

Thallus dark brown in colour, up to 40 cm long, bushy, foliose, tufted, erect, occasionally calcified in basal portion, epilithic. Holdfast discoid, large, 1-2.5 mm wide, attached tightly on rocky substrata in lower intertidal zones. Stipe or main axis stalked, dark, cylindrical to terete, tufted, up to 2 cm long and 1-3 mm wide, rough. Fronds well developed, bushy, differentiated into several primary and secondary branches; primary branches up to 35 cm long, cylindrical to terete, slightly flattened, glabrous; secondary branches cylindrical or terete, 2-10 cm long, ultimate branches small, leaves develop on lateral branches, simple, thick, turbinoid-spathulate or oblong to elliptical, stalked or subsessile; base cuneate; surface coriaceous, rough; midrib distinct in basal region, gradually disappearing towards apex; margins irregularly dentate to broadly serrate; apex round to broadly obtuse. *Microscopic*: Cryptostomata minute, very few, irregularly scattered on both surfaces of leaves. Air vesicles and receptacles always develop on lateral branches; vesicles spherical or subspherical, 3-5 mm across, stalked with a cylindrical base and gradually flattened upwards, apex rounded to apiculate, lateral wings present on both sides; receptacles develop on lateral branches in the axil of leaves, slightly flat.

Occurrence: Summer and monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district. **India:** Andaman & Nicobar Islands, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Species Examined: Karnataka: Serikuli, *Palanisamy* 135209, 25.02.2016, St. Mary Island, Malpe, *Palanisamy & Yadav* 135602, 26.08.2016

4. Sargassum polycystum C. Agardh, Syst. Alg.: 304. 1824; J. N. Misra, Phaeophyceae India: 182. 1966; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 14.1970; K.S. Sriniv., Phycol.Ind. 2: 26. 1973; Kaliap. & al. in Seaweed Res. Utiln. 18: 85. 1996; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 694. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 136. 2001; P.S.N. Rao & Gupta, Algae India 3: 30. 2015.

Sargassum ambiguum Sond. in Abh. Naturwiss. Ver Hamburg 5(2): 41. 1871.

Thallus light-dark brown in colour, usually 10-30 (-60) cm long, bushy, tufted, erect, epilithic. Holdfast rhizoidal or discoid, up to 1.2 cm wide, attached tightly on rocky substrata in lower intertidal zones, occasionally secondary holdfast develops in mature thallus. Stipe or main axis stalked, dark, wiry, cylindrical to terete, rough, usually calcified. Fronds well developed, bushy, stout, differentiated into several primary and secondary lateral branches; primary branches cylindrical to terete, often muricated towards base; secondary branches several, alternately

or spirally arranged, 4-10 cm long, alternate, densely crowded towards apex; leaves simple, develop directly on primary laterals, small, linear to narrowly lanceolate, 0.5-4 × 0.4-1.5 cm wide, usually alternate or radially arranged, thin, membranous, stalked; base cuneate to narrowly tapering; surface usually smooth; midrib distinct towards base, gradually vanishing towards apex; margins dentate to broadly toothed, dentation straight or turning upwards; apex narrowly acute to obtuse. *Microscopic*: Cryptostomata minute, irregularly scattered on both surfaces of leaves and air vesicles, spherical to slightly elongate, 145-350 µm across, ostiolate with hairs. Air vesicles (bladders) and receptacles develop on lateral branches; vesicles numerous, spherical to oval, small, 1-5 × 0.8-3.5 mm across, not mucronate, stalked; stalk terete, surface with distinct cryptostomata, occasionally porous; receptacles richly branched, forming racemose clusters, axillary, rigid, linear or elongate, slightly compressed, dioecious, up to 1.5 cm long and 1.2 cm wide.

Occurrence: Summer and monsoon season. Rare.

Distribution: Karnataka: Dakshina Kannada and Udupi districts. **India:** Andhra Pradesh, Goa, Kerala and Tamil Nadu.

Specimen Examined: Karnataka: surathkal, *Palanisamy* 133360, 18.02.2016; St. Mary Island, Malpe, *Palanisamy* 133394, 20.02.2016.

5. Sargassum swartzii C. Agardh, Syst. Alg.: 1: 120. 1820; V. Krishnam. & H.V.Joshi, Checkl. Ind. Mar. Alg.: 15.1970; Untawale & al., List Mar. Alg. India: 23. 1983; Chennubhotla & al. in Bull. Centr. Mar. Fish. Res. Inst., 41: 10. 1987; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 700. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 138. 2001; P.S.N. Rao & Gupta, Algae India 3: 31. 2015.

Thallus dark brown in colour, 10-50 cm long, bushy, tufted, profusely branched, epilithic. Holdfast discoid, 0.5-2 mm wide, attached tightly on rocky substrata. Stipe stalked, dark, cylindrical-terete, 0.8-2.5 mm wide, rough, stout. Fronds well developed, profusely branched into several primary and secondary lateral branches; primary branches cylindrical to terete or slightly compressed, usually 8-45 long; secondary branches several, usually distichous, cylindrical to compressed, 5-12 cm long, usually densely crowded towards apex, distance between the branches 1-3 cm, bearing leaves, vesicles and receptacles; leaves simple, elongated, linear-lanceolate, 5-8 × 0.3-1.2 cm, alternate, leaves towards apex usually larger, subsessile to stalked, base cuneate; surface thick, coriaceous; midrib distinct towards apex; margins wavy to lightly serrate; apex narrowly acute to obtuse. *Microscopic*: Cryptostomata present, few, minute, irregularly scattered in one row on leaf surface, 45-190 µm across. Air vesicles (bladders) and receptacles develop on secondary branches; vesicles simple, elliptical in outline, 2-8 × 1.5-6 mm across, stalked; stalk terete; apex usually round in young vesicles, distinctly pointed in mature one; Receptacles axillary, branched, clustered, rigid with rough to slightly dentate margins, terete or oblong-linear, up to 1.5 cm long and 2 mm wide.

Occurrence: Summar season. Rare.

Distribution: Karnataka: Uttara Kannda district (Talgode, Om beach). **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Talgode, *Palanisamy* 135015, 23.02.2016.

6. Sargassum tenerrimum J. Agardh, Spec. Gen. Ord. Alg. 1: 305. 1848; Kaliap. & al. in Seaweed Res. Utiln. 20(1&2): 141. 1998; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 702. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 139. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 31. 2015.

Thallus yellowish-dark brown in colour, up to 30 (50) cm long, bushy, tufted, erect in young stage, epilithic. Holdfast discoid, rigid, firmly attached on rocky substrata in intertidal zones. Stipe stalked, stout, simple or branched, cylindrical to terete. Fronds well developed, stout, primary branches 10-20 cm long and 0.5-4 mm wide, glabrous, cylindrical towards base and terete to compressed towards apex, bearing several secondary branches in upper region; secondary branches cylindrical or terete to compressed, usually alternate to radial; leaves develop on primary as well as on secondary branches, linear-lanceolate, 1.5-8 × 0.2-1.4 cm, alternate, usually large towards base and gradually become smaller towards apex, sometimes irregular, stalked or subsessile; base cuneate; surface usually smooth, thick, coriaceous; midrib prominent, thick towards base, occasionally inconspicuous; margins sinuate or dentate, wavy in young stage, dentation towardsapex; apex acute to narrowly obtuse. *Microscopic*: Cryptostomata minute, spherical to slightly elongate, 240-520 µm across, irregularly scattered on both sides of the midrib and air vesicles, ostiolate. Air vesicles (bladders) and receptacles on secondary branches in the axil of leaves; vesicles stalked, round to spherical, 3-6 × 2.5-5.5 mm across; apex obtuse to slightly mucronate; stalk 2-5 mm long and 500-980 µm wide; receptacles axillary, profusely branched at maturity, rigid, spinose, rough, linear or elongate, monoecious or dioecious; conceptacles dioecious.

(Plate 25. f)

Occurrence: Usuall monsoon and post-monsoon seasons. Moderate.

Distribution: **Karnataka**: Udupi (St. Mary's island) and Uttara Kannda (Majali and Harwada) districts. **India**: Andaman Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: St. Mary Island, Malpe, *Palanisamy & Yadav* 131092, 12.10.2014; Ukursia Island, Harwada, *Palanisamy & Yadav* 131212, 18.10.2014; Majali coast, *Palanisamy* 135093, 27.02.2016.

7. Sargassum wightii Grev. in J. Agardh, Spec. Gen. Ord. Alg. 1: 329. 1848; M.U. Rao in Bull. Centr. Mar. Fish. Res. Inst. 9: 42.1969; K.S.Sriniv., Phycol. Ind.: 2: 28. 1973; Untawale & al., List Mar. Alg. India: 23. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 633. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 141. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 31. 2015.

Thallus dark brown in colour, usually 10-30 cm long, erect, epilithic. Holdfast discoid, 1-3.4 mm wide, stout, occasionally calcified, firmly attached. Stipe stalked, cylindrical to terete, 1-3 mm wide, rough, occasionally calcified in older thallus. Fronds well developed, forming bushy appearance, differentiated into primary and secondary branches; primary branches cylindrical-terete, 5-25 cm long and 1.5-5 mm wide, usually glabrous; secondary branches cylindrical or terete, occasionally slightly compressed in upper region, alternately arranged; leaves develop on primary as well as on secondary branches, narrowly oblong-linear or lanceolate, 2.3-8.4 × 0.6-12 cm, alternate, stalked or subsessile; stalk up to 2 mm long; base cuneate; surface glabrous or rough, thick; midrib usually inconspicuous; margins entire to wavy or sinuate; apex broadly acute. *Microscopic*: Cryptostomata very few, usually spherical, 200-390 µm across, irregularly scattered on both surfaces of leaves. Air vesicles and receptacles develop separately on secondary branches; vesicles stalked, spherical to ellipsoidal, 4-8 × 3-5 mm across; apex apiculate; stalk up to 3.4 mm long and 1 mm wide; receptacles axillary, richly branched, rigid, cylindrical to slightly compressed; conceptacles distinct, both male and female conceptacles develop on separate receptacles.

Occurrence: Monsoon season. Rare.

Distribution: Karnataka: Udupi district (St. Mary's island and Someshwar temple area). **India:** Andaman & Nicobar Islands, Andhra Pradesh, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: St. Mary Island, Malpe, *Palanisamy* 133396, 20.02.2016; Someshwar temple, *Palanisamy* 134949, 21.02.2016.

2. Turbinaria J.V. Lamour.

Thallus dark-brown in colour, bushy, up to 25 cm long, lithophilic. Holdfast fibrous, firmly attached. Stipe stalked, simple or branched. Fronds stalked, supported by unbranched laterals and wedge shaped or truncate leaves. Air bladders (vesicles) hollow. Receptacles dendroid, develop on fertile laterals in axillary position; conceptacles monoecious with small clusters of antheridia and oogonia.

Currently 30 taxa in world (Guiry & Guiry, 2017), 13 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Turbinaria ornata (Turner) J. Agardh, Spec. Gen. Ord. Alg. 1: 266. 1848; V. Krishnam. & H.V. Joshi, Checkl. Ind. Mar. Alg.: 15. 1970; Untawale & al., List Mar. Alg. India: 24. 1983; Kaliap. & al. in Seaweed Res. Utiln. 14: 123. 1992; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 714. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 144. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 32. 2015. *Fucus turbinatus* L. var. *ornata* Turner, Fuci. 1: 50. 1807.

Sargassum turbinatum var. *ornatum* (Turner) C. Agardh, Icons Alg.: 42. 1821.

Thallus light-dark brown in colour, large, usually 8-20 (-40 cm) long, tufted, stalked, bushy, erect, epilithic, mature thallus occasionally epiphytised by other

corallinaceous algae. Holdfast fibrous, coarsely branched, up to 6 mm wide, attached firmly on rocky substratum in lower intertidal zones, occasionally found offshore. Stipe stalked, cylindrical or terete, rough, usually develop solitary or in group from the holdfast. Fronds well developed, consists of a main axis and several laterals; main axis stalked, simple or rarely branched, usually 8-15 cm long and 3-5 mm thick, cylindrical or terete, rough, basal portion bearing short stumps of shaded laterals, upper portion densely branched; lateral branches turbinate, clumped, up to 2 cm long; leaves alternate or radially arranged, turbinate, thick, coriaceous, surface smooth, enclosing a centrally immersed vesicle, midrib inconspicuous; margins coarsely dentate, dentation 350-900 × 500-900 µm, sometimes slightly curved. *Microscopic*: Cryptostomata minute, irregularly distributed on main axis, leaves and air vesicles, usually spherical, ostiolate. Air vesicles (bladders) and receptacles always develop separately; vesicles immersed in central upper part of the leaves, solitary, spherical in outline, up to 4 mm across; receptacles develop on stalk in the axil of upper laterals, up to 1 cm long, cylindrical or terete; conceptacles monoecious, ostiolate.

Occurrence: Usually post-monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district. **India:** Andaman & Nicobar Islands, Gujarat, Kerala, Lakshadweep Islands and Tamil Nadu.

Uses: It is one of the economically important seaweeds and is harvested along with *Sargassum* for the production of alginate (Jha & al., 2009).

Note: This species has been included here based on the report by Ambiye & Untawale (1991). However, it was not being collected freshly during our survey

CLASS: RHODOPHYCEAE

Under the class Rhodophyceae, 16 orders are represented in India (Oza & Zaidi, 2001), of which 10 are available in Karnataka coast. Therefore, key to the orders, which are represented in Karnataka, is given below.

Key to orders

1a.	Thallus foliose, filamentous or membranous; cells with stellate chromatophores, protoplasmic connection absent	**Bangiales**
1b.	Thallus filamentous–complex, often massive forms, protoplasmic connection present	**2**
2a.	Auxilliary cells absent	**3**
2b.	Auxilliary cells present	**5**
3a.	Gonimoblast filaments intermingled with nutritive filaments	**Gelidiales**
3b.	Gonimoblast filaments usually not intermingled with nutritive filaments, develop directly from the fertilized carpogonium or rarely from the hypogynous cell	**4**
4a.	Central axial cell not visible in the pseudoparenchymatous thallus, carpogonial branches 2-celled	**Gracilariales**
4b.	Central axial cell visible in the pseudoparenchymatous thallus, carpogonial branches3-celled	**Bonnemaisoniales**

5a.	Auxiliary cell formed only after fertilization	**Ceramiales**
5b.	Auxiliary cell formed before fertilization	**6**
6b.	Thallus usually calcified, tetrasporangia develop in conceptacles	**Corallinales**
6b.	Thallus usually not calcified, tetrasporangia do not develop in conceptacles	**7**
7a.	Auxiliary cells formed in special accessory branches	**Cryptonemiales**
7b.	Auxiliary cells not formed in special accessory branches or branch clusters	**8**
8a.	Cells formed from the supporting cell of a carpogonial branch acts as the auxiliary cell	**Rhodymeniales**
8b.	Intercalary cells of a vegetative filament act as the auxiliary cell	**9**
9b.	Pit pluds always membranous, spermatangial sori large, gonimoblast filaments develop in upward or downward directions	**Gigartinales**
9b.	Pit pluds always naked, spermatangial sori small, gonimoblast filaments develop in upward direction only	**Ahnfeltiales**

1.BANGIALES

BANGIACEAE

Thallus light to pinkish or dark red in colour, filamentous or foliaceous, simple, branched or membranous, fragile, mucilaginous, epiphytic. Cells with central stellate chromatophores.

This family is represented by 2 genera in India and 1 genus in Karnataka

Porphyra C. Agardh

Thallus dark-pinkish red in colour, up to 20 cm long, membranous, mucilaginous, mono-di-stromatic, usually epilithic. Fronds undifferentiated, foliaceous, surface smooth, margins entire to lacinate, with or without microscopic spinous outgrowths. Cells with 1-2 stellate chloroplasts.

Currently 79 taxa in world (Guiry & Guiry, 2017), 10 in India (Rao & Gupta, 2015; Kavale & al., 2015) and 2 in Karnataka.

Key to species

1a.	Thallus usually simple, linear to lanceolate, large, up to 25 cm; carpospores 16, spermatangia 128	**1. P. kanyakumariensis**
1b.	Thallus usually lobed, up to 7 cm long; carpospores 8	**2. P. vietnamensis**

1. Porphyra kanyakumariensis V. Krishnam. & Baluswami in Seaweed Res. Utiln. 7(1): 35. 1984; Nair & al. in Biol. Sci. 52: 738. 1986b; Chennubhotla & al. in Seaweed Res. Utiln. 13(1): 2. 1990; Desikachary & al., Rhodophyta, 2 (2A): 37. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 92. 1996; P.S.N. Rao & Gupta, Algae India 3: 34. 2015.

Thallus dark-pinkish red in colour, foleaceous, flat, 5-25 × 2-8 cm, membranous, fragile, mucilaginous, monostromatic, epilithic. Holdfast minute, discoid, loosely attached on rocky substrata in surf-exposed areas. Stipe small, stalked or subsessile. Fronds membranous, linear or lanceolate; surface smooth, slippery with reticulate orientations; margins entire to deeply laciniate with a

number of unicellular microscopic spinulose processes; apex acute or obtuse. *Microscopic*: Cells in surface view spherical to polygonal, thick walled, irregularly arranged, forming a reticulate structure. Cells with single stellate chromatophore. Reproductive structures develop on thallus surface, monoecious; fertile areas lightly coloured. **(Plate 26.a)**

Occurrence: Post-monsoon season. Moderate.

Distribution: **Karnataka**: Udupi (Someshwar Temple area) and Uttara Kannda (Mundoli, Uppandar, Madiyendri, Vannali, Tadri, Belekeri, Harwada-Tarangamett, Karwar and Majali) districts. **India**: Kerala and Tamil Nadu.

Specimen Examined: Karnataka: Karwar *Palanisamy & Yadav* 135778, 31.08.2016.

2. Porphyra vietnamensis Tuy. Tanaka & P.H. Ho in Mem. Fac. Fish. Kagoshima Univ. 11: 34, figs 10, 11. 1961; V. Krishnam. & Baluswami in Seaweed Res. Utiln. 7(1): 34. 1984; Desikachary & al., Rhodophyta, 2 (2A): 36. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 94. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.:4. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 126. 2011; P.S.N. Rao & Gupta, Algae India 3: 34. 2015.

Thallus light-dark purple red in colour, foliaceous, 2-7 × 0.5-4 cm, membranous, transparent, fragile, mucilaginous, epilithic. Holdfast minute, discoid, loosely attached on rocky substrata in surf-exposed areas. Stipe minute, usually stalked or slightly flattened, occasionally (sub) sessile. Fronds membranous, usually lobed into 2-6 parts, sometimes simple; lobes usually lobed, linear- lanceolate; surface smooth, slippery; base cordate to ovate; margins usually undulate, dentate with frequent microscopic spinulose processes; apex round to obtuse. *Microscopic*: Cells in surface view usually spherical to elongate or polygonal, 12-20 µm across, thick walled, compactly arranged; spinulose processes 10-20 × 8-12 µm. In cross section, thallus monostromatic, 18-25 µm thick in vegetative portions and up to 36 µm thick in fertile portions; heavily mucilaginous; cells usually elongate to spherical, 12-20 × 6-15 µm, thick walled, usually sparsely arranged. Cells with single chromatophore; chromatophores substallate with a central pyrenoid. Reproductive structures develop on thallus surface, fertile areas lightly coloured, distinctly arranged; spermatangia develop in patches near the margins; spermatia 64, arranged in 4 tiers.

Occurrence: Throughout the year. Common.

Distribution: **Karnataka**: Dakshina Kannada(Ullal, Someshwar ,Surathkal), Udupi (Malpe Beach ,St Mary's Island) and Uttara Kannda (Gorte ,Karwar Talgode and Majali) districts. **India**: Andhra Pradesh, Goa, Kerala and Tamil Nadu.

Specimen Examined : Karnataka: Gorte, *Palanisamy* 133228, 20.09.2015; Talgode, *Palanisamy* 133244, 21.09.2015.

2. AHNFELTIALES

AHNFELTIACEAE

Thallus dark-blackish red in colour, tufted, bushy, up to 10 cm long, erect, lithophilic, attached firmly with discoidal holdfast. Fronds terete, cylindrical or slightly compressed, repeatedly dichotomously branched with acute apices. Anatomically, thallus consists of compactly arranged moniliform cortical cells and oval to spherical medullary cells, pit connections lack any cap membranes. It is a monogeneric family and present in India as well as in Karnataka.

Ahnfeltia Fr.

Generic characters are similar to family characters.

Currently 10 taxa in world (Guiry & Guiry, 2017), 1 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Ahnfeltia plicata (Huds.) Fr., Fl. Scan., 1: 310. 1835; Untawale & al., List Mar. Alg. India: 40. 1983; Desikachary & al., Rhodophyta 2 (2B): 161. 1998; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 131. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 14. 2001; Palanisamy & al. in Thahira Banu & Keishing (eds): Therap. Mar. Bioact. Comp.: 21. 2015; P.S.N. Rao & Gupta, Algae India 3: 38. 2015.

Fucus plicata Huds., Flora Angl. 470. 1762.

Thallus dark-reddish purple in colour, becomes blackish red after drying, bushy, wiry, tufted, corymbose, 2-10 cm long, epilithic. Holdfast small, discoid, up to 3.2 mm in diameter, firmly attached. Stipe erect, stalked, cylindrical to terete or compressed, up to 1.5 cm long. Fronds erect, usually cylindrical-terete towards base and distinctly compressed towards apex; usually dichotomously branched and giving corymbose appearance; surface smooth; margins entire, slightly swollen below dichotomy; apex with equal dichotomy, usually obtuse to round, occasionally acute. *Microscopic*: Cells in surface view usually spherical to round, 20-30 µm across, thick walled, sparsely arranged. In cross section, thallus multilayered; thallus differentiated into cortex and medulla cells; cortex cells small, spherical to moniliferous, compact; medulla cells large, oval to slightly elongate, sparsely arranged. Tetrasporophytic plant usually associated with the gametophytes.

Occurrence: Monsoon Post - Monsoon seasons. Rare.

Distribution: Karnataka Uttarkanada District (Sedekuli,Oyingi Beach, Ramangindy coast **India**: Goa, Gujarat and Maharashtra.

Specimen Examined : Karnataka: Oyingi beach, *Palanisamy & Yadav* 131187, 15.10.2014; Ramangindy coast, *Palanisamy & Yadav* 131192, 16.10.2014; Sirikuli beach, *Palanisamy & Yadav* 131205, 17.10.2014.

2. GELIDIALES

Key to families

1a. Fronds usually flat or compressed; medullary tissue with rhizoids **1. Gelidiaceae**
1b. Fronds usually cylindrical or terete; medullary tissue without rhizoids **2. Gelidiellaceae**

1. GELIDIACEAE

Thallus light to dark purple red in colour, flat or compressed, bushy, cartilaginous, tufted, prostrate or erect, epilithic. Fronds pinnately or irregularly branched, often distichous. Anatomically, medullary cells contain rhizoids or hyphae.

This family is represented by 2 genera in India and 1 genus in Karnataka.

Gelidium J.V. Lamour.

Thallus dark-purple red in colour, erect, up to 15 (-20) cm long, cartilaginous, lithophilic. Fronds compressed or flattened, pinnately or irregularly branched with several branchlets; margins irregularly branched. Anatomically, thallus uniaxial, consisting of compactly arranged cortex and large medullary cells. Carpogonial branches united in sori near branch apices or proliferations.

Currently 131 taxa in world (Guiry & Guiry, 2017), 9 in India (Rao & Gupta, 2015) and 2 species in Karnataka.

Key to species

1a. Thallus purple-dark red in color, large, 3-6 cm long **1. G. micropterum**
1b. Thallus dark red in color, small, less than 2 cm long **2. G. pusillum**

1. Gelidium micropterum Kuetz., Tab. Phycol. 18: 21. 1868; Untawale & al., List Mar. Alg. India: 28. 1983; Desikachary & al., Rhodophyta, 2 (2A): 195. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 139. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 15. 2001; Palanisamy& al. in Seaweed Res. Utiln. 35(1&2): 25. 2013; P.S.N. Rao & Gupta, Algae India 3: 38. 2015.

Thallus dark-purple red in colour, flattened, tufted, erect, cartilaginous, 2-6 cm long, epilithic. Holdfast small, rhizoidal, branched, up to 1.5 mm long and 0.2 mm wide, firmly attached on calcareous stones and bedrocks in tidal and intertidal regions. Stipe small, flat, rarely cylindrical. Fronds erect, flattened more in middle portion and gradually narrowing towards both ends, profusely branched; branches irregular, pinnate, flattened, 2-5 cm long and 0.3-2.5 mm wide; pinnules usually develop marginally in opposite or irregular fashion, dense in middle and upper portion, thick, flat to slightly slender in shape, sometimes spathulae, up to 5 mm long and 1 mm wide; surface smooth; margins entire in lower portion and wavy to truncate or irregular in upper portion; apex acute or obtuse, occasionally irregularly forked, fertile tip usually blunt. *Microscopic*: Cells in surface view usually spherical, 7-11 µm across, thick walled; cells sparsely arranged. In cross section, thallus up to 170 µm thick, multilayered, differentiated into outer cortical

layers and central medulla layers. Tetrasporangia develop on swollen fertile tips of fronds; sporangia ovoid - subspherical, up to 36 µm across. **(Plate 26. b)**

Occurrence: Throughout the year. Common.

Distribution: Throughout Karnataka coast. **India**: Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined : Karnataka: Belekeri coast, *Palanisamy & Yadav* 131208, 18.10.2014; Someshwar coast, *Palanisamy & Yadav* 131227, 04.06.2015; surathkal, *Palanisamy & Yadav* 131248, 05.06.2015.

2. Gelidium pusillum (Stackh.) Le Jolis in Mem. Soc. Imp. Sci. Nat. Cherbourg 10: 139. 1863; Desikachary & al., Rhodophyta, 2 (2A): 197. 1990; Sindhu & Panikkar in Seaweed Res. Utiln. 14: 122. 1992; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 140. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 16. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 38. 2015.

Fucus pusillm Stackh., Nereis Brit. 1: Pls. 1-8. 1795.

Thallus dark red in colour, flattened, tufted, erect, cartilaginous, small, 1-3 cm long, epilithic. Holdfast very minute, rhizoidal or stoloniferous, branched, firmly attached on calcareous stones and bedrocks in tidal and intertidal regions. Stipe small, flat, up to 3 mm long and 0.4 mm wide. Fronds erect, terete in lower portion and flattened in middle, gradually narrowing towards both ends, profusely branched in upper region; branches irregular, pinnate, flattened; pinnules develop marginally in opposite or irregular fashion, thick, tufted, usually truncate to slightly flat, up to 3 mm long and 1 cm wide; surface smooth; margins entire or truncate or irregular; apex acute or obtuse; fertile tip blunt or rounded. *Microscopic*: Cells in surface view round- spherical. In cross section, thallus up to 155 µm thick, multilayered, differentiated into outer cortical layers and central medulla layers. Tetrasporangia develop on sori, usually found near the fertile tips of fronds; sporangia ovoid-subspherical. **(Plate 26. c)**

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: Karnataka: Dakshina Kannada, Udupi and Uttara Kannda districts. **India:** Andaman Islands, Andhra Pradesh, Goa, Gujarat, Kerala Maharashtra, Tamil Nadu and West Bengal.

Specimen Examined : Karnataka : Mundoli, *Palanisamy* 133234, 21.09.2015; Talgode, *Palanisamy* 133241, 21.09.2015; Peribail, *Palanisamy & Yadav* 135232, 24.08.2016.

2. GELIDIELLACEAE

Thallus light to dark red in colour, erect, up to 15 cm long, cartilaginous, erect, epilithic. Holdfast rhizomatous or discoid, creeping. Fronds cylindrical-terete or flattened, erect, tufted, irregularly or pinnately divided into several branchlets.

It is a monogeneric family and present in India and rnataka.

Gelidiella Feldmann &Hamel

Generic characters are similar to family characters.

Currently 16 taxa in world (Guiry & Guiry, 2017), 6 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Gelidiella acerosa (Forssk.) Feldmann & Hamel in Rev. Gen. Bot. 46: 529. 1934; Untawale & al., List Mar. Alg. India: 28. 1983; Desikachary & al., Rhodophyta, 2 (2A): 205. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 147. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 17. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Yadav & al. in Elix. Biosci. 82: 32149. 2015; P.S.N. Rao & Gupta, Algae India 3: 39. 2015.

Fucus acerosus Forssk., Fl. Aegypt.-Arab.: 190. 1775.

Thallus light-dark brownish red in colour, cylindrical to terete, wiry, flexible, cartilaginous, up to 15 cm long, densely caespitose, creeping or erect, epilithic. Holdfast small, rhizoidal, branched, arising from the creeping stolons, attached firmly on rocks in surf-exposed areas in intertidal regions. Stipe stalked, cylindrical, up to 1.8 cm long and 0.6-4 mm wide. Fronds erect, cylindrical to terete, slightly compressed towards apex, up to 8 cm long and 1-3.5 mm wide, profusely branched in middle and upper portions, older branches often naked towards apex; branches usually regularly pinnate or bipinnate, rigid; pinnules usually develop in opposite or irregular fashion, cylindrical, surface usually rough or smooth; margins entire; apex acute or bluntly obtuse. *Microscopic*: In cross section, thallus multilayered, differentiated into outer cortical layers and central medulla layers; cortex cells round, oval or spherical, 5-8 µm across, dark pigmented, compact; medulla cells large, usually circular to slightly elongate, 20-35 µm in diameter, loosely packed. Tetrasporangia develop in sori mainly on swollen fertile tip of pinnules.

Occurrence: Monsoom season. Rare.

Distribution: Karnataka: UttarKannada District (Majali Near Goa Border) India: Andaman Islands, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: It is the type species of the genus *Gelidiella.* It is a pantropical species (Coppejans & al., 2009) and is usually found growing in shallow water pools, exposed to frequent waves.

Specimen Examined : Karnataka : Majali (Near Goa Border), *Palanisamy & Yadav* 135800, 31.08.2016.

4. GRACILARIALES
GRACILARIACEAE

Thallus light to dark or purple red in colour, cylindrical to terete or compressed, variable in length, irregularly or dichotomously branched, usually cartilaginous, tufted, erect or prostrate. Growth apical or by marginal meristem. Anatomically, thallus differentiated into densely packed cortical cells and internal medullary cells.

This family is represented by 2 genera in India and 1 genus in Karnataka.

Gracilaria Grev.

Thallus dark-pinkish red in colour, cylindrical-terete or flattened, up to 60 cm long, erect to prostrate, cartilaginous, lithophilic. Fronds irregularly or dichotomously branched, occasionally alternate or lateral; margins entire to proliferated. Anatomicall, thallus multilayered, consisting of cortex and medullary cells. Thallus mono- or dioecious.

Currently 186 taxa in world (Guiry & Guiry, 2017), 35 in India (Rao & Gupta, 2015) and 5 in Karnataka.

Key to species

1a.	Fronds terete or cylindrical, irregularly branched	**2**
1b.	Fronds flat, foliose, dichotomously branched	**4**
2a.	Thallus small, up to 16 cm long, irregularly branched	**4. G. salicornia**
2a.	Thallus large, up to 1 m long, irregularly and profusel branched	**3**
3a.	Fronds almost uniformaly cylindrical, up to 1 m long and uniformly thin throughout	**5. G. verrucosa**
3b.	Fronds slightly compressed at the branching points and gradually narrower towards apex, up to 15 vm long	**2. G. edulis**
4a.	Fronds uniformaly flattened regualrly dichotomous branched, fronds without laciniate end & Proliferous infrequent	**1. G. corticata**
4b.	Fronds irregularly flattened, regularly or irregularly branched and towards apex, fronds with laciniate or pointed end	**3. G. foliifera**

1. Gracilaria corticata (J. Agardh) J. Agardh, Spec. Gen. Ord. Alg. 2 (2): 602. 1852; Dhargalkar & al. in Indian J. Mar. Sci. 9: 297. 1980; Untawale & al., List Mar. Alg. India: 32. 1983; Desikachary & al., Rhodophyta 2 (2B): 122. 1998; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Palanisamy & al. in Seaweed Res. Utiln. 36(1&2): 4. 2014; P.S.N. Rao & Gupta, Algae India 3: 40. 2015.

Rhodymenia corticata J. Agardh in Linnaea, 15: 14. 1841.

Thallus light-dark brownish or yellowish red in colour, flattened, up to 20 cm long, bushy, tufted, cartilaginous, rigid, epilithic. Holdfast small, discoid, up to 5 mm in diameter, firmly attached on rocky substrata in tidal and intertidal areas. Stipe flattened, rigid. Fronds cartilaginous, flattened to slightly cylindrical, up to 20 cm long and 5 mm wide; regularly dichotomously branched with narrow segments; surface usually smooth; margins entire; apex mostly acute to narrowly obtuse, rarely proliferated. *Microscopic*: Cells in surface view usually spherical to polygonal, 3-10 µm across, thick walled, sparsely arranged. In cross section, thallus up to 0.6-2 mm thick, multilayered, differentiated into outer cortical layers and central medulla layers. Spermatangia develop in cavity like structures, 450-530 µm across. Carpogonial system consists of basal supporting cells, a 2-celled

carpogonial branch and 1-2-celled sterile branches. Cystocarps hemispherical, protruded externally, 0.5-1.5 mm across constricted towards base.**(Plate 26. d)**

Specimen Examined: Karnataka: Uchila Udupi district , *Palanisamy & Yadav* 131263, 05.06.2015; kapu beach, *Palanisamy & Yadav* 131267, 05.06.2015, goolte , *Palanisamy & Yadav* 131293, 07.06.2015.

Key to varieties

1a. Fronds uniformly flatted, cartilagenosu, branching regualrly dichotomous **1a.** var. **corticata**

1b. Fronds flat below and cylindrical-subterete upwards, branches sparse below and dense above, dichotomous, rarely irregular **1b.** var. **cylindrica**

1a. Gracilaria corticata (J. Agardh) J. Agardh var. **corticata**

Characters as above.

Occurrence: Throughout the year. Common.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Karnataka, Maharashtra and Tamil Nadu.

1b. Gracilaria corticata (J. Agardh) J. Agardh var. **cylindrica** M.U. Rao in J. Mar. Biol. Assoc. India. 14: 678, figs. 2 C-D; pl. 1: C, E. 1974; Kaliaperumal & al., Seaweed Res. Utiln., 15(1&2): 191. 1992; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 162. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 24. 2001; Jha & al., Seaweeds Gujarat: 117. 2009; P.S.N. Rao & Gupta, Algae India 3: 40. 2015.

Thallus dark to yellowish red in colour, 4-15 cm long, bushy, tufted, cartilaginous, rigid, epilithic. Holdfast small, discoid, firmly attached on rocky substrata in intertidal zones. Stipe flatterned to slightly terete, rigid, 0.4-1.4 mm wide. Fronds flattened below and gradually become cylindrical to subterete upwards, alternately or irregularly dichotomously branched; branches usually sparse below and dense towards apex; margins entire; apex acute or narrowly pointed. **(Plate 26. e)**

Occurrence: Summer season. Rare.

Distribution Dakshina Kannada (Ullal, Someshwar coast, Surathkal beach), Udupi (Uchila, Padubidri, Gorte coast) and Uttara Kannda districts (Shiroor coast, Majali coast, Karwar). **India:** Andaman & Nicobar Islands, Gujarat, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Shiroor coast, *Palanisamy & Yadav* 131123, 14.10.2014; Golte coast, *Palanisamy & Yadav* 131159, 14.10.2014,. Surathkal beach, *Palanisamy & Yadav* 131023, 09.10.2014.

2. Gracilaria edulis (Gmelin) Silva P.C. Silva in Univ. Calif. Publ. Bot., 25: 292. 1952; Untawale & al., List mar. alg. India,32. 1983; P. C. Silva & al., Cat. benth. mar. alg. Ind. Ocean, 165. 1996; Oza&Zaidi, Rev. Checkl. Ind. mar. alg.,25. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011.

Fucus edulis S.G. Gmel. Hist. fun. 113. 1768.

Thalli up to 27 cm tall, brownish-red, each arising from a discoid holdfast; branching dense and fastigiate, divaricate, dichotomous to trichotomous Plants attached to coral stones at a depth of 0.5-1 m; frond erect, Cylendrical and highly branched, arinsing from an irregularly discoid base; Branches lateral occationaly apperaring subdichotomous, opposite, sub opposite, often alternate, polymorphic; branches 1.5mm at base gradually increasing 2mm into middle and attenuating towards the tip;

Occurrence: Summer season.

Distribution: Chilka Lake, Tamil Nadu, Lakshadweep & Andaman Islands.

Specimen Examined: Karnataka: Uppandar, *Palanisamy & Yadav* 135629, 27.08.2016;

3. Gracilaria foliifera (Forssk.) Boergesen in Dansk Bot. Ark. 8(2): 7. 1932; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 168. 1996; Desikachary & al., Rhodophyta 2 (2B): 120. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 27. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011;Jha & al., Seaweeds Gujarat: 121. 2009; P.S.N. Rao & Gupta, Algae India 3: 40. 2015.

Fucus foliifera Forssk. Fl. Aegypt-Arab.: 191. 1775.

Thallus dark-brownish red in colour, foliose, compressed, up to 20 cm long, bushy, tufted, cartilaginous, older thallus usually heavily calcified towards base because of epizoans, epilithic. Holdfast discoid, tufted, up to 3 mm in diameter, firmly attached on rocky substrata in heavy surf-exposed areas in tidal and intertidal zones. Stipe flatterned, rigid, up to 4 cm long and 3 mm wide. Fronds cartilaginous, flattened, regularly (sub)dichotomously or polychotomously branched, dense towards apex, ultimate branches laciniate (gradually pointed) or acuminate; surface usually smooth, older thallus rough due to calcification of deposition of sands; margins entire to irregularly and richly proliferated; apex mostly acuminate to acute. *Microscopic*: Cells in surface view usually polygonal; in cross section, thallus up to 1.8 mm thick, multilayered, differentiated into single layered cortex and central medulla layers; cortex cells usually elongated, radially arranged, 5-10 × 6-8 µm; medullary cells large, spherical to radially compressed, surrounded by 1-2 layers of oblong cells of outer medullary layer. Hair cells often present, hyaline, cylindrical. Cystocarps usually found scattered over thallus surface, elevated, subspherical, slightly constricted at base, up to 2 mm across.

(Plate 26. f)

Occurrence: During Monsoon and post-monsoon seasons. Moderate.

Distribution: Throughout Karnataka coast**. India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Serikuli, *Palanisamy & Yadav* 135756, 30.08.2016; Majali (Near Goa Border), *Palanisamy & Yadav* 135816, 23.11.2016; Paradise beach, *Palanisamy & Yadav* 135890, 24.11.2016.

4. Gracilaria salicornia (C. Agardh) E.Y. Dawson in Bull. South. Calif. Acad. Sci., 53: 1. 1954; P. C. Silva & al., Cat. benth. mar. alg. Ind. Ocean, 175. 1996; Oza & Zaidi, Rev. Checkl. Ind. mar. alg., 29. 2001; Jha& al., Seaweeds Ind.: diver. distrib. Seaweeds Gujarat, 122. 2009.

Sphaerococcus salicornia C. Agardh, Icon.Alg.Ined., 1: 4. 1820.

Plants brownish to yellowish red in color; upto 16cm in height; attached by small discs; thsllus bushy with irregularly branched; cylindical axis; lower branches cylindrical not attenuated at the base; upper branches attenuated below; elongate, clávate, swollen at the ápex; and showing apical depressions; cystocarps scattered all over the thallus;

Occurrence: November - April

Distribution: Gujarat coast, Andaman Islands, Laccadive Islands, Nicobar Islands,

Specimen Examined: Karnataka: Surathkal beach, *Palanisamy & Yadav* 131024, 09.10.2014.

5. Gracilaria verrucosa (Huds.) Papenf. in Hydrobiologia 2:195. 1950; Untawale & al., List Mar. Alg. India: 32. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 118. 1996; Desikachary & al., Rhodophyta 2 (2B): 110. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 30. 2001; P.S.N. Rao & Gupta, Algae India 3: 41. 2015.

Fucus verrucosus Huds., Flora Angl.: 470. 1762.

Thallus dark-brownish red in colour, cylindrical to terete, profusely branched in upper region, appearing hair like when free floating, usually 10-50 (-100) cm long, prifusely branched, usually epilithic. Holdfast small, circular to discoid, firmly attached on substrata in shallow intertidal zones, occasionally found free floating. Stipe cylindrical, variable in size, up to 1.5 mm wide. Fronds almost uniformly cylindrical in basal region and gradually becoming narrow upwards, variable in length, 0.2-1.6 mm in diameter; margins entire; apex usually acute, ultimate branchlets usually dichotomously forked or simple, up to 1.5 cm long. *Microscopic*: Cells in surface view elongate to circular in outline, thin walled, 3-9 µm across, irregularly arranged. In cross section, thallus differentiated into outer cortex and central medulla layers; cortex 2-4-layered. Spermatangia growing in deep cavities; Carpogonial branch system consists of 2-celled carpogonial branch and 1-2-celled sterile branches. **(Plate 27. a)**

Occurrence: Post-monsoon season. Moderate.

Distribution: Karnataka: Uttara Kannda districts (Karwar). **India:** Andaman & Nicobar Islands; Andhra Pradesh, Goa, Gujarat; Karnataka; Lakshadweep Islands; Maharashtra; Odisha, Puducherry, Tamil Nadu.

Specimen Examined: Karnataka: Harwada-Tarangamett, *Palanisamy & Yadav* 135821, 23.11.2016.

2.CRYPTOMANIALES

HALYMENIACEAE

Thallus greenish-dark or pruple red in colour, foliose, mucilaginous, cartilaginous, erect, usually lithophytic. Fronds foliose, compressed, usually dichotomously, pinnately or palmately branched, marginal proliferations common. Anatomically, thallus multilayered, consists of cortex and medullary layers. Cystocarps usually embedded in thallus, ostiolate.

This family is represented by 5 genera in India and 1 genus in Karnataka.

Grateloupia C. Agardh

Thallus greenish-light red in colour, foliose, compressed, up to 100 cm long, mucilaginous, erect or procumbent, epilithic. Holdfast discoid or rhizoidal, firmly attached. Fronds foliose, heavily mucilaginous, usually pinnately or palmately or irregularly proliferated; surface thick, leathery, lubricous; margins entire-irregularly proliferated. Cystocarps small, scattered over the thallus surface, immersed inside and open with a central minute ostiole.

Currently 92 taxa in world (Guiry & Guiry, 2016), 9 in India (Rao & Gupta, 2015) and 3 species in Karnataka.

Key to species

1a. Thallus much proliferated, often pinnately branched, highly variable **1. G. filicina**
1b. Thallus simple, proliferations absent or often less, only occasionally branched **2**

2a. Thallus large, usually 20-55 cm long; fronds 1-3 cm wide, old blades often proliferated **2. G. indica**
2a. Thallus small, usually 8-20 cm long; fronds 0.3-1.5 cm wide, proliferations absent or very rarely **3. G. lithophila**

1. Grateloupia filicina (J.V. Lamour.) C. Agardh, Spec. Alg. 1(2): 223. 1822; Untawale & al., List Mar. Alg. India: 30. 1983; Desikachary & al., Rhodophyta, 2(2A): 240. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 194. 1996; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Palanisamy & al. in Seaweed Res. Utiln. 36(1&2): 4. 2014; P.S.N. Rao & Gupta, Algae India 3: 42. 2015.

Delesseria filicina J.V. Lamour. in Ann. Mus. Hist. Nat. Paris 20: 125. 1813.

Thallus brownish to greenish or violet red in colour, foliose, irregularly flattened, usually 8-15(-20) cm long, bushy, tufted, mucilaginous, epilithic. Holdfast small, discoid, up to 6 mm in diameter, dark, firmly attached on rocky substrata in intertidal regions. Stipe small, subcylindrical to slightly flattened. Fronds foliose, linear-elongate, up to 20 cm long and 1-5(-8) mm wide, usually pinnately branched into several branches; branches monopodial, pectinate, cirrhose or irregular, narrow, linear-elongate, variable in length; surface thick, smooth, heavily mucilaginous; margins profusely proliferated and highly variable, usually entire in non proliferated areas; apex more or less acute to round or rarely truncate.

Microscopic: Cells in surface view usually oval to spherical. In cross section, thallus 140-220 µm thick, multilayered, differentiated into outer cortical and central medullary layers. Cystocarps usually irregularly scattered and immersed on fronds surface, sub-spherical, 180-220 µm across, ostiolate.

Occurrence: Throughout the year. Moderate

Distribution: Throughout Karnataka coast. **India:** Andhra Pradesh, Goa, Gujarat, Kerala, Maharashtra, Odisha and Tamil Nadu.

Specimen Examined: Karnataka: Surathkal beach, M.Palanisamy & S.K.Yadav, 131026, 09.10.2014; Uchila coast, M.Palanisamy&S.K.Yadav, 131064, 10.10.2014; St. Mary Island, Malpe, M.Palanisamy& S.K. Yadav, 135296, 26.08.2016.

2. Grateloupia indica Boergesen in Bull. Misc. Inform. 119. 1932; K.S. Sriniv., Phycol. Ind.: 1: 19, pl 19. 1969; Untawale & al., List Mar. Alg. India: 30. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 195. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 34. 2001; Yadav & al. in Rajendran & Aravindhan (eds.), Biodiv. Cons.: Asp. Prosp.: 57. 2015; P.S.N. Rao & Gupta, Algae India 3: 42. 2015.

Thallus dark purple-greenish red in colour, foliose, distinctly flat, linear-oblong, usually 8-40 (-100) cm long, thick, mucilaginous, epilithic. Holdfast small, discoid, up to 8 mm in diameter, dark, tufted, firmly attached to rocky substrata in intertidal regions. Stipe distinct, slightly cylindrical to gradually compressed towards fronds, cuneate at base, up to 2.5 cm long and 0.4-7 mm wide. Fronds foliose, linear-oblong, simple or lobed, usually broadly flat in basal region and uniform to irregular at middle region and narrowly tapering towards apex; surface consistently thick, heavily mucilaginous, smooth, occasionally perforated; margins usually entire to wavy or sinuate, sparsely proliferated towards apex in older thallus; apex acute to obtuse, occasionally truncate with irregular proliferated. *Microscopic*: Cells in surface view spherical or oval to slightly elongate, 3-15 µm across, sparsely arranged. In cross section, thallus up to 550 µm thick, multilayered, differentiated into outer cortical and central medullary layers; Cystocarps scattered on frond surface, subspherical to slightly elongate, 100-250 µm across; tetrasporangia scattered on frond surface, oval-oblong, 15-38 µm across, cruciate.

Occurrence: Monsoon and post-monsson seasons. Rare.

Distribution: Karnataka: Dakshina Kannada (Surathkal beach), Uttara Kannda districts(Vannali beach, Sedikuli , Madibengre). **India:** Goa and Gujarat.

Specimen Examined: Karnataka: Surathkal Beach, *Palanisamy & Yadav* 131027, 09.10.2017; Vannali brach Kumta, *Palanisamy & Yadav* 131194,16.10.2014; Sedikuli M.Palanisamy& S.K. Yadav 135750, 26.08.2016.

3. Grateloupia lithophila Boergesen in J. Indian Bot. Soc. 17: 215. 1938; K.S. Sriniv., Phycol. Ind.: 1: 20, pl 20. 1969; Untawale & al., List Mar. Alg. India:

30. 1983; Desikachary & al., Rhodophyta, 2 (2A): 238. 1990; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 118. 1996; Palanisamy & al. in Seaweed Res. Utiln. 36(1&2): 4. 2014; P.S.N. Rao & Gupta, Algae India 3: 43. 2015.

Thallus dark-greenish red in colour, becomes dark olive- brown after drying, foliaceous, flattened, 5-20 cm long, bushy, tufted, usually caespitose, mucilaginous, epilithic. Holdfast small, discoid, up to 6 mm in diameter, dark, firmly attached on rocky substrata in intertidal regions. Stipe small, flattened or subcylindrical; sometimes indistinct. Fronds foliose, linear-lanceolate, tapering from the middle to both ends, up to 20 cm long and 0.4-1.8 cm wide, usually several fronds arise directly from discoid base; surface thick, smooth, heavily mucilaginous; margins usually entire to sinuate or undulate, rarely sparsely proliferated; apex more or less truncate, obtuse to round, rarely acute, occasionally proliferated in mature thallus. *Microscopic*: Cells in surface view usually spherical to oval, 2-6 µm across, sparsely arranged. In cross section, thallus up to 360 µm thick, multilayered, differentiated into outer cortical region and central medullary region; cortex 2-6-layered, cells round or oval to slightly elongate, 3-10 µm across, compact in outer layer and gradually become loose inwards; medulla usually hollow or loosely interwoven by rhizoidal filaments of 3.5-7 µm width, cells stellate, 10-16 µm in diameter. Spermatangia develop in sori near the frond tip, terminal on cortical cells, usually subspherical or ovoid; cystocarps usually embedded in frond surface, globose to spherical, ostiolate. **(Plate 27. b)**

Occurrence: Throughout the year. Common.

Distribution: Throughout Karnataka coast. **India:** Andhra Pradesh, Goa, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Surathkal beach, *Palanisamy & Yadav* 131025, 09.10.2014; Uchila coast, *Palanisamy & Yadav* 131059, 10.10.2014; Gorte coast,

Palanisamy & Yadav 131172, 14.10.2014.

3. CORALLINALES

CORALLINACEAE

Thallus light-brownish or whitish red in colour, occasionally colourless, calcareous, coraline, articulated, brittle in nature. Fronds with crustose base and cylindrical or compressed axes, usually dichotomously or pinnately branched, rarely trichotomous or irregular, differentiated into altérnate bands of genicula and intergenicula.

This family is represented by 16 genera in India (Oza & Zaidi, 2001) and 3 in Karnataka.

Key to genera

1a. Conceptacles scattered over the surface on the intergeniculata; geniculata multizonal **1. Amphiroa**

1b. Conceptacles not scattered all over the surface on the intergeniculata; geniculata unizonal **2**

2a. Thallus pinnately branched **3. Corallina**
2b. Thallus usually dichotomously branched **3**

3a. Conceptacles latero-apical on the wings of the intergeniculata, mainly confined to the winged processes **2. Cheilosporum**
3b. Conceptacles terminal on the wings of the intergeniculata; fertile segments often larger than sterile ones **4. Jania**

1. Amphiroa J.V. Lamour.

Thallus brownish-whitish red in colour, up to 10 cm long, dichotomously branched, rarely trichotomous or irregular, articulated, calcified, fragile; geniculata mostly multizonal, not calcified; intergeniculata multizonal, calcified; conceptacles lateral, scattered on the surface of the intergeniculata; sporangia usually tetrapartite.

Presently, 54 taxa in world (Guiry & Guiry, 2016), 7 in India (Rao & Gupta, 2015) and 2 in Karnataka.

Key to species

1a. Thallus purple red in colour, large, much branched, heavily calcified **1. A. anceps**
1b. Thallus light-pinkish red in colour, small, less branched, lightly calcified **2. A. fragilissima**

1. Amphiroa anceps (Lam.) Decne., Ann. Sci. Nat. Bot. 18: 125. 1842; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 40.2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 44. 2015.

Corallina anceps Lam. Mem. Mus. Hist. Nat. (Paris) 2: 238. 1815.

Thallus red to bright purple red in color; 5 – 10cm tall, erect articulate, with stongly calcified segments; often tufted and much branched dichotomously (rarely with small proliferations) from the upper end of each intergeniculum, branching essentially complanate, intergenicula more or less terete near the base, compressed to flat above and 4–10 (–15) mm long, (0.5–) 1–3 (–4) mm broad and (300–) 500–1000 µm thick centrally, edges thinner and more or less sharp-edged, margins parallel to slightly broader above, calcification over genicula closer near the margins. Holdfast crustose, 2–10 mm across, bearing numerous fronds; epilithic. *Structure* multiaxial. Intergenicula consisting of numerous curved tiers of medullary cells with the filaments splaying laterally, with lateral secondary pit-connections between the medullary cells forming arcs across the intergenicula. **(Plate 27. c)**

Occurrence: Usually Post-Monsoon season. Moderate.

Distribution: Karnataka : Uttara Kannda district (Talgode, Majali, Gprte) **India:** Andaman & Nicobar Islands, Gujarat, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Mundoli beach (Bhatkal), *Palanisamy* 134996, 23.02.2016; Talgode, *Palanisamy* 135020, 23.02.2016; Mundoli beach (Bhatkal), *Palanisamy* 134997, 23.02.2016.

2. Amphiroa fragilissima (L.) J.V. Lamour., Hist. Polyp. Corall. 298. 1816; Untawale & al., List Mar. Alg. India: 29. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 223. 1996; Desikachary & al., Rhodophyta, 2 (2B):60.1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 40.2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 44. 2015.

Corallina fragilissima L. Syst. Nat. Ed. 10, 1: 806. 1758.

Thallus light-pinkish grey in colour, occasionally yellowish white or colourless, cylindrical-terete, up to 4.5 cm long, calcified, solid, fragile, caespitose, usually epilithic. Holdfast minute, discoid, sometimes indistinct, britle, attached on rocky substrata in intertidal region. Stipe stalked, cylindrical. Fronds erect, cylindrical to terete, regularly dichotomously branched, articulated, sometimes irregularly proliferated, consist of alternate segments of cylindrical intergenicula and narrow bands of genicula, mature fronds usually covered with prominent hemispherical reproductive parts. *Microscopic*: Intergenicula markedly cylindrical, margins usually smooth in young thallus and rough in mature or older one; apex usually round to broadly obtuse, up to 410 µm in diameter, characteristically marked with pad like swellings of up to 400 µm length; geniculata usually linear, extremely thin. Conceptacles prominently developed throughout on frond surface, densely crowded in mature thallus, distinctly projected, hemispherical in shape.

(Plate 27. d)

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Karnataka: Uttara Kannda district (Majali coast, Karwar, Oyingi beach) **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala,Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Oyingi beach, *Palanisamy & Yadav* 131188, 15.10.2014; Majali coast, Karwar; M. Palanisamy & S.K. Yadav; 131215; 18.10.2014.

2. Cheilosporum (Decne.) Zanardini

Thallus whitish-dark or pinkish red in colour, occasionally colourless, up to 10 cm long, calcareous, brittle, dichotomously or irregularly branched, epilithic or epiphytic. Fronds erect, articulated, consists of long intergeniculata and minute stripe of geniculata. Conceptacles scattered on the surface near apical margins (latero-apical in position).

Currently 3 taxa in world (Stegenga 1997), 2 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Cheilosporum spectabile Harv. ex Grunov in J. Mus. Godeffroy 3: 41. 1874; Untawale & al., List Mar. Alg. India: 29. 1983; Agadi in Seaweed Res. Utiln. 8(1&2): 38. 1985; Desikachary & al., Rhodophyta 2(2B): 67. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 41. 2001; Jha & al., Seaweeds Gujarat: 135. 2009; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 45. 2015.

Thallus light-whitish or purple red in colour, calcareous, bushy, fragile, erect, articulated, caespitose, epilithic. Holdfast minute, rhizoidal, brittle. Stipe minute, stalked, up to 0.6 mm long, sometimes indistinct. Fronds erect, filamentous, up to 5 cm long, usually regularly dichotomously branched, articulated, segmented, consist of alternate segments of long and flattened intergenicula and narrow bands of genicula. *Microscopic*: Intergenicula markedly flattened, thick, winged, rarely cylindrical and unwinged in central segments, variable in length and width, 230-9850 µm long and 200-250 µm wide in basal portion, 300-380 µm long in central portion and 530-1200 µm towards apex; midrib prominent or inconspicuous, winged; wings equal or unequal, angular; margins entire to irregularly incised to slightly dentate or mucronate in middle segments and obtuse to rounded in upper segments. Geniculata represented by a thin stripe between the intergenicular segments, 12-30 µm thick. In cross section, intergeniculata multizonal, consists of thin and isodiametric cortical cells and longitudinal strands of medullary cells; geniculata always unizonal. Conceptacles develop near the tip of intergenicular wings, solitary or in groups, immersed or protruded outside as swellings, spherical to elongate, 6-15 µm across.

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Karnataka: Uttara Kannda district (Murudeshwar coast, Talgode, Om beach). **India:** Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Gorte, *Palanisamy & Yadav* 131284, 07.06.2015; Onnahalli, M.Palanisamy, 135042, 24.02.2016; Om beach, *Palanisamy* 135076, 25.02.2016; St. Mary Island, Malpe *Palanisamy* 134918, 20.02.2016.

3. Corallina L.

Thallus light-purple red in colour, up to 8 cm long, calcareous with crustose base, fragile, articulated, epilythic, attached with small discoid holdfast. Genicula unizonal. Conceptacles usually terminal, sometimes in axillary position on the lateral branches.

Currently 32 taxa in world (Guiry & Guiry, 2017), 2 in Injdia (Rao & Gupta, 2015) and 1 in Karnataka.

Corallina officinalis L. Syst.nat.ed., 1: 805. 1758; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 231. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 41. 2001; P.S.N. Rao & Gupta, Algae India 3: 45. 2015.

Thallys light purple red in colour, uo to 5 (-8) cm long, bushy, calcareous, erect, articulated. Holdfast minute, rhizoidal or discoid, firmly or loosely attached. Stipe stalked, cylindrical. Fronds erect, 80-250 µm in diameter, pinnately differentiated into long and cylindrical intergeniculata and narrow bands of genicula, slightly constricted in geniculata region.

Occurrence: Post-monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district (Majali, Gorte) **India**: Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Gorte, *Palanisamy* 135091, 27.02.2016.

4. Jania J.V. Lamour.

Thallus light-dark red in colour, up to 5 cm long, erect, calcareous, fragile, articulated, epilithic. Fronds dichotomously branched at intervals of one to few segments; intergenicula cylindrical, multizonal; genicula unizonal with one transverse band of cells. Conceptacles develop in axial position on ultimate branchlets, one on each intergeniculum, horned (antenniferous) or smooth (non-antenniferous), ostiole.

Currently 49 taxa in world (Guiry & Guiry, 2017), 5 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Jania rubens (L.) J.V. Lamour., Hist. Polyp. Corall. 271. 1816; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 224. 1996; Desikachary & al., Rhodophyta 2(2B): 71. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 43. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011;P.S.N. Rao & Gupta, Algae India 3: 46. 2015.

Corallina rubens L., Syst. Nat. ed. 10, 1: 806. 1758.

Thallus light-dark purple red in colour, cylindrical, up to 5 cm long, bushy, calcareous, erect, articulated, solid, fragile, caespitose, epilithic. Holdfast minute, rhizoidal or discoid, firmly or loosely attached. Stipe stalked, cylindrical, up to 8 mm long, calcified. Fronds erect, cylindrical, 1.5-5 cm long and 100-300 µm in diameter, filamentous, regularly differentiated into long and cylindrical intergeniculata and narrow bands of genicula, slightly constricted in geniculata region and widened near dichotomies, main axis usually regularly dichotomously branched; branches profuse in upper regions, forming a cymoid structure. *Microscopic*: Intergenicula cylindrical, slightly constricted in centre and swollen at both the ends, anatomically multizonal, consists of 3-5 rows of medullary strands and 2-3-layered cortex; medulla cells almost umiformly elongate, 60-100 × 5-12 µm; cortex cells usually circular or flattened to isodiametric, 6-20 µm across. Geniculata extremely thin, usually constricted, unizonal, cells elongate; margins usually smooth; apex usually acute to narrowly obtuse, usually with white tinge. Conceptacles terminal in position, usually clustered, 200-280 µm in diameter, antenniferous with a single apical pore.

Occurrence: Monsoon and post-monsoon seasons. Rare.

Distribution: Karnataka: Uttara Kannda district (Murudeshwar coast, Talgode, Golte). **India:** Andaman Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Note: This species has been included here based on the report by Kaladharan & al. 2011. However, during the present study, it could not be traced and collected freshly.

4. GIGARTINALES

Key to families

1a.	Thallus uniaxial, tetrasporangia zonate	**2**
1b.	Thallus multiaxial, tetrasporangia zonate or cruciate	**2. Gigartinaceae**
2a.	Thallus flat, procarp absent	**1. Caulacanthaceae**
2b.	Thallus usually cylindrical to terete, procarp present	**3. Hypneaceae**

1. CAULACANTHACEAE

Thallus light-dark pinkish or brownish red in colour, foliose, cylindrical, terete or compressed, up to 8 cm long, erect, lithophilic. Fronds segmented, or branched in all directions, usually differentiated into nodes and interodes. Anatomically, thallus uniaxial, multilayered. Spermatangia scattered over the surface; carposporangia develop either singly or in chains.

This family is represented by 2 genera in India and 1 genus in Karnataka.

Catenella Grev.

Thallus brownish-dark red in colour, flattened to terete, up to 5 cm long, erect, epilithic. Fronds compressed, segmented, differentiated into nodes and internodes, branches develop from the nodes. Spermatangia scattered over the surface; carpogonial branches usually 2-3-celled, carposporophyte produces carposporangia in chain; cystocarps without any sheath, ostiolate; tetrasporangia scattered, embedded in the outer cortical layer.

Currently 6 taxa in world (Guiry & Guiry, 2017), 3 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Catenella impudica (Mont.) J. Agardh, Spec. Gen. Ord. Alg. 2: 701. 1852; Desikachary & al., Rhodophyta 2 (2B):146. 1998; Sahoo & al., Seaweeds Ind. Coast: 169. 2001; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 49. 2001; Jha & al., Seaweeds Gujarat: 138. 2009; P.S.N. Rao & Gupta, Algae India 3: 48. 2015.

Lomentaria impudica Mont. in Ann. Sci. Nat. Bot. 2(8): 197. 1840.

Thallus blackish to dark-purple red in colour, foliose or frondose, creeping, decumbent, fragile, epilithic, attached by discoidal haptera at nodes. Holdfast discoid, fimbriate or branched, up to 2 mm long. Stipe minute, indistinct. Fronds articulated, irregularly di-trichotomously branched; branches usually sparse below and profuse towards apex; differentiated into nodes and internodes; internodal segments slender to slightly flattened in young stage, later become spindle, expanded or sickle shaped, 1-8 × 0.3-2.2 mm, deeply constricted at nodes; surface smooth; margins entire, apex irregularly forked with acute to acuminate tips, 400-1250 × 180-300 µm. *Microscopic*: Cells in surface view usually spherical, 8-18 µm across, irregularly or sparsely arranged. In cross section, thallus up to 1.5 mm thick, differentiated into outer cortical region and central hollow or loosely interwoven medullary region. Spermatangia scattered over the surface; carposporangia develop in chains; tetrasporangia zonate, scattered or embedded in cortical region. **(Plate 27. e)**

Occurrence: Monsoon season. Rare.

Distribution: Karnataka-UttaraKannda district (Om Beach,Tadri,Harwada-Tarangamett). **India:** Andhra Pradesh, Gujarat, Kerala, Maharashtra. Odisha and Tamil Nadu.

Specimen Examined: Karnataka: Om Beach, M.Palanisamy & S.K. Yadav, 135732, 30.08.2016; Tadri, M.Palanisamy & S.K.Yadav, 135745, 30.08.2016; Harwada-Tarangamett, *Palanisamy & Yadav* 135823, 23.11.2016.

2. GIGARTINACEAE

Thallus usually dark-purple red in colour, cylindrical, terete, slightly compressed or foliose, usually cartilaginous, multiaxial, lithophilic. Fronds cartilaginous, usually irregularly branched, spinulose-forked, rarely unbranched. Anatomically, thallus multilayered. Tetrasporangia solitary or in rows, scattered on thallus surface or embedded in cortical region.

This family is represented by 1 genus in India as well as in Karnataka.

Chondracanthus Kuetz.

Thallus dark-purple red in colour, cylindrical-terete or slightly compressed, up to 13 cm long, prostrate, cartilaginous, lithophilic. Fronds irregularly or pinnately branched, spinulose-forked. Gametophytic thallus monoecious or dioecious, spermatangia develop in superficial sori on fertile branchlets; cystocarps distinct, globose; tetrasporangial sori usually small, develop in inner cortical region.

Currently 21 taxa in world (Guiry & Guiry, 2017), 2 in India (Desikachary & al., 1998) and 1 in Karnataka.

Chondracanthus acicularis (Roth) Fredericq in Hydrobiologia 26: 117. 1993; Desikachary & al., Rhodophyta 2 (2B): 128. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 50. 2001; Palanisamy & al. in Rajendran & Aravindhan (eds.). Biodiv. Cons.: Asp. Prosp.: 42. 2015; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Ceramium aciculare Roth, Cat. Bot. 3: 114. 1806.

Thallus dark-purple red in colour, occasionally greenish towards base in young stage, usually cylindrical, wiry, up to 12 cm long, cartilaginous, prostrate, loosely intricate, tufted, epilithic; Holdfast minute, rhizoidal, delicate, firmly attached on rocky substrata in surf-exposed areas in intertidal regions. Stipe small or indistinct. Fronds slender, slightly compressed, rigid, profusely branched; branches irregular, pinnate or dichotomous, slightly curved or forked towards apex; surface smooth; margins entire; apex acute-acuminate with usually light purple colour, apical dichotomy 0.4-5.5 mm long and 180-350 µm broad. *Microscopic*: Cells in surface view oval-spherical, small, 2-8 µm across. In cross section, thallus multilayered, 280-500 µm thick, differentiated into anticlinally arranged cortex and central filamentous medulla layers; cortex multilayered, 20-50 µm thick, cells small, oval to spherical; medulla occupy major part of the thallus, 300-350 µm

across, cells filamentous, irregular. Cystocarps develop on ultimate branchlets, sessile, solitary or in groups of 2-4; tetrasporangia develop in sori on the lower side of the branchlets. **(Plate 27. f)**

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: Karnataka: Udupi and Uttara Kannda districts (Oyingi beach, Gorte, Talgode coast, Madiyengri, Majali, Tadri coast, Om Beach, Murudeshwar coast). **India:** Andaman Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Oyingi beach, *Palanisamy & Yadav* 131181, 15.10.2014; Talgode, *Palanisamy* 132417 08.06.2015; Madiyengri, *Palanisamy & Yadav* 136245, 26.11.2016; St. Mary's Island, Malpe, *Palanisamy & Yadav* 136382, 29.11.2016.

3. HYPNEACEAE

Thallus greenish-brownish or dark red in colour, cylindrical-slightly compressed, lithophytic. Fronds simple or branched, margins entire or proliferated or covered with spinulose processes. Anatomically, thallus multilayered. Cystocarp develops on thallus surface, usually globose; pericarp thick without any ostiole, tetrasporangia usually develop on thallus or in stichidium, occasionally in nemathecia.

This family is represented by only 1 genus in India as well as in Karnataka.

Hypnea J.V. Lamour.

Thallus brownish-dark red in colour, cylindrical-terete, or compressed, up to 40 cm long, erect or entangled, bushy, epilithic. Fronds usually profusely branched, entire or covered with minute ramuli or spinulose processes. Anatomically thallus pseudo-parenchymatous, multi-layered. Cystocarps develop as swellings on frond surface, usually globose to spherical, sessile; pericarps thick; tetrasporangia develop in nemathecia or sori on swollen portion of ultimate branchlets.

Currently 61 taxa in world (Guiry & Guiry, 2016), 10 in India (Rao & Gupta, 2015) and 6 in Karnataka.

Key to species

1a. Thallus with a single main axis arising from holdfast **2**
1b. Thallus with several main axes arising directly from holdfast **3**

2a. Thallus small, up to 5 cm long; fronds with straight branches, not ending into hook like apices; ramuli usually not soft **4. H. spinella**
2b. Thallus large, up to 30 cm long; fronds densely covered with incurved branches **3**

3a. Thallus up to 30 cm long; ramuli hook like, usually sparsely arranged **3. H. musciformis**
3b. Thallus large, up to 15 cm long; ramuli densely arranfed and forming thick tomentose appearance **2. H. flagelliformis**

4a. Thallus large; fronds cylindrical to distinctly compressed, moderately covered with ramuli; ramuli large **1. H. esperi**

4b. Thallus small; fronds cylindrical to terete, densely covered with minute ramuli **5. H. valentiae**

1. Hypnea esperi Bory, Voy. Coquille 157. 1828; Untawale & al., List Mar. Alg. India: 31. 1983; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 298. 1996; Desikachary & al., Rhodophyta 2 (2B): 157. 1998; Jha & al., Seaweeds Gujarat: 145.2009; Palanisamy & al. in Rajendran & Aravindhan (Eds.). Biodiv. Cons.: Asp. Prosp: 43. 2015; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Thallus light greenish-dark red in colour, bushy, terete or cylindrical to slightly flat, up to 30 cm long, tufted, usually forming thick mat like layer in suitable condition, epilithic. Holdfast small, usually discoid, up to 0.6 cm in diameter, firmly attached. Stipe small, sometimes indistinct or undifferentiated, smooth or sparsely clothed with ramuli. Fronds usually cylindrical to terete in basal region and slightly compressed upwards, usually 10-20 (-30) cm long, profusely branched; branches alternate or irregular, upwardly directed and closely arranged, up to 15 cm long, densely and almost uniformly covered with ramuli throughout; ramuli hair like, soft, 0.3-8 mm long and 100-200 µm in diameter; apex acute to acuminate, simple, rarely forked. *Microscopic*: In cross section, thallus up to 1.5 mm thick, multilayered, differentiated into outer cortex and central medullary layers; Spermatangia develop on branchlets, slightly swollen; tetrasporangia zonately divided. **(Plate 28. a)**

Occurrence: Post-monsoon and summer seasons. Moderate.

Distribution: Karnataka: Dakshina Kannada(Someshwar coast,Uchila), Udupi (Uchila coast) and Uttara Kannda (Shiroor coast Om beach) districts. **India:** Gujarat, Lakshadweep Islands and Tamil Nadu.

Specimen Examined: Karnataka: Shiroor coast, *Palanisamy & Yadav* 131126, 14.10.2014; Uchila coast, *Palanisamy* 132505, 16.09.2015; Someshwar coast, *Palanisamy*132512,16.09.2015; Uchila, *Palanisamy* 133342, 18.02.2016.

2. Hypnea flagelliformis Grev. ex J.Agardh, Sp. Alg. 2: 446. 1851; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 51. 2001; Jha & al., Seaweeds Gujarat: 140. 2009; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Thallus purple to dark reddish in colour, up to 15 cm long, bushy, epilithic. Holdfast minute, rhizoidal or discoid, firmly attached. Fronds bushy, usually 8-15 cm long, sparsely branched, several branches arising from the base and forming a flagelliform structure, prominently covered with minute ramuli; ramuli spinous, densely crowded and froming tomentose appearance.

Occurrence: November to April

Distribution: **Karnataka**: Dakshina Kannada district (Om beach) districts. **India**: Indian coast (Rao & Gupta, 2015), Tamil Nadu (Cape comorin).

Specimen Examined: Karnataka: Om beach, *Palanisamy* 135071, 25.02.2016.

3. Hypnea musciformis (Wulfen) J.V. Lamour. in Ann. Mus. Hist. Nat. 20: 131. 1813; Desikachary & al., Rhodophyta 2(2B): 156. 1998; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 300. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 51. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Palanisamy & al. in Seaweed Res. Utiln. 35(1&2): 26. 2013; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Fucus musciformis Wulfen in Jacquin Coll. 3: 154, Pl. 14, fig. 3. 1789.

Thallus light-dark pinkish or brownish red in colour, bushy, cylindrical to slightly flattened, freely and irregularly branched with characteristic hook like apices, up to 30 cm long, tufted, epilithic. Holdfast small, usually discoid, up to 6 mm in diameter, firmly attached, occasionally free floating. Stipe up to 1.5 cm long and 0.5-2 mm wide, usually clothed with minute ramuli. Fronds cylindrical to slightly flattened, 4-30 cm long, alternate, opposite or irregularly branched, densely or sparsely covered with minute ramuli; ramuli develop in all directions, smooth or spinous, up to 5 mm long; surface usually rough; apex acute with distinctly hook like curves. *Microscopic*: Cells in surface view circular to slightly elongate, 4-10 µm across, compact. In cross section, thallus up to 1.6 mm thick, differentiated into outer cortex and central medullary regions; cortex 2-5-layered, cells spherical to slightly elongate, 15-85 µm across, progressively increasing from periphery towards centre; medulla cells comparatively large, usually circular to round, 80-150 µm across, sparsely arranged. Spermatangia develop in chain usually near the base of the branchlets, swollen; cystocarps round or spherical, conspicuous; tetrasporangia usually on ultimate branches. **(Plate 28. b)**

Occurrence: Throughout the year. Common.

Distribution: Throughout Karnataka coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Om beach, *Palanisamy* 135071, 25.02.2016.

4. Hypnea spinella (C.Agardh) Kuetz. in Bot. Zeitung 5: 23. 1847; Untawale & al., List Mar. Alg. India: 31. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 53. 2001; Jha & al., Seaweeds Gujarat: 143. 2009; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Spherococcus spinella C. Agardh, Algern. Syst.: 1(2): 323. 1822.

Hypnea cervicornis J. Agardh Sp. Alg. 2(2): 451`. 1851.

Thallus pinkish-purple red in colour, sometimes light-yellowisg green, bushy, cylindrical to terete, small, usually 2-5 cm long, tufted, pulvinate, intricately branched, occasionally cushioned, caespitose, epilithic. Holdfast small, usually discoid, loosely attached, occasionally free floating. Stipe small, up to 5 mm long, sometimes indistinct. Fronds cylindrical, up to 1.6 mm in diameter, irregularly entangled, erect, tapering towards apex, profusely branched; branches

intricately alternately, subdichotomous or irregular, frequent in basal region; main axis and branches densely covered with minute spines or ramuli; spines minute with pointed apices, 0.4-2.2 mm long, closely arranged; apex of the branches and branchlets acute. *Microscopic*: In cross section, thallus up to 1.5 mm thick, multilayered, differentiated into outer cortex and central medullary layers; cortex cells 2-3-layered, thick walled; medullary cells usually large. Spermatangia borne on branchlets, slightly swollen, spherical or globular. **(Plate 28. c)**

Occurrence: Monsoon season. Rare.

Distribution: Karnataka: Dakshina Kannada (Someshwar coast, Surathkal beach, Uchila coast), Udupi (St. Mary Island, Malpe) and Uttara Kannda (Om beach Shiroor coast) districts **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Someshwar coast, M. Palanisamy & S.K. Yadav 131013, 09.10.2014; Surathkal beach, *Palanisamy & Yadav* 131032, 09.10.2014; Uchila coast,*Palanisamy & Yadav* 131061, 10.10.2014; Shiroor coast, *Palanisamy & Yadav* 131125, 14.10.2014.

5. Hypnea valentiae (Turner) Mont. in Ann. Sci. Nat. Bot. 2(16): 161. 1841; Untawale & al., List Mar. Alg. India: 31. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 118. 1996; Desikachary& al., Rhodophyta 2 (2B): 159. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 53. 2001; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Fucus valentiae Turner in Fuci, 2: 17, Pl. 78. 1808.

Thallus light-dark greenish-pinkish red in colour, bushy, cylindrical or terete to slightly flattened, usually 4-10(-20) cm long, caespitose, epilithic. Holdfast small, discoid, firmly attached on rocky substrata, occasionally free floating. Stipe small, sometimes indistinct. Fronds cylindrical or terete to slightly flattened, up to 10 cm long ans up to 2 mm in diameter, gradually decreasing towards apex, usually alternate or irregularly branched, densely covered with spinous ramuli throughout, usually sparse towards the apex, branches and branchlets directed upward; spines 0.3-5.2 mm long; apex acute. *Microscopic*: In cross section, thallus up to 2 mm thick, multilayered, differentiated into outer cortex and central medullary layers; cortex 2-4-layered, progressively increasing from periphery towards centre; medulla cells comparatively large, usually 2-3-layered, usually circular to round. Thallus usually dioecious; cystocarps develop on branchlets, round or globular, conspicuous, sessile; tetrasporangia usually develop in swollen nemathecia near the base of branchlets, zonately divided.

Occurrence: Throughout the year. Moderate.

Distribution: Karnataka: Dakshina Kannada, Udupi (Uchila coast) and Uttara Kannda districts(Sedikuli ,Shiroor coast, Gorte coast ,Om beach, Vannali beach, Mundoli beach (Bhatkal)). **India:** AndhraPradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Uchila Udupi district, *Palanisamy & Yadav* 131260, 05.06.2015; someshwar coast, *Palanisamy* 133355, 18.02.2016, surathkal, *Palanisamy* 133366, 18.02.2016.

5. RHODYMENIALES

Key to families

1a. Thallus filamentous, soft, heterotrichous **1. Champiaceae**
1b. Thallus crustose, hard, flat, discoid or irregular **2. Rhodymeniaceae**

CHAMPIACEAE

Thallus dark-purple red in colour, frondose, erect, lithophilic. Fronds cylindrical- filiform or compressed, flattened, simple or irregularly branched; gland cells present. Growth by apical meristem. Carpogonial branch 3-4-celled; cystocarps external, with or without ostiole; tetrasporangia scattered over the surface or develop in sori, terminal or intercalary.

This family is represented by 2 genera in India and 1 genus in Karnataka.

Champia Desv.

Thallus purple red in colour, caespitose, frondose, hollow, cylindrical to slightly compressed, flattened, up to 20 cm long, epilithic. Fronds usually hollow, slightly constricted into regular segments by uniseriate septa, articulated, simple or branched. Spermatangia develop in sori, superficial; carpogonial branch 4-celled, develop on short branched gonimoblasts; cystocarps external; tetrasporangia usually intercalary.

Currently 36 taxa in world (Guiry & Guiry, 2017), 8 in India (Rao & Gupta, 2015) and 2 in Karnataka.

1. Champia compressa Harv., Gen. Afr. Pl.: 402. 1838; Boergesen in J. Indian Bot. Soc. 16: 332, fig. 8. 1937; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 345. 1996; Desikachary & al., Rhodophyta 2 (2B):187. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 58. 2001; Jha & al., Seaweeds Gujarat: 154. 2009; P.S.N. Rao & Gupta, Algae India 3: 51. 2015.

Thallus light-bright purple or occasionally greenish red in colour, frondose, caespitose, densely clumped, articulated, up to 5 cm long, membranous, usually transparent, gelatinous, erect, epilithic. Holdfast usually rhizoidal, irregularly branched, firmly attached. Stipe small, cylindrical to slightly compressed, up to 8 mm long. Fronds foliose, compressed to gradually flattened upwards, up to 5 cm long and 1-3 mm wide, segmented; segments 0.5-1.2 mm apart; sparsely branched; branches alternate or sub-opposite or irregular; surface smooth to slightly rough with markedly parallel constrictions; margins entire to irregularly proliferated; apex obtuse to acute, occasionally acuminate. *Microscopic*: Cells in surface view angular to polygonal, 45-60 µm across, irregularly or sparsely arranged. In cross section, thallus thin, single layered, cells usually squarish, 30-40 µm across. Cystocarps scattered on frond segments, sessile, usually conical; tetrasporangia scattered or aggregated on thallus surface or embedded, zonately divided.

(Plate 28. d)

Occurrence: Post-monsoon season. Rare.

Distribution: Karnataka: *Distribution*: Karnataka: Udupi (St. Mary's Island, Malpe)and Uttara Kannda districts(Gorte coast) **India:** Goa, Gujarat, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Gorte coast, *Palanisamy & Yadav* 136320 27.11.2016; St. Mary's Island, Malpe, *Palanisamy & Yadav* 136388, 29.11.2016.

2. Champia parvula (C.Agardh) Harv., Ner. Bor. Amer. 2:76. 1853; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 345. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 59. 2001; Jha & al., Seaweeds Gujarat: 157. 2009; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 658. 2014; P.S.N. Rao & Gupta, Algae India 3: 51. 2015.

Thallus pinkish red in colour, usually 2-6 cm long, gelatinous, bushy, soft, erect, caespitose, epilithic or epiphytic in nature. Holdfast usually rhizoidal, minute. Stipe small, cylindrical, up to 1 mm long. Fronds cylindrical, segmented into several nodes and internodes like structures, profusely branched in lower portion, densely matted with blunt apices, segmented, beaded (below, with cystocarps), with nodal diaphragms, segments about as broad as long, filled with a watery mucilage. **(Plate 28. e)**

Occurrence: Post-monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district (Gangolli and Gorte coast). India: Andhra Pradesh, Goa, Gujarat, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Goolte, *Palanisamy & Yadav* 131271, 07.06.2015.

1. RHODYMENIACEAE

Thallus usually pinkish red in colour, foliose, flattened, cylindrical to compressed, lithophilic. Fronds simple or dichotomous-pinnately branched, cartilaginous. Anatomically, thallus multilayered, consists of few layered cortex and rhizoidal medulla, gland cells often present in cortex.

This family is represented by 7 genera in India and 1genus in Karnataka.

Gelidiopsis F. Schmitz

Thallus dark-brownish or greenish red in colour, up to 14 cm long, wiry, cylindrical, bushy, cartilaginous, lithophilic, attached with discoidal or stolonous holdfast; Fronds simple or irregularly branched, apex acute to obtuse. Anatomically, thallus multilayered, consisting of smaller cortex and elongated medulla cells with slight gelatinous matrix.

Currently 12 taxa in world (Guiry & Guiry, 2017), 4 in India (Rao & Gupta, 2015) and 2 in Karnataka.

Key to species

1a. Thallus usually light-purple red in color; fronds dichotomously or pinnately branched, branches sparsely arranged **1. G.repens**

1b. Thallus usually dark-purple red in color; fronds simple or irregularly branched, dense, or caespitose, apices usually simple, remarkably flattened or compressed **2. G. variabilis**

1. Gelidiopsis repens (Kuetz.) Weber Bosse, Siboga Exped. 59: 425. 1928; Untawale & al., List Mar. Alg. India: 32. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 361. 1996; Desikachary & al., Rhodophyta 2 (2B):176. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 62.2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 52. 2015

Gelidium repens Kuetz., Tab. Phycol. 18: 21, pl. 60, figs. a,b. 1868.

Thallus light-dark or purple red in colour, bushy, cylindrical or wiry, up to 10 cm long, regularly dichotomously branched, cartilaginous, flexible, epilithic. Holdfast minute, usually rhizoidal, branches up to 1 cm long, firmly attached on rocky substrata in intertidal region. Stipe stalked, cylindrical, up to 1 cm long and 0.5 mm in diameter. Fronds solid, tufted, erect, cylindrical or filiform to slightly compressed or terete, regularly dichotomously or pinnately branched; branches usually sparse in lower parts and more towards apex; surface smooth; margins entire; apex acute. *Microscopic*: In cross section, thallus multilayered, differentiated into outer cortical region and central medullary layers; cortex 3-6-layered, cells usually spherical to angular, compact; modulla cells spherical to elongate, variable in sizes, hyaline. Cystocarps borne on upper branches, spherical-ovoid.

Occurrence: Throughout the year. Moderate.

Distribution: Karnataka: Dakshina Kannada(Surathkal), Udupi(Madiyengri) **India:** Tamil Nadu. Kerala

Specimen Examined: Karnataka: Surathkal, *Palanisamy & Yadav* 131245 05.06.2015; Madiyengri *Palanisamy* 132470, 09.06.2015.

2. Gelidiopsis variabilis (J. Agardh) F. Schmitz in Bot. Jahrb. Syst. 21: 148. 1895; Untawale & al., List Mar. Alg. India: 32. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 362. 1996; Desikachary & al., Rhodophyta 2 (2B):176. 1998; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Palanisamy & al. in Seaweed Res. Utiln. 36(1&2): 4. 2014; P.S.N. Rao & Gupta, Algae India 3: 52. 2015.

Gelidium variabile J. Agardh, Spec. Gen. Ord. Alg. 2(2): 468. 1851.

Thallus dark-brownish red in colour, bushy, cylindrical or wiry, up to 12 cm long, branched, erect, cartilaginous, epilithic. Holdfast discoid or rhizoidal, firmly attached. Stipe stalked, cylindrical, up to 0.6 mm in diameter. Fronds solid, tufted, cylindrical or filiform to slightly compressed towards apex, up to 12 cm long, simple or branched; branches usually dense in lower parts and moderate towards apex, irregular to (sub)opposite or pinnate, up to 5 cm long; surface smooth;

margins entire; apex acute, slightly compressed, light pinkish-purple in colour. *Microscopic*: Cells in surface view usually spherical. In cross section, thallus multilayered, differentiated into outer cortical region and central medullary layers; cortex 3-8-layered, 5-21 µm across; medulla multilayered, cells spherical to elongate. Cystocarps borne on upper branches, ovoid, sessile, solitary or densely aggregated.

Occurrence: During Monsoon and post-monsoon seasons. Moderate

Distribution: Throughout Karnataka coast **India:** Andhra Pradesh, Goa, Gujarat, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Uchila coast, *Palanisamy & Yadav* 131073 10.10.2014; Surathkal Palanisamy & S.K. Yadav, 131239, 05.06.2015; Kapu Beach M. Palanisamy 133393, 19.02.2016; Mundoli beach (Bhatkal, *Palanisamy* 135000, 23.02.2016.

10. CERAMIALES

Key to families

1a. Gonimoblasts naked, without a distinct pseudoparenchymatous pericarp **1. Ceramiaceae**
1b. Gonimoblasts with a distinct pseudo-parenchymatous pericarp **2**

2a. Gonimoblasts sympodial in development, cylindrical to flat, tufted **3.** **Rhodomelaceae**
2b. Gonimoblasts monopodial in development, foliose, flat, membranous **2. Delesseriaceae**

1. CERAMIACEAE

Thallus light-dark pinkish red in colour, filamentous, uniaxial, usually fragile, epilithic, epiphytic or epixoic. Fronds monosiphonous, often corticated, simple or branched; branches alternate, opposite, uniseriate; pericentral cells present. Spermatangia usually terminal, develop in sori on laterals; gonimoblast naked, occasionally enveloped with non-parenchymatous pericarp; tetrasporangia cruciate or tetrahedral.

This family is represented by 24 genera (Desikachary & al., 1998) in India and 3 in Karnataka.

1. **Centroceras** Kuetz.

Thallus dark-pinkish red in colour, cylindrical-terete, up to 8 cm long, erect, rarely prostrate, fragile, epilithic or epiphytic. Fronds filamentous, differentiated into nodes and internodes, dichotomously branched, corticated; spines prominent in apical nodal. Cystocarps globose, sessile, involucrate; tetrasporangia develop in whorls, emergent, tetrahedral.

Currently 17 taxa in world (Guiry & Guiry, 2017), 1 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Centroceras clavulatum (C. Agardh) Mont., Fl. Algerie: 140. 1846; Untawale & al., List Mar. Alg. India: 34. 1983; Desikachary & al., Rhodophyta, 2 (2B): 215. 1998; P. C. Silva & al.,Cat. Benth. Mar. Alg. Ind. Ocean: 387. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 65. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 53. 2015.

Ceramium clavulatum C. Agardh in Kunth: Syn. Pl. 1: 2. 1822.

Thallus dark to pinkish red in colour, filamentous, up to 5 (-8) cm long, bushy, gregarious, erect, fragile, epilithic, occasionally epiphytic. Holdfast discoid, loosely attached. Stipe small, cylindrical, usually undifferentiated. Frond filamentous, dichotomously branched, up to 8 cm long; filaments differentiated into corticated nodes and internodes; surface smooth in internodal region, spinous in cortical regions. *Microscopic*: Internodal cells 80-400 × 100-150 µm, ultimate branches forcipate, slightly curved, 95-650 × 50-120 µm, cells in surface view rectangular to squarish, cells 7-14 × 6-12 µm across, compactly arranged towards apex; Nodal regions 20-55 µm × 100-150 µm, cells circular in outline, nodes bearing a whorl of 1-3-celled cortical spines; spines 25-50 × 10-30 µm; dichotomy on filaments usually with 5-12 segments.

Occurrence: During Monsoon and post-monsoon seasons. Moderate.

(Plate 28. f)

Distribution: Throughout Karnataka coast. **India**: Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Kerala, Lakshadweep Islands, Odisha, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Someshwar coast, *Palanisamy* 132519, 16.09.2015; surathkal, *Palanisamy* 132539, 17.09.2015; Padubidri, *Palanisamy* 132554, 17.09.2015.

2. Ceramium Roth

Thallus dark-light red in colour, filamentous, up to 25 cm long, erect or prostrate, monosiphonous, epilithic or epiphytic, attached with minute discoidal holdfast. Frond filamentous, cylindrical-terete, pseudodichotonously or irregularly branched, differentiated into nodes and internodes, usually cortication only in the nodal regions, rarely throughout (*C. rubrum*). Spermatangia develop in sori in nodal region; carpogonial branch 4-celled.

Currently 207 taxa in world (Guiry & Guiry, 2017), 17 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Ceramium flaccidum (Kuetz.) Ardiss. in Nuova Giorn. Bot. Ital. 3: 40. 1871; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 397. 1996; Desikachary & al., Rhodophyta 2 (2B): 213. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 67. 2001; Anilkumar in Bull. Bot. Surv. India 45(1-4): 174, figs. 1-5, 8-9. 2003.

Hormoceras flaccidum Kuetz. in Tab. Phycol. 12: 21, pl. 69. figs, a-d. 1862.

Thallus dark to purple red in colour, filamentous, up to 10 (-15) mm long, bushy, gregarious, creeping, usually forming entangled mass, fragile, epilithic, occasionally epiphytic. Holdfast minute, rhizoidal, loosely attached on rocky substrata. Stipe small or usually inconspicuous. Frond filamentous, usually alternately branched, distinctly differentiated into nodes and internodes; cortication only at nodes, cortical bands distinctly divided into two zones by a transverse line; apices divergent, non-forcipate, occasionally slightly incurved. *Microscopic*: Nodes and internodes conspicuous, internodes 8-30 µm long, ecorticated, larger in lower portion and gradually reducing upwards, slightly conpressed; nodes corticated, gradually shorter towards down and gradualy increasing upwards, dark or purple coloured; Spermatangia usually adaxial, whorled; cystocarps terminal, 25-30 µm across. **(Plate 29. a)**

Occurrence: Post-monsoon season. Moderate

Distribution: Throughout Karnataka coast. **India:** Andhra Pradesh, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Someshwar coast, *Palanisamy* 132513, 16.09.2015, Uchila Udupi district , *Palanisamy* 132570, 18.09.2015; onnahalli, *Palanisamy* 135046, 24.02.2016.

1. Chondria C. Agardh

Thallus dark to purplish red in colour, variable in size, up to 1 m long, usually profusely and irregularly branched. Frond filamentous, polysiphonous with 5 pericentral cells.

Currently 80 tax in world (Guiry & Guiry, 2017), 7 in India (Rao & Gupta, 2015) and 2 in Karnataka.

Key to species

1a.	Thallus up to 10 cm long, pinnately branched, ramuli small	**1. C. armata**
1b.	Thallus up to 15 cm long, cruciform or pyramidately branched, ramuli large	**2. C. cornuta**

1. Chondria armata (Kuetz.) Okamura, Icon. Jap. Alg. 1: 69. 1907; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 479. 1996; Desikachary & al., Rhodophyta 2 (2B): 334, fig. 86 D. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 86. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 59. 2015.

Lophura armata Kuetz. Tab. Phycol. 16: 2, pl. 3, figs. a,b. 1866.

Thallus pinkish to violet red in colour, feathery, up to 8 (-10) cm long bushy, gregarious, tufted, epilithic. Holdfast minute, usually rhizoidal, firmly attached. Stipe small or indistinct. Frond remiform, usually 3-8 cm long, cylindrical to slightly flattened, in basal region, pinnately branched, covered with numerous ramuli; ramuli erect, spinous, up to 0.8 cm long, usually sub-distichously branched, densely arranged at distal end. Cystocarps develop on ramuli, usually subterminla in position. **(Plate 29. b)**

Occurrence: Post-monsoon season. Moderate

Distribution: **Karnataka**: Uttara Kannda district. **India**: Andhra Pradesh, Goa, Gujarat, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Illustration: Desikachary & al. *op. cit.*

Specimen Examined: Karnataka: Honnahalli, *Palanisamy* 135047, 24.02.2016; Om beach, *Palanisamy* 135073, 25.02.2016; Vannali beach, *Palanisamy & Yadav* 135899, 25.11.2016.

2. Chondria cornuta Boergesen, Bull. Misc. Inf. Kew. 130, figs. 15, 16. 1932; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 481. 1996; Desikachary & al., Rhodophyta 2 (2B): 335, figs. D-F. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 86. 2001; P.S.N. Rao & Gupta, Algae India 3: 59. 2015.

Thallus dark to muddy red in colour, remiform, up to 15 cm long, bushy, gregarious, tufted, epilithic. Holdfast usually rhizoidal, firmly attached. Stipe small or indistinct. Frond remiform, usually 5-12 cm long, cylindrical, prominently branched in upper region; branches (ramuli) cruciform or pyramidate, up to 2 cm long, longer in the lower portion and gradually shorter in the upper region, tapering near the base and at the apex. Cystocarps develop terminally on the branches and branchlets.

Occurrence: Post-monsoon season. Rare.

Distribution: **Karnataka**: Uttara Kannda district (Karwar). **India**: Andhra Pradesh, Goa, Gujarat, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Illustration: Desikachary & al. *op. cit.*

Specimen Examined: Karnataka: Karwar coast, *Palanisamy & Yadav* 135817.

3. DELESSERIACEAE

Thallus dark-brown purple or light red in colour, foliaceous, membranous, compressed, occasionally filamentous. Fronds simple or branched or segmented into lobes, midrib usually conspicuous. Growth apical, axial cells usually surrounded by 4 pericentral cells. Spermatangia develop in sori, scattered over frond surface.

This family is represented by 12 genera in India and 2 genera in Karnataka.

Key to genera

1a. Thallus small, up to 7 cm long, midrib distinct, net like structure absent **1. Caloglossa**

1b. Thallus large, up to 30 cm long, foliose with flabellate lamellae, mibrib absent, net like structure preent **2. Martensia**

1. Caloglossa J. Agardh

Thallus brownish-dark red in colour, foliaceous, dichotomously branched, epilithic, occasionally on coastal wastes. Fronds membranous, thin, delicate, midrib

distinct, branches or proliferations usually arise from the midrib. Spermatangia develop in sori on both sides of the frond wings; cystocarps develop in midrib region.

Currently 20 taxa in world (Guiry & Guiry, 2017), 5 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Caloglossa leprieurii (Mont.) G. Martens in Flora 52: 234. 1869; Untawale & al., List Mar. Alg. India: 35. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 451. 1996; Desikachary & al., Rhodophyta 2 (2B): 254. 1998; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 58. 2015.

Delesseria leprieurii Mont. in Ann. Sci. Nat. Bot. 13: 196, pl. 5: fig. 1. 1840.

Thallus brownish-dark red in colour, foliose, flattened, up to 6 cm long, membranous, delicate, gregarious, prostrate, overlapped, epilithic, occasionally growing on coastal wastes. Holdfast minute, clustered, colourless, rhizoidal, arising from the nodes, attached to the rocky and muddy substrata in intertidal regions. Stipe minute, foliaceous. Fronds flattened or ribbon like, up to 6 cm long, dichotomously branched, branches dense towards apex, differentiated into nodes and internodes; nodes 75-240 µm wide; internodal segments flat, linear to lanceolate, usually compressed at base and expanded towards apex, 0.4-3 × 0.1-0.6 mm wide; surface smooth, membranous; midrib prominent in mature filaments; apex acute-acuminate, equally or unequally forked. *Microscopic*: Cells in surface view quadrangular to hexagonal, 6-20 µm across, compact, midrib cells 35-70 × 6-20 µm. Spermatangia in sori on both sides of midribs; cystocarps sessile, develop in midrib region on terminal part of mature thallus. **(Plate 29. c)**

Occurrence: Throughout the year. Moderate.

Distribution: Karnataka: Uttara Kannda districts**. India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Maharashtra, Tamil Nadu and West Bengal.

Specimen Examined: Karnataka: Mundoli, *Palanisamy & Yadav* 135668, 28.08.2016; Vannalli, *Palanisamy & Yadav* 135718, 29.08.2016; Om Beach, *Palanisamy & Yadav* 135733, 30.08.2016.

2. Martensia K. Hering

Thallus dark to pinkish red in colour, foliaceous, fan shaped with flabbelae blades, up to 30 cm long, usually fragile epilithic. Frond flat, irregularly lobed into several lobes.

Currently 18 taxa in world (Guiry & Guiry, 2016), 3 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Martensia fragilis Harv. in Hook. J. Bot. 6; 145. 1854; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 460. 1996; Desikachary & al., Rhodophyta 2 (2B): 272, figs. 76 a-d. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 80. 2001; ; P.S.N. Rao & Gupta, Algae India 3: 58. 2015.

Martensia pavonica (J. Agardh) J. Agardh in Spec Gen. Ord. Alg.. 80. 2001.

Thallus dark to pinkish red in colour, foliose, flattened, 4-10 cm long and 3-6 cm wide, membranous, thin, epilithic. Holdfast minute, attached with rhizoidal haptera. Stipe small, sessile or stlked to slightly flattened upwards. Fronds thin, foleaceous, flattened, reticulately oriented, lobed or irregularly divided; surface rough, margins entire to undulate. *Microscopic*: Cells in surface view shows alternate belts of coherent and reticulate tissues, reticulate tissues consists of parallel arranged lamellae; lamellae interconnected with cross connection and forming net like appearance.

Occurrence: Usually Monsoon season. Rare.

Distribution: Karnataka: Uttara Kannda district (Om beach). **India:** Goa, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Honnahalli, *Palanisamy* 135043, 24.02.2016.

Note: It is a new addition to the seaweed flora of Karnataka coast .

4. RHODOMELACEAE

Thallus light-dark or purple red in colour, bushy, filamentous, polysiphonous or pseudo parenchymatous, epiphytic, epilithic or epizoic. Fronds usually profusely branched, corticated or uncorticated; branches radially or dorsiventrally organized, indeterminate or determinate, exogenous or endogenous; cells of the main axis interconnected by means of pit connections, pericentral cells occasionally produce wing shaped extensions.

This family is represented by 21 genera in India and 4 in Karnataka.

Key to genera

1a.	Thallus showing dorsiventral organisation	**2. Bostrychia**
1b.	Thallus showing radial organisation	**2**
2a.	Thallus filamentous, erect, prostrate or heterotrichous, usually fragile	**4. Polysiphonia**
2a.	Thallus not filamentous, pseudoparenchymatous, usually erect, tufted	**3**
3b.	Thallus mostly cylindrical, spinous; central axial cell and pericentrals visible in thallus	**1. Acanthophora**
3b.	Thallus cylindrical-flattened, not spinous; central axial cell and pericentrals not clearly visible in thallus	**3. Laurencia**

1. Acanthophora J.V. Lamour.

Thallus light-dark brownish or purple red in colour, bushy, epilithic. Fronds irregularly or alternately branched, usually covered with spines. Anatomically, thallus polysiphonous, central cell surrounded by 5 pericentral cells.

Currently 7 taxa in world (Guiry & Guiry, 2017), 4 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Acanthophora spicifera (Vahl) Boergesen, Bot. Tidsskr. 30: 201. 1910; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 470. 1996; Desikachary & al., Rhodophyta 2 (2B): 332. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.:83. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 2. 2015.

Fucus spicifera Vahl, Skr. Naturahist.-Selsk., 5(2): 44. 1802.

Thallus greenish-dark purple red in colour, remiform, bushy, compressed or cylindrical to terete, upto 10 (-20) cm long, tufted, epilithic. Holdfast small, rhizoidal, clustered, colourless, branched, firmly attached. Stipe small, stalked, up to 1.5 cm long and 0.4-2.6 mm wide, rigid. Fronds bushy, consists of main axis and lateral branches; main axis usually compressed to terete, up to 15 cm long, spines usually absent; branches usually alternate or irregular; branchlets densely and spirally arranged, ultimate branchlets determinate, 200-920 × 150-300 µm, densely covered with spines; spines short, broadly subulate, 125-220 × 80-150 µm. *Microscopic*: Cells of the main axis pseudoparenchymatous, polysiphonous, axial cell with 5 pericentral cells, connected by thick cortical cells; cells mostly elongate or longitudinally rectangular. Reproductive structures develop on short branchlets; spermatangia develop in clusters on trichoblasts; cystocarps conical, usually with a lateral spine; tetrasporangial branches usually swollen, clothed with microscopic spines, tetrasporangia develop in series in obovate stichidium.

(Plate 29. d)

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: Uttara Kannda districts **India:** Andaman & Nicobar Islands, Goa, Gujarat, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Om Beach, *Palanisamy & Yadav* 135735, 30.08.2016; Paradise beach, *Palanisamy & Yadav* 135884, 24.11.2016; Gorte coast, *Palanisamy & Yadav* 136311, 27.11.2016.

2. Bostrychia Mont.

Thallus light to dark or brownish red in colour, decumbent, filamentous, subcylindrical to compressed, usually distichous, epilithic, attached by haptera or by rhizoids. Frond polysiphonous, axial cell surrounded by usually 5-10 transversely divided pericentral cells; branches exogenous. Cystocarps terminal.

Currently 38 taxa in world (Guiry & Guiry, 2017), 3 in India (Desikachary & al., 1998) and 1 in Karnataka.

Bostrychia tenella (J.V. Lamour.) J. Agardh, Spec. Gen. Ord. Alg. 2(3): 869. 1863; Untawale & al., List Mar. Alg. India: 38. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 475. 1996; Desikachary & al., Rhodophyta 2 (2B): 315. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 85. 2001; P.S.N. Rao & Gupta, Algae India 3: 59. 2015.

Plocamium tenellum J.V. Lamour., Ann. Mus. 20: 138. 1813.

Thallus dark-brownish to reddish purple in colour, prostrate, decumbent, bushy, up to 5 cm long, profusely branched, feather like appearance, epilithic. Holdfast rhizoidal, develops from the pericentral cells, further branched into several uniseriate hair like structures, up to 1.3 mm long, attached to the substratum at regular intervals. Stipe small, stalked, up to 5 mm long. Fronds bushy, main axis filamentous, subcylindrical, 1-5 cm long and 120-350 µm wide; branched alternately, pinnate, further divided up to 3 orders, branches profuse in apical region, cylindrical. *Microscopic*: Cells of the main axis and primary laterals polysiphonous, corticated, axial cells with 5-8 pericentral cells, 8-30 × 6-16 µm, thick walled, cells interconnected by means of pit connections; cells of the ultimate laterals always monosiphonous, 6-25 × 6-15 µm, thick walled, ultimate cells pointed to slightly curved. Thallus dioecious, spermatangia develop in clusters by the transformation of ultimate branchlets, cylindrical to terete, tapering towards both ends; cystocarps sub-terminal, solitary, ovoid to spherical.**(Plate 29. e)**

Occurrence: During Monsoon and post-monsoon seasons. Moderate.

Distribution: Karnataka: Uttara Kannda districts (Om Beach, Tadri Belekeri coast, Gorte coast). **India:** Goa, Gujarat and Tamil Nadu, Kerala.

Specimen Examined: Karnataka: Gorte, *Palanisamy & Yadav* 135661, 28.08.2016; Om Beach, *Palanisamy & Yadav* 135734, 30.08.2016; Tadri, *Palanisamy & Yadav* 135746, 30.08.2016.

Laurencia J.V. Lamour.

Thallus light to dark or pinkish red in colour, solitary or densely tufted, epilithic. Fronds cylindrical, terete to distinctly flattened, pinnate, palmate, alternate to radially or irregularly branched, branches usually with apical depressions. Anatomically, thallus consists of small cortical cells and large medullary cells.

Currently 145 taxa in world (Guiry & Guiry, 2017), 22 in India (Rao & Gupta, 2015) and 2 in Karnataka.

Key to species

1a. Thallus up to 25 cm long, fronds sparsely branched, apex obtuse **1. L. obtusa**
1b. Thallus up to 15 cm long, fronds densely covered with wart like tuberculae, apex acute to obtuse **2. L. papillosa**

1. Laurencia obtusa (Huds.) J.V. Lamour. in Ann. Mus. Hist. Nat. Paris 20: 130. 1813; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 515. 1996; Desikachary & al., Rhodophyta 2 (2B): 350. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 91. 2001; Jha & al., Seaweeds Gujarat: 198. 2009; P.S.N. Rao & Gupta, Algae India 3: 61. 2015.

Fucus obtusa Huds. Fl. Angl. 2: 586. 1778.

Thallus dark-pinkish red in colour, bushy, terete to slightly compressed, up to10 (-25) cm long, caespitose, tufted, epilithic. Holdfast small, usually disc oidal, firmly attached. Stipe small, stalked, tufted, up to 3.6 mm in diameter. Fronds

terete to complessed towards apex, profusely branched; branches usually pinnate to verticilate or opposite deccusate, cylindrical to terete or compressed, 3.5-13 × 0.8-2.5 mm, upper branches usually shoter and form a pyramidal shape; ramuli small, slightly constricted at base; margins entire, apex obtuse *Microscopic*: In cross section, thallus consists of outer small cortical cells and central large medullary cells; medullary cells spherical to polygonal, thin walled, devoid of lenticulatar thickenings. Reproductive structures develop on branches and ramuli; spermatangia develop in apical cup shaped sunken region, trichoblasts present **(Plate 29. f)**

Occurrence: Summer season Rare

Distribution: Karnataka: Uttara Kannda district (Gorte). **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Keala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Gorte, *Palanisamy* 134975, 22.02.2016; 134983, 135003, 23.02.2016.

2. Laurencia papillosa (C. Agardh) Grev. Alg. Brit. 52. 1830; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 517. 1996; Desikachary & al., Rhodophyta 2 (2B): 353. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 92. 2001; Jha & al., Seaweeds Gujarat: 199. 2009; Kaladharan & al. In J. Mar. Biol. Ass. India 53 (1): 125. 2011.

Thales dark-brownish or pinkish red in colour, up to 12 cm long, slender cylindrical stips, bushy, tufted, epilithic. Holdfast usually discoidal, firmly attached. Fronds cartilaginous, cylindrical, erect, irregularly branched, decreasing in diameter from the primary to the tertiary branches; branched densely covered with minute wart tike outgrowths or tuberculi; secondary branches are 0.6-3 cm long. Reproductive bodies develop on fertile branches; fertile branches vetricose with dilated apices.

Occurrence: Summer season Rare

Distribution: Karnataka. India: Andaman Islands, Laccadive Islands, Goa, Gujarat, Maharashtra.

Note: This species has been included here based on the report by Kaladharan & al. 2011. However, during the present study, it could not be traced and collected freshly.

4. Polysiphonia Grev.

Thallus light to dark or brownlish red in colour, filamentous, polysiphonous, erect, prostrate or heterotrichous, bushy, gregarious, caespitose, fragile, epilithic, epiphytic, epizoic or occasionally endophytic. Frond filamentous, cylindrical, simple or profusely branched; axial filaments with 4-24 pericentral cells. Cystocarps globose, spherical or urn shaped; tetrasporangia usually terminal on fertile branchlets, tetrahedral.

Currently 233 taxa in world (Guiry & Guiry, 2017), 13 in India (Rao & Gupta, 2015) and 1 in Karnataka.

Polysiphonia platycarpa Boergesen in Bull. Misc. Inform. Kew 1934: 23, figs., 15-17. 1934; K.S. Sriniv. in Bull. Bot. Surv. India 7: 248. 1965; Desikachary & al., Rhodophyta 2 (2B): 300. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 97. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; P.S.N. Rao & Gupta, Algae India 3: 63. 2015.

Polysiphonia gopanathensis Thivy & P.S. Rao in Bot. Mar. 5: 25, pls 1, 2. 1963.

Thallus dark-brownish or puple red in colour, filamentous, usually 2-5 (-8) cm long, bushy, erect, caespitose, usually epilithic. Holdfast minute, rhizoidal, loosely attached, occasionally free floating. Stipe small, filamentous, occasionally inconspicuous. Frond filamentous, up to 5 cm long and 130-200 µm in diameter, irregularly branched, distinctly differentiated into segments; segments 30-55 × 20-35 µm in basal region, gradually becoming shorter and attenuating upwards; apices narrowly obtuse to acute. *Microscopic*: Pericentral cells 4, elongate to cylindrical, 25-50 × 6-15 µm in basal region and smaller towards apex. Spermatangia develop in clusters; cystocarps spherical to urceolate, ostiolate; tetrasporangia usually oval.

Occurrence: Monsoon and post-monsoon seasons. Rare.

Distribution: Dakshina Kannada (Someshwar beach), Udupi (St. Mary Island, Malpe, Gangolli F.H.) and Uttara Kannda (Belekeri coast, Shiroor coast Mundoli) districts. **India:** Andhra Pradesh, Gujarat, Maharashtra and Tamil Nadu.

Specimen Examined: Karnataka: Belekeri coast, *Palanisamy & Yadav* 135828, 23.11.2016; Shiroor coast, *Palanisamy & Yadav* 131154, 14.10.2014; St. Mary Island, Malpe, *Palanisamy & Yadav* 131093, 12.10.2014.

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