

SEAWEED FLORA OF GOA COAST



भारतीय वनस्पति सर्वेक्षण
BOTANICAL SURVEY OF INDIA



2022



About the book

The present book on “Seaweed Flora of Goa Coast” is the 3rd in series of BSI publications on seaweeds, after Kerala (2020) and Karnataka (2022). It is an outcome of the extensive field explorations and collection of about 1130 field numbers of seaweeds from 58 stations spread in about 110 km long stretch of Goa coast during the years 2017-19. The book provides a comprehensive taxonomic account of seaweeds of the state of Goa, and records 90 taxa of seaweeds, belonging to 42 genera, 25 families and 18 orders. It includes 36 taxa of Rhodophyceae (40 %), 28 taxa of Chlorophyceae (31%) and 26 taxa of Phaeophyceae (29 %) and provides detailed taxonomic account including descriptions, keys, seasonal occurrence and distribution of each taxon, with additional notes wherever required. We hope, this book will serve as an important reference for phycologists, students and researchers in the field of marine science.

SEAWEED FLORA OF GOA COAST

M. PALANISAMY
S.K. YADAV



BOTANICAL SURVEY OF INDIA
2022



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Front cover:

A red seaweed *Chondria armata* (Kuetz.) Okamura (Rhodomelaceae)

Back cover:

Enormous growth of *Acanthophora spicifera* (M. Vahl) Boergesen at Reis Magos

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PREFACE

The present book on “Seaweed Flora of Goa Coast” is an outcome of the extensive field explorations along the 110 km long stretch of Goa coast during the years 2017-19. During this period, about 1130 field numbers of seaweeds were collected in duplicates from 58 coastal stations in different seasons. These specimens were thoroughly studied and well preserved in the form of herbarium specimens, and deposited at Madras Herbarium (MH), BSI, SRC, Coimbatore. The book illustrates a comprehensive taxonomic account of seaweed flora of the state, and records 90 taxa of seaweeds, belonging to 42 genera, 25 families and 18 orders. It includes 36 taxa of Rhodophyceae (40 %), 28 taxa of Chlorophyceae (31 %) and 26 taxa of Phaeophyceae (29 %). It is observed that the coastline of Goa is smaller than those of Kerala and Karnataka, it represents comparatively less diversity of seaweeds. The book provides detailed taxonomic account including additional notes wherever required. We are hopeful that this hand book will serve as an important reference for phycologists, students and researchers in the field of marine science.

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. 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 staff of the Publication Section, Botanical Survey of India, Kolkata for their kind support and help in editing, composing and finalizing this publication.

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We would also like to acknowledge the help rendered by the Director, ICAR-Central Coastal Agricultural Research Institute (ICAR-CCARI), Goa for accommodation during the field explorations; the Director, CSIR –National Institute of Oceanography (CSIR-NIO), Goa for permission to visit and refer the herbarium specimens, especially collections of Dhargalkar, Untawale, Kavlekar etc. deposited at NIO. We are also thankful to all those, who helped us in various ways, directly or indirectly, during the study period.

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FOREWORD

The Marine flora is one of the important components of the Indian Flora and plays an important role in sustainability of the marine. The Indian coastline is endowed with about 7,500 km length of coastline, spreading into 9 maritime states and 4 UTs, and exhibits a wide range of coastal habitats such as rocky coast, beaches, backwaters, estuaries, creeks, cliffs, lagoons, mangroves and coral reefs and support a large number of flora, such as marine algae (micro & macro), seagrasses, mangroves etc. In the present age, the conservation of marine biodiversity is a matter of global concerns, as it faces many challenges, both natural and anthropogenic. Therefore, extensive field explorations and proper documentation of the marine flora is a prerequisite for its proper conservation and sustainable utilization.

The present book titled “Seaweed Flora of Goa Coast” authored by Dr. M. Palanisamy, Scientist E and Dr. S.K. Yadav, Botanist is third in series of BSI publications on marine flora, after Seaweed Flora of Kerala and Karnataka states. The book presents a comprehensive taxonomic account of 90 taxa of seaweeds, belonging to 42 genera, 25 families and 18 orders. It includes 36 taxa of Rhodophyceae (40 %), 28 taxa of Chlorophyceae (31 %) and 26 taxa of Phaeophyceae (29 %) from the coastline of the state of Goa.

I congratulate the authors for their endeavors to bring out this valuable series on Seaweeds of Goa state in the public domain. I am sure, this book will be useful for the botanical fraternity, phycologists, students and researchers.

(A.A. Mao)

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GOA STATE



Map 1: Goa state with important coastal localities.

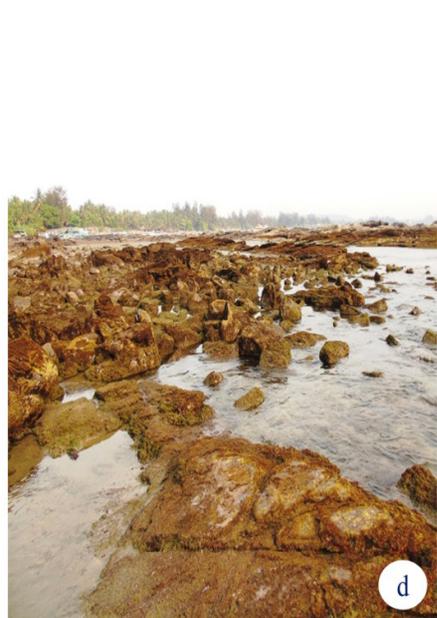
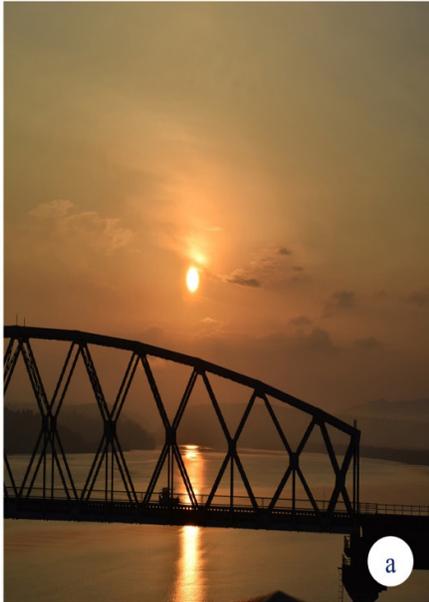


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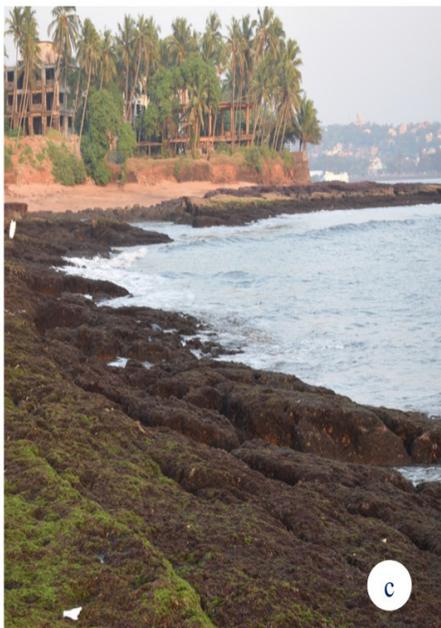


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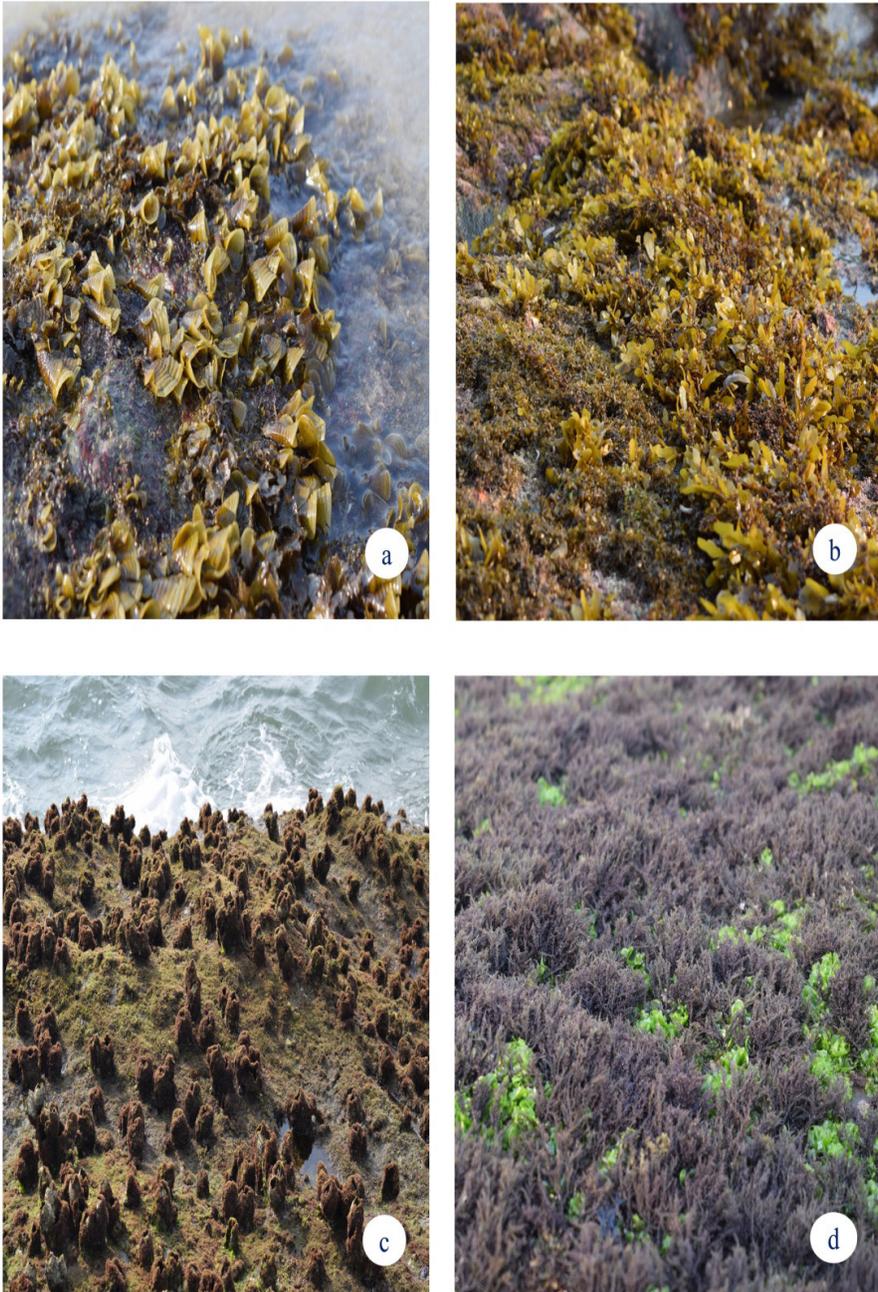


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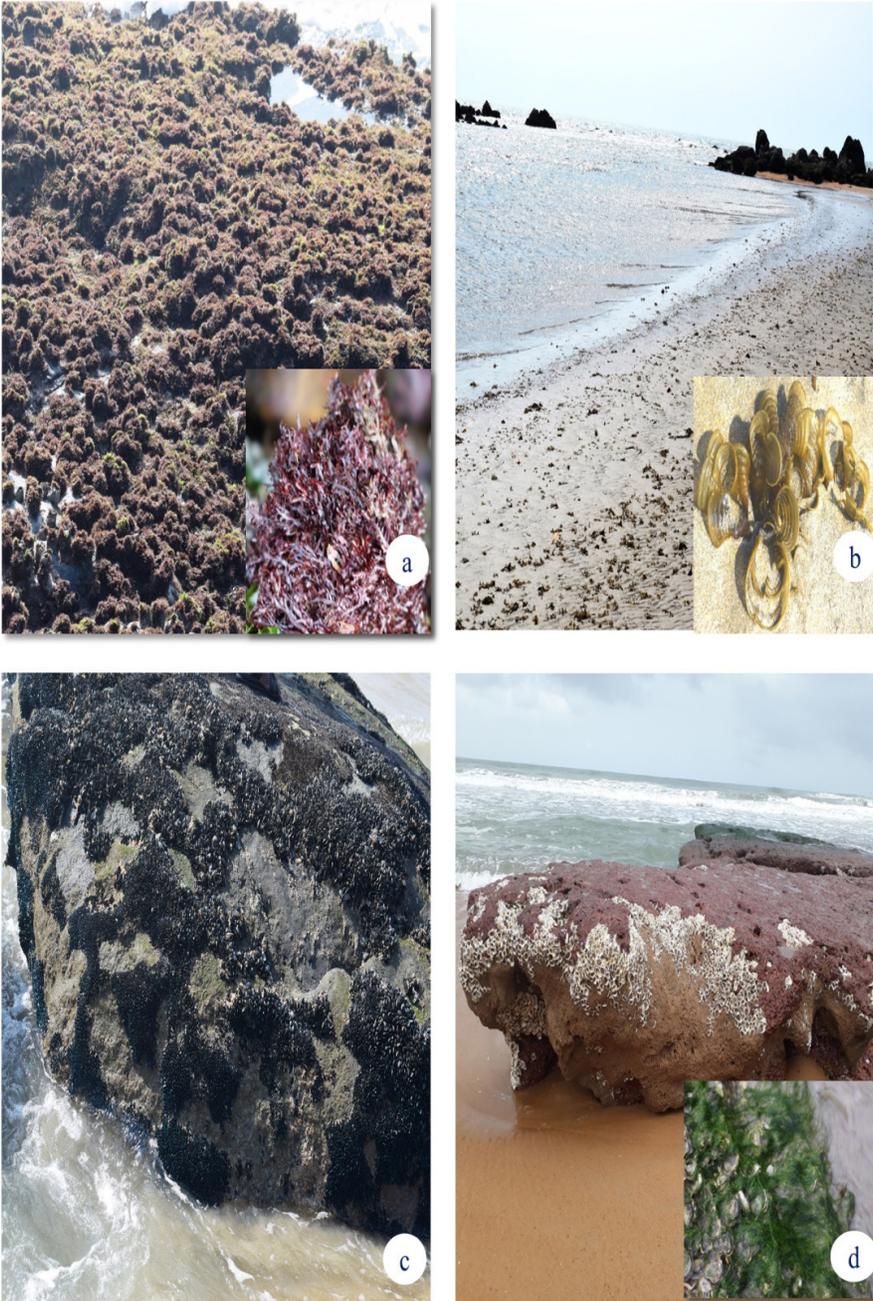


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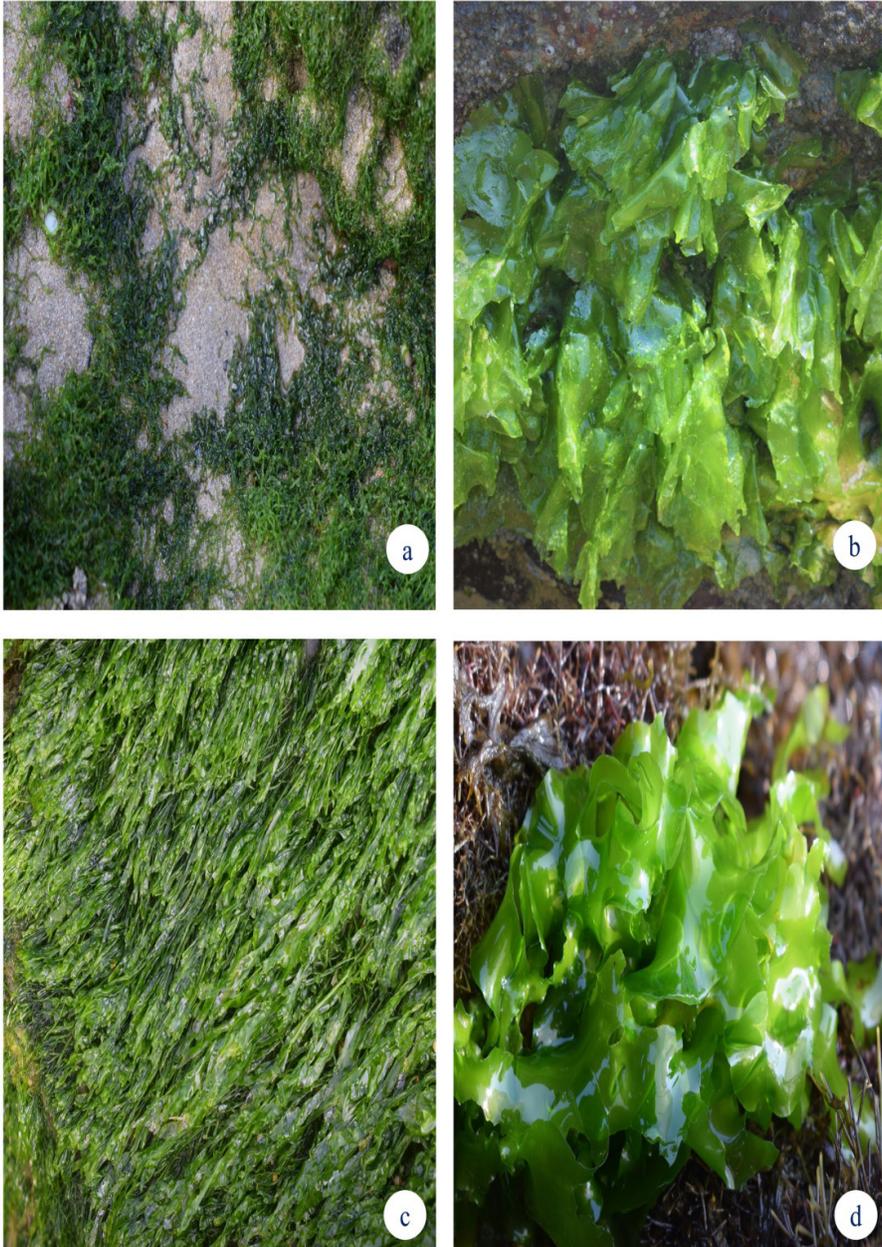


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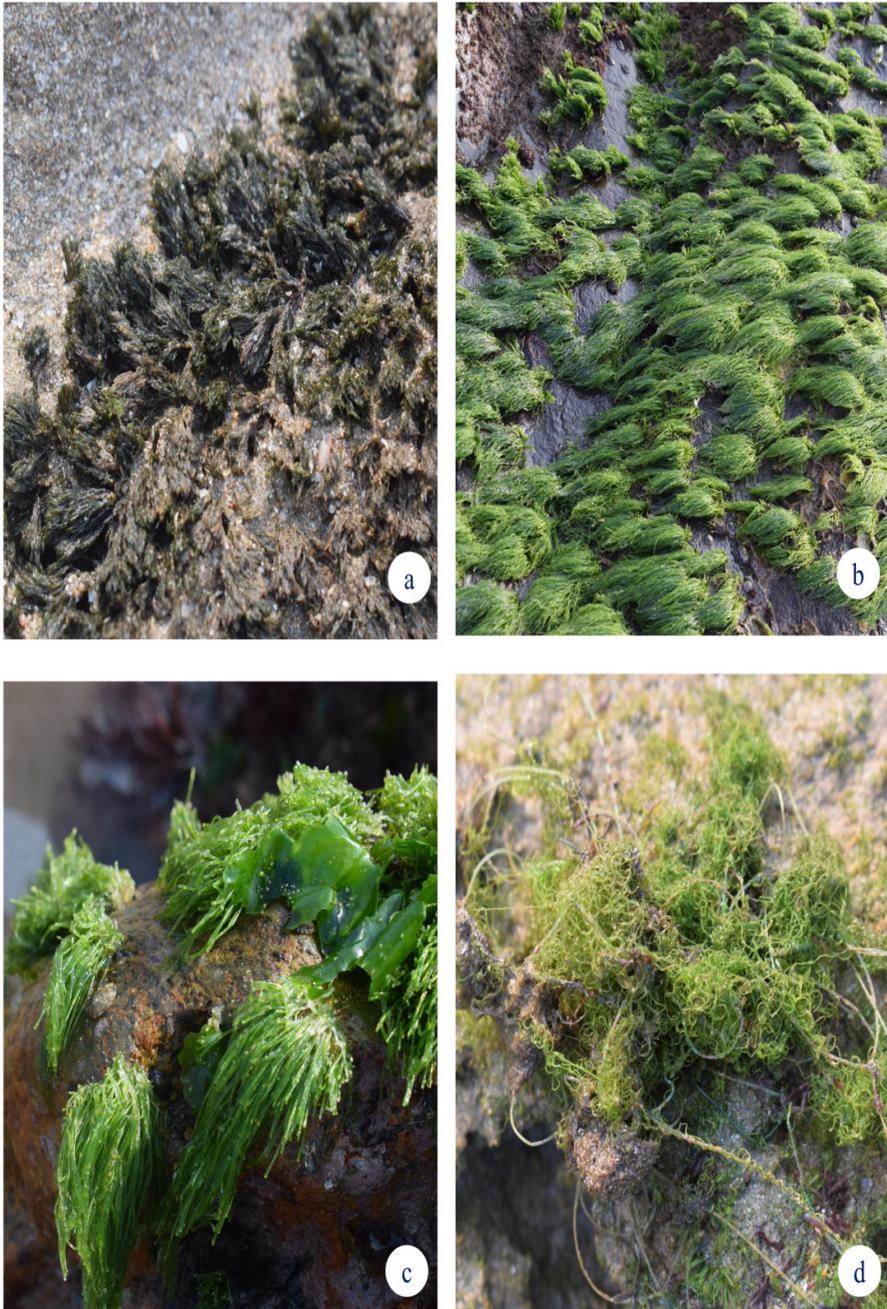


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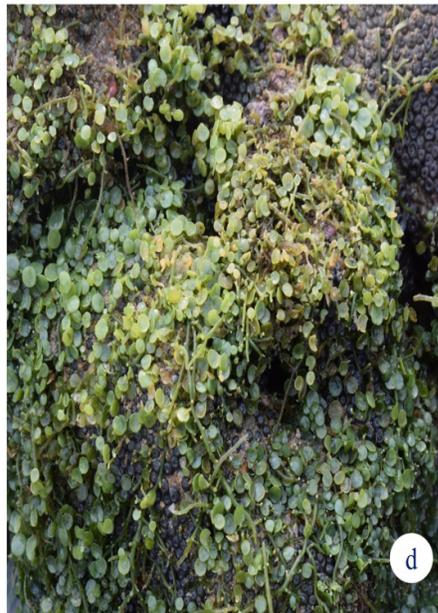


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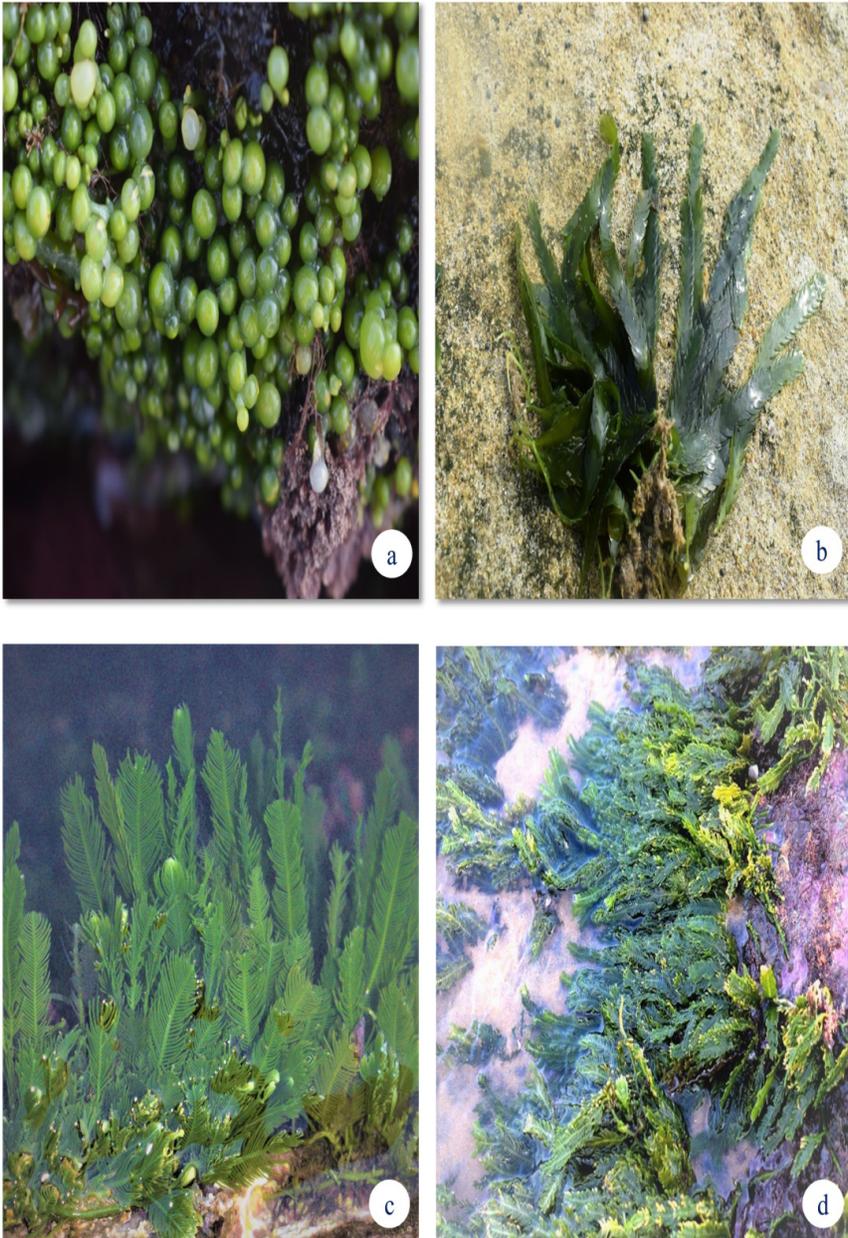


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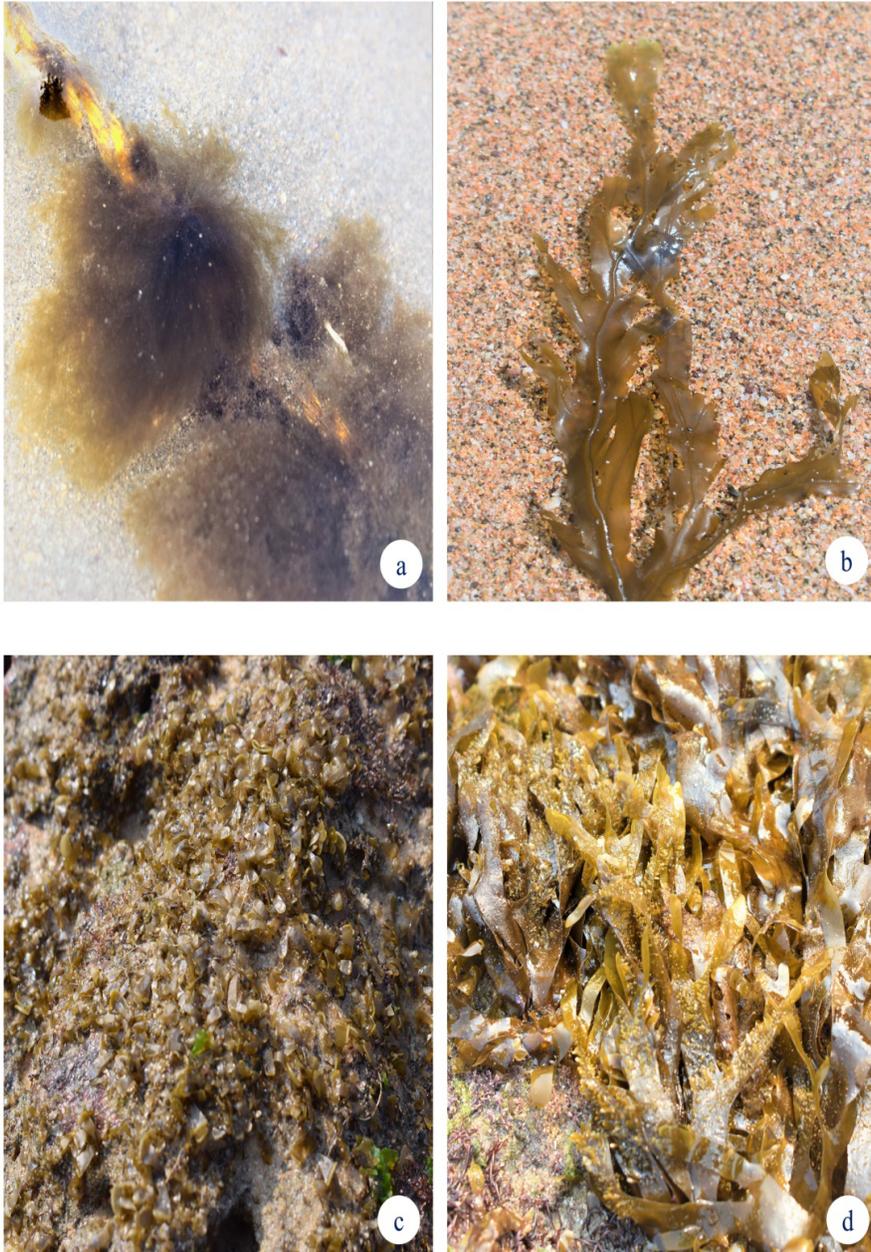


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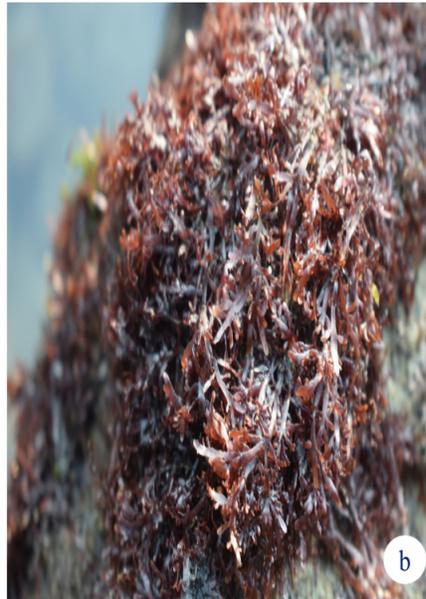


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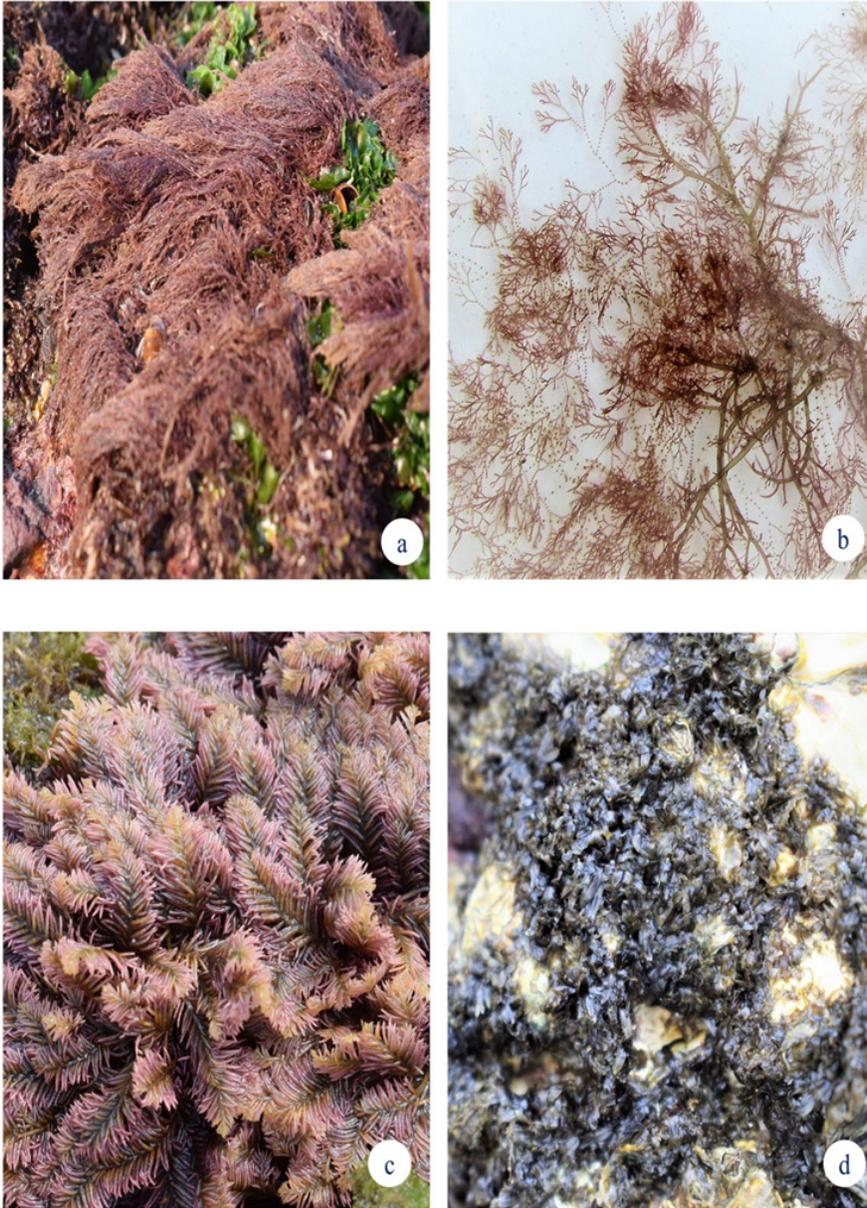


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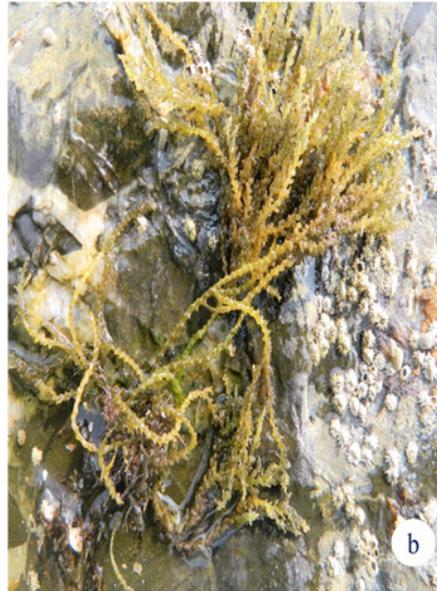
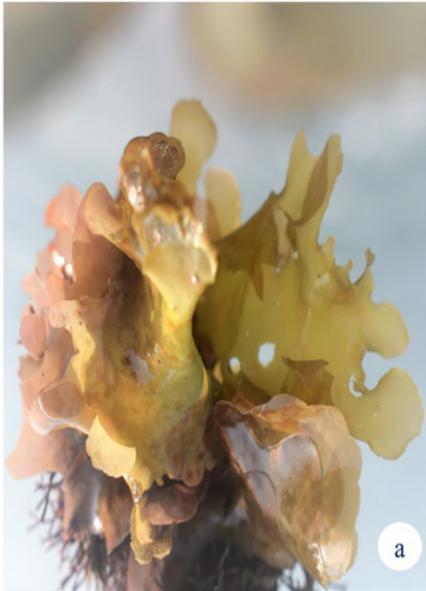


Plate XXII. Rhodophyceae: a - *Martensia fragilis* Harv.; b - *Acanthophora spicifera* (Vahl) Boergesen; c - *Bostrychia tenella* (J.V. Lamour.) J. Agardh; d - *Polysiphonia denudata* (Dillwyn) Grev.

INTRODUCTION

*“With every drop of water you drink, every breath you take,
you are connected to the sea. No matter where on Earth you live.”*

-Sylvia Earle

Biodiversity and its conservation are the main concerns of the present days at both International and nation levels. The marine ecosystems, which accounts around 97% of the aquatic ecosystems of the world, supports the lives of countless number of plants and animals, ranging from microscopic unicellular forms like diatoms, protozoans to the giant forms like kelps and Blue whales. Therefore, conservation of aquatic ecosystems is a matter of great importance.

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.

The term ‘Algae’ was first introduced by Linnaeus (1753), meaning the Hepaticae. According to Fritsch (1935), algae are the holophytic organisms that fail to reach the higher level of differentiation. 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*, *Diatom* 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 km². 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 244 taxa (Karthick & al., 2021) (Muthuvelan & al., 2001); Karnataka with 108 taxa, comprising of 36 chlorophyceae, 30 phaeophyceae and 42 rhodophyceae members (Palanisamy & Yadav, 2017); Diu island with 70 species (Mantri & 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 Goa coast has been taken into account.

AREA OF STUDY

Goa (**Map 1**), ($14^{\circ}53'$ – $15^{\circ}40'$ N latitude and $73^{\circ}40'$ – $74^{\circ}20'$ E longitude) located in the southwest coast of India, is well known for its beautiful beaches and tourism. It is bounded in the west by the Arabian Sea, in the east and south by the state of Karnataka and in the north by the state of Maharashtra. It is one of the smallest states in India with an area of 3,702 km². Goa, also known as Konkan, is also endowed with the rising mountain ranges of the Western Ghats, which separate it from the Deccan Plateau. The highest point of mountain range in Goa is Sansogor, with an altitude of 1,167 m.

The state of Goa has a coastline of *ca* 110 km length, and spreads into two districts *i.e.* North Goa and South Goa. The coastline is interrupted by a number of rivers, estuaries, beaches, rocky shores, cliffs, bays and creeks and covered with dense coconut plantations. The major rivers are Mandovi, Zuari, Terekhol, Chapora kushavati river and the Sal. It has seven estuaries and three bays. The coastline is more rocky in the North Goa and supports more growth and diversity of seaweeds. Some of the important places of algal growth at Goa coast are Querim, Vagator, Anjuna, Mormugao, Cabo de Rama, Palolem, Galgibag, and Polem coasts. The state is also gifted with several beautiful beaches along the coastline like Galgibaga, Querim, Arambol, Mandrem, Morjim, Ashwim, Vagator, Anjuna, Reis-Magos, Aguada, Siquerium fort coast, Candolim, Calangute, Baga, Miramar, Dona Paula, Bambolim, Valsao, Mormugao, Bogmallo, Hollant, Valsao, Arossim, Utorda, Majorda, Betalbatim, Colva, Sernabatim Beach, Varca, Carmona, Cavelossim, Mobor, Cabo de Rama Fort, Cola, Agonda, Paloleum, Colomb, Rajbagh, Patnem, Galgibag and Polem. Goa beaches are naturally endowed with beautiful landscapes and attracting large number of national and international tourists (Plates I - III). Fishing and tourism are the main occupations of the local people in coastal areas.

GEOLOGY

Geologically, the state of Goa forms a aperts of the Indian Precambrian shield. The late Cretaceous Deccan Traps are found only at the northeastern alluvium of the state. Whereas the Laterite and alluvium and sand on the coastal-estuarine plains cover most of the geological formations (Fernandes, 2009).

METEOROLOGY

Climate

Atmospheric Temperature °C

The state of Goa is usually warm and humid for almost throughout the year. The hottest month of the year is usually May, when the day time temperature reaches up to 36°C. However, Goa also experience a short cool season ranging from mid December to mid February with an average night temperature of *ca* 25°C and day temperature of *ca* 29°C. The average daily hours of sunshine is 9-10 hours in summer while 3-5 hours during the monsoon.

Seawater Temperature °C

The Goa coastal water attracts large number of tourists. The maximum seawater temperature was recorded 36.5°C during summer season and the lowest seawater temperature was recorded 23.5°C during winter season.

Rainfall

The average annual rainfall in the state is approximately 325 cm. Monsoon is the main season when Goa receives maximum rain. The monsoon arrives in the state in July and ends in September. Once the monsoon has run its course, the sky appears clear and the weather becomes pleasant.

Wind

The nature of wind over the coastal region of Goa is highly variable. During the southwest monsoon, the coastal region of the state experiences high magnitude of wind.

Tides

The regular rise and fall of the sea water is known as tides. When it rises to its highest level, it is called high tide and during this period most parts of the coastline get covered with water. Similarly, when the level of water falls down to its lowest level, it is called low tide and during this period, most parts of the shoreline get exposed. In Goa coast, the average tidal value ranges from -0.1 to 2.2 m. The tidal nature in the Arabian Sea along the Goa coastline is not always uniform throughout the year. Usually, the wave activity becomes very strong and violent during the south-west monsoon.

Coastal Topography

The study of arrangement of the natural and artificial physical features of the coastal region is called coastal topography. The pattern of the natural and artificial features of the coastline is an important factor for influencing seaweed vegetation. Natural rocks, bed rocks, dead corals, pebbles, bivalve shells and man-made constructions are the main substrata on which seaweeds germinate and grow. The coastline of Goa is very small and spreads only into two districts *i.e.* North and South Goa. The northern part of the coastline is comparatively more rocky and supports good vegetation of marine algae whereas the southern part is mostly sandy with rocky cliffs of the Western Ghats and supports limited diversity of seaweeds.

Salinity

Salinity is the measurement of concentration of salt content in sea water. It also plays an important role in determining the marine algal vegetation in a particular habitat. During the present study, the lowest salinity (25.4‰) was recorded in monsoon season whereas the highest (36.9‰) was recorded during the summer season. The low saline water supports more diversity 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 showed a wide range of fluctuation during the study period. The high value (8.7) was recorded during the summer season and the low (7.8) value during the monsoon season.

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 28.6 mg/l during monsoon season whereas the lowest as 1.5 mg/l during the summer. The high DO value indicates more concentration of oxygen and therefore it high biomass in the area.

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 Moravian 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), Bhavnagarpublished *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 studied 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. Similarly, the marine algal diversity along the coastline of Karnataka has also been studied by various workers. 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. Untawale & al. (1989) reported the presence of 65 species of seaweeds belonging to 42 genera from the northern 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. Kaladharan & al. (2011) reported 78 species of seaweeds and species of seagrasses from the entire Karnataka coast. Palanisamy & Yadav (2017) surveyed the entire coastline of Karnataka and documented 108 taxa of marine macro algae.

Besides the 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 Subharamaiah & 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 GOA

A perusal of literature pertaining to study on the algal flora of Goa coast revealed that the survey and documentation of the marine algal research in Goa coastline is sporadic and incomplete. The initial survey of the Goa coast was done by the scientists of the National Institute of Oceanography (NIO), Goa during 1975. The pioneer works on the seaweed resources of this region were done by Agadi (1985), Untawale & al. (1981, 1983), Dhargalkar (1981), Dhargalkar & Untawale (1991), Untawale, 1998) and Dhargalkar & Pereira (2005). Later, few other researchers like Rao & Mantri (2006) Dhargalkar (2008), sporadically published reports on seaweeds of Goa coast. Dhargalkar (1981) and Agadi (1986) reported 74 species of seaweeds from Goa. Recently, Pereira & Almeida (2012) published a checklist and reported 145 species of marine algae, including micro algae which comprises 64 species of Rhodophyceae, 41 species of Chlorophyceae and 40 species of Phaeophyceae from the Goa coast. However, there is no any comprehensive study on the taxonomic aspects of seaweeds in the form of flora. Therefore, it is being proposed to carry out the comprehensive survey of Goa coast with the following objectives:

OBJECTIVES

- ❖ Survey and collection of seaweeds in different seasons from entire coast of Goa.
- ❖ Herbarium preparation and documentation of the seaweed resources of the Goa coast.
- ❖ Study of the economically important seaweeds.
- ❖ Liquid preservation of economically important seaweeds in BSI, SRC museum, Coimbatore.
- ❖ The preparation of data and compilation of manuscript in the form of SEAWEED FLORA OF GOA COAST, INDIA.

MATERIALS AND METHODS

The present study on seaweed resources of Goa coast is primarily based on the fresh collection of seaweeds, consultation of seaweed herbarium and scrutiny of the relevant literature pertaining to the study area.

Marine Macro Algal Collection

During the study period from 2017-19, a total of 5 botanical exploration tours were undertaken to the entire coastal regions of Goa, spread into two districts i.e. North Goa and South Goa for Marine Macro Algae (seaweeds) collection. 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 starting to the field trips, tide tables were collected from the Meteorological department website to fix the suitable days and time for the survey/collection of seaweeds. The seaweeds were randomly collected from rocks, artificial cement boulders, mollusc shells and coastal wastes like nets, plastics, cloths etc during low tides. 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, a total of 58 localities (Table I) were selected from the entire coastline of Goa and 1135 field (Table 2) 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 IV- VI) habit, habitats, GPS coordinates of collection locality and vegetation pattern etc. were noted in field notebook. Photographs of the coastline, habit, habitats and vegetation patterns were taken using digital as well as underwater cameras.

Table I: GPS co-ordinates of collection locations of Goa coast

Sl. No.	Seaweed collection locations	Latitudes	Longitudes
1. SOUTH GOA DISTRICT			
1	Tilmati	14° 53' 93.7" N	74° 05' 64.9" E
2	Polem	14° 54' 50.3" N	74° 04' 70.9" E
3	Xandrem	14° 56' 36.6" N	74° 02' 62.4" E
4	Galgibag	12° 57' 79.7" N	74° 02' 85.3" E
5	Talpona	12° 57' 77.7" N	74° 02' 44.4" E
6	Talpona river with back water area	14° 59' 12.2" N	74° 02' 62.7" E
7	Rajbag	14° 59' 52.8" N	74° 02' 14.4" E
8	Patnem	14° 59' 62.3" N	74° 02' 08.7" E
9	Colomb	15° 00' 11.2" N	74° 01' 67.5" E

10	Palolem	15° 00' 69.8" N	74° 00' 93.0" E
11	Agonda	15° 03' 21.5" N	73° 58' 80.7" E
12	Cola beach	15° 03' 56.9" N	73° 53' 20.7" E
13	Cabo de Rama Fort	15° 06' 32.3" N	73° 55' 43.4" E
14	Capegao	15° 06' 32.5" N	73° 55' 40.9" E
15	Neum beach	15° 06' 74.5" N	73° 56' 10.7" E
16	Canaguinim	15° 07' 71.3" N	73° 56' 10.9" E
17	Betul fort	15° 08' 51.8" N	73° 56' 92.8" E
18	Mobor	15° 09' 39.1" N	73° 56' 69.9" E
19	Cavelossim	15° 10' 30.2" N	73° 56' 49.1" E
20	Carmona	15° 12' 31.5" N	73° 55' 71.6" E
21	Zalore	15° 12' 32.9" N	73° 55' 97.8" E
22	Fatrade	15° 12' 69.34" N	73° 55' 91.7" E
23	Varca	15° 12' 77.4" N	73° 55' 88.2" E
24	Benaulim	15° 14' 74.7" N	73° 55' 33.0" E
25	Colva	15° 16' 56.2" N	73° 54' 78.8" E
26	Betalbatim	15° 17' 53.6" N	73° 54' 47.9" E
27	Majorda	15° 18' 65.5" N	73° 54' 09.6" E
28	Utorda	15° 19' 14.4" N	73° 53' 92.2" E
29	Arossim	15° 20' 47.7" N	73° 53' 39.6" E
30	Cansaulim	15° 21' 06.4" N	73° 53' 25.9" E
31	Velsao	15° 21' 26.1" N	73° 53' 03.0" E
32	Hollant	15° 22' 19.5" N	73° 51' 76.0" E
33	Bogmalo	15° 22' 09.4" N	73° 50' 08.5" E
34	Siridao	15° 26' 48.9" N	73° 51' 60.2" E
35	Baina	15° 23' 71.1" N	73° 48' 21.4" E
36	Mormugao	15° 24' 41.2" N	73° 47' 17.1" E
2. NORTH GOA DISTRICT			
37	Bambolim	15° 26' 56.6" N	73° 51' 48.9" E
38	Oxdel	15° 27' 23.9" N	73° 49' 60.2" E
39	Dona Paula	15° 18' 99.6" N	73° 48' 41.9" E
40	Mormugao (Japanese park)	15° 24' 41.1" N	73° 47' 16.4" E
41	Rajbhawan coast (Marivel beach)	15° 27' 61.1" N	73° 47' 86.1" E
42	Mirmar	15° 29' 00.5" N	73° 48' 42.5" E
43	Mandovi river basin (Betim ferry)	15° 28' 01.7" N	73° 48' 41.3" E
44	Reis-Magos	15° 29' 77.6" N	73° 47' 93.7" E
45	Aguada fort	15° 29' 53.4" N	73° 46' 66.9" E
46	Sinquerium	15° 29' 85.7" N	73° 45' 90.0" E

47	Candolim	15° 31' 07.7" N	73° 45' 74.3" E
48	Calangute	15° 32' 72.9" N	73° 45' 28.2" E
49	Baga	15° 33' 71.8" N	73° 44' 85.8" E
50	Nyx	15° 35' 08.1" N	73° 44' 21.0" E
51	Anjuna	15° 35' 90.1" N	73° 43' 97.4" E
52	Vagator	15° 36' 41.4" N	73° 43' 93.1" E
53	Ashwem	15° 38' 61.6" N	73° 43' 03.2" E
54	Morjim	15° 37' 05.6" N	73° 43' 90.6" E
55	Mandrem	15° 39' 97.2" N	73° 42' 62.6" E
56	Arambol	15° 41' 46.7" N	73° 42' 03.8" E
57	Kiranpani	15° 43' 42.9" N	73° 42' 66.8" E
58	Querim	15° 42' 37.7" N	73° 41' 61.0" E

Table 2: Summary of the field tours conducted and field nos. vouched

Tour No.	Duration of the tour	Field book series	F. Nos. vouched / collected
1	06.10.2017 to 15.10.2017	139801 – 139900 139901 – 139989	189
2	11.12.2017 to 22.12.2017	139990 – 140000 140001 – 140100 142301 – 142400 137701 – 137800 140101 – 140118	329
3	12.02.2018 to 25.02.2018	140119 – 140200 140201 – 140300 142201 – 142300 142301 – 142348	330
4	19.06.2018 to 26.06.2018	142349– 142400 142401 – 142431	83
5	22.10.2018 to 02.11.2018	142432 – 142500 143801– 143900 143901 – 143935	204
Total field nos. vouched			1135

Preservation of Collected Samples

All the collected marine macro algal samples were washed thoroughly with sea water, followed by using fresh water to remove attached sand particles, sediments and debris without damaging the specimens. Later, they were preserved by adopting two methods.

1. Wet Preservation (Pickle method)
2. Dry Preservation (Herbarium method)

Wet Preservation

The specimens were preserved in mixed solution of 4% formalin, 1% ethyl alcohol and 95 % seawater in different size plastic containers (50 ml, 100 ml, 250 ml, 500 ml and 1000 ml) and tightly sealed. All the containers were labeled properly with name of the species, field number, date, place of collection and collector/s name. All the preserved materials were 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 tray and standard herbarium sheet (28 × 42 cm) was immersed in between tray 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 delicate.
- Each herbarium sheet was pasted a field number 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 mess pres 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 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 of herbaria is an important part of the taxonomic studies. It helps the researchers in confirming the identity of the taxa and also in understanding the distributional, and vegetation pattern of the taxa of a particular place. During the present study, consultation of herbarium, museum and library of National Institute of Oceanography (CSIR-NIO), Goa, Goa University, Goa and Madras Herbarium (MH), Coimbatore were referred and all the available herbarium specimens were studied. 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 consulted in order to get the recent literature and updates in the field of marine algal science.

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 in confirming the identity of the species. For anatomical study, series of sections were made using the standard techniques (Prasad & Krishna Prasad, 1986). The best sections were selected and examined using optical microscopes (NIKON SMZ1500 & NIKON ECLIPSE 50i) to study the anatomical characters and confirm the identity of the species.

Description

Descriptions of all the collected marine macro algal taxa were written based on the field observation, study of morphological and anatomical characters. All the identified and enumerated taxa from Goa 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 Goa 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, are provided in italic. Nomenclature has been updated following the recent International Code of Nomenclature for Algae, Fungi and Plants (Turland & al., 2018). The names of authors of plant names are after *Authors of Plant Names* by Brummitt & Powell (1992) whereas the 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 Goa and India in alphabetical order, and notes and uses, wherever necessary have been provided.

Identification

All the collected samples were identified using morphological and anatomical characters and by referring the following standard references: *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/), and other standard books etc.

RESULTS AND DISCUSSION

FLORISTIC ANALYSIS

In the present scenario, Biodiversity and its conservation has become the matter of great environmental concern. The marine floral resources are the integral part of the country's biodiversity and its documentation and conservation are more essential in current scenario. In the present study, all attempts have been made to survey and document the diversity and distribution of the marine macro algae of Goa coast. During the study period (2017-2019), 5 botanical explorations tours were undertaken to entire coastlines of Goa in various seasons and totally 58 coastal stations / localities (Table 1) were fixed and surveyed. A total of 1135 field numbers of seaweeds were collected and preserved in dry form *i.e.* herbarium method and wet form, following the standard procedures. The collected specimens were studied morphologically & anatomically under microscopes for detailed information. Besides, consultation of herbarium specimens at various institutions and study of the standard literature were done for accurate identification of the seaweeds. The significant results of the present study are summarized and given below under different headings.

The present study reveals a total of 90 taxa (including varieties and forma) under 42 genera belonging to 25 families and 18 orders. Out of 90 taxa recorded 36 taxa are of Rhodophyceae, 28 taxa of Chlorophyceae and 26 taxa of Phaeophyceae (Table 3 & 4). Among 3 classes (Fig. 1), Rhodophyceae is dominant with 36 taxa (40%), followed by Chlorophyceae with 28 species (31%) and Phaeophyceae with 26 species (29%). Therefore, the present study records the highest diversity of seaweeds as compared to previous workers Agadi (1985), Untawale & al. (1981, 1983), Dhargalkar (1981), Dhargalkar & Untawale (1991), Untawale, 1998) and Dhargalkar & Pereira (2005). The other important findings of the present study are dealt below under various headings.

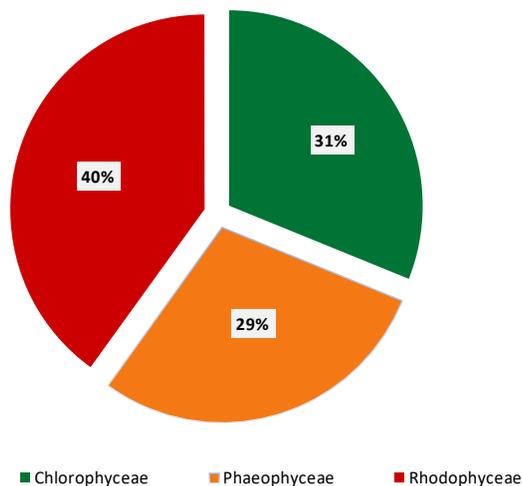


Fig. 1: Pie chart showing seaweed diversity in Goa coast

Table 3. List of the seaweed taxa recorded from goa coast, india

Sl. No.	Order	Family	Genus	Species name
CHLOROPHYCEAE (GREEN SEAWEEDS)				
1.	ULOTRICHALES	ONOSTROMATACEAE	Monostroma (1)	Monostroma latissimum Witt.
2.	ULVALES	ULVACEAE	Ulva (8)	Ulva compressa L.
3.				Ulva conglobata Kjellman
4.				Ulva fasciata Delile
5.				Ulva flexuosa Wulfen
6.				Ulva intestinalis L.
7.				Ulva lactuca L.
8.				Ulva prolifera O.F.Muell.
9.				Ulva rigida C. Agardh
10.	ACROSIPHONIALES	ACROSIPHONACEAE	Acrosiphonia (1)	Acrosiphonia orientalis (J. Agardh) P.C. Silva
11.	CLADOPHORALES	CLADOPHORACEAE	Chaetomorpha (5)	Chaetomorpha aerea (Dillwyn) Kuetz.
12.				Chaetomorpha antennina (Bory) Kuetz.
13.				Chaetomorpha crassa (C. Agardh) Kuetz.
14.				Chaetomorpha linum (O.F. Muell.) Kuetz.
15.				Chaetomorpha spiralis Okamura
16.			Cladophora (1)	Cladophora vagabunda (L.) C. Hoek
17.	SIPHONOCLADALES	SIPHONOCLADACEAE	Cladophoropsis (1)	Cladophoropsis sundanensis Reinbold
18.			Phyllocladion (1)	Phyllocladion anastomosans (Harvey) Kraft & M.J.Wynne
19.		VALONIACEAE	Valoniopsis (1)	Valoniopsis pachynema (G. Martens) Boergesen
20.	BRYOPSISDALES	BRYOPSISDAEAE	Bryopsis (3)	Bryopsis hypnoides J.V. Lamour.
21.				Bryopsis pennata J.V. Lamour.
22.				Bryopsis plumosa (Huds.) C. Agardh
23.		CAULERPACEAE	Caulerpa (6)	Caulerpa peltata J.V. Lamour.
24.				Caulerpa racemosa (Forssk.) J. Agardh

25				<i>Caulerpa racemosa</i> (Forssk.) J. Agardh var. <i>turbinata</i> (J. Agardh) Eubank
26				<i>Caulerpa scalpelliformis</i> (R. Br. ex Turner) C. Agardh
27				<i>Caulerpa sertularioides</i> (S.G. Gmel.) M. Howe
28				<i>Caulerpa taxifolia</i> (Vahl) C. Agardh
PHAEOPHYCEAE (BROWN SEaweEDS)				
29	ECTOCARPALES	ECTOCARPACEAE	Ectocarpus (1)	Ectocarpus siliculosus (Dillwyn) Lyngb.)
30			Iyengaria (1)	Iyengaria stellata (Boergesen) Boergesen
31	DICTYOTALES	DICTYOTACEAE	Dictyopteris (2)	Dictyopteris australis (Sond.) Askenasy
32				Dictyopteris delicatula J.V. Lamour.
33			Dictyota (6)	Dictyota bartayresiana J.V. Lamour.
34				Dictyota cervicornis Kuetz.
35				Dictyota ceylanica Kuetz.
36				Dictyota ciliolata Kuetz.
37				Dictyota dichotoma (Huds.) J.V. Lamour.
38				Dictyota pinnatifida Kuetz.
39			Padina (5)	Padina boergesenii Allender & Kraft
40				Padina boryana Thivy
41				Padina gymnospora (Kuetz.) Sonder
42				Padina pavonica (L.) Thivy
43				Padina tetrastratica Hauck
44			Spatoglossum (1)	Spatoglossum asperum J. Agardh
45			Stoehospermum (1)	Stoehospermum marginatum (C.Agardh) Kuetz.
46			Zonaria (1)	Zonaria crenata J.Agardh
47	SCYTOSIPHONALES	SCYTOSIPHONACEAE	Colpomenia (1)	Colpomenia sinusa (G. Mertens ex Roth) Derbes & Solier
48			Rosenvingea (1)	Rosenvingea intricata (J. Agardh) Boergesen
49	FUCALES	SARGASSACEAE	Sargassum (6)	Sargassum cinctum J. Agardh
50				Sargassum cinereum J. Agardh

51				<i>Sargassum linearifolium</i> (Turner) C. Agardh
52				<i>Sargassum polycystum</i> C. Agardh
53				<i>Sargassum tenerrimum</i> J. Agardh
54				<i>Sargassum wightii</i> Grev.
RHODOPHYCEAE (RED SEAWEEDS)				
55	BANGIALES	BANGIACEAE	Porphyra (2)	<i>Porphyra crispata</i> Kjellm.
56				<i>Porphyra vietnamensis</i> Tak. Tanaka & P.H. Ho
57	GELIDIALES	GELIDIACEAE	Gelidium (2)	<i>Gelidium micropterum</i> Kuetz.
58				<i>Gelidium pusillum</i> (Stackh.) Le Jolis
59	GRACILARIALES	GRACILARIACEAE	Gracilaria (3)	<i>Gracilaria corticata</i> (J. Agardh) J. Agardh
60				<i>Gracilaria corticata</i> (J. Agardh) J. Agardh var. <i>cylindrica</i> M.U. Rao
61				<i>Gracilaria foliifera</i> (Forssk.) Boergesen
62				<i>Gracilaria textorii</i> (Suringar) De Toni
63	CRYPTOMANIALES	HALYMENIACEAE	Grateloupia (2)	<i>Grateloupia filicina</i> (J.V. Lamour.) C. Agardh
64				<i>Grateloupia lithophila</i> Boergesen
65	CORALLINALES	CORALLINACEAE	Amphiroa (3)	<i>Amphiroa anceps</i> (Lam.) Desce.
66				<i>Amphiroa fragilissima</i> (L.) J.V. Lamour.
67				<i>Amphiroa rigida</i> J.V. Lamour.
68			Cheilosporum (1)	<i>Cheilosporum spectabile</i> Harv. ex Grunov
69			Jania (1)	<i>Jania rubens</i> (L.) J.V. Lamour.
70		HYDROLITHACEAE	Hydrolithon (1)	<i>Hydrolithon reinboldii</i> (Weber Bosse & Foslie) Foslie
71	GIGARTINALES	GIGARTINACEAE	Chondracanthus (1)	<i>Chondracanthus acicularis</i> (Roth) Fredericq
72		HYPNEACEAE	Hypnea (5)	Hypnea (5)
73				<i>Hypnea flagelliformis</i> Grev. ex J. Agardh
74				<i>Hypnea musciformis</i> (Wulfen) J.V. Lamour.
75				<i>Hypnea spinella</i> (C. Agardh) Kuetz.
76				<i>Hypnea valentiae</i> (Turner) Mont.

77	RHODYMENIALES	CHAMPIACEAE	Champia (1)	<i>Champia compressa</i> Harv.
78		RHODYMENIACEAE	Gelidiopsis (2)	<i>Gelidiopsis repens</i> (Kuetz.) Weber-Van Bory
79				<i>Gelidiopsis variabilis</i> (J. Agardh) F. Schmitz
80	CERAMIALES	CERAMIACEAE	Centroceras (1)	<i>Centroceras clavulatum</i> (C. Agardh) Mont.
81			Ceramium (1)	<i>Ceramium flaccidum</i> (Kuetz.) Ardiss.
82			Chondria (1)	<i>Chondria armata</i> (Kuetz.) Okamura
83		DELESSERIACEAE	Caloglossa (1)	<i>Caloglossa leprieurii</i> (Mont.) G. Martens
84			Martensia (1)	<i>Martensia fragilis</i> Harv.
85		RHODOMELACEAE	Acanthophora (2)	<i>Acanthophora muscoides</i> (L.) Bory
86				<i>Acanthophora spicifera</i> (Vahl) Boergesen
87			Bostrychia (1)	<i>Bostrychia tenella</i> (J.V. Lamour.) J. Agardh
88			Laurencia (1)	<i>Laurencia obtusa</i> (Huds.) J.V. Lamour.
89			Polysiphonia (2)	<i>Polysiphonia denudata</i> (Dillwyn) Grev.
90				<i>Polysiphonia platycarpa</i> (Dillwyn) Grev. ex Harvey

Table 4. Summary on the numerical report of seaweeds in Goa coast

S. No	Class	Order	Family	Genus	Species
1.	Chlorophyceae	6	8	10	28
2.	Phaeophyceae	4	4	11	26
3.	Rhodophyceae	8	13	21	36
4.	Total	18	25	42	90

Dominant families and genera found in Goa coast

An analysis of the taxa recorded in the present study reveals that family Dictyotaceae shows the highest diversity with 7 genera and 18 species, followed by Ulvaceae, comprising of single genus *Ulva* with 8 species, Cladophoraceae comprising of 2 genera with 6 species, Sargassaceae, comprising of single genus *Sargassum* with 6 species and Caulerpaceae with single genus *Caulerpa* with 6 species (Table 5). Similarly, among various genera *Ulva*, *Dictyota* and *Sargassum*, *Chaetomorpha*, *Caulerpa*, *Padina* and *Hypnea* are most dominant genera as shown in Table 6.

Table 5. Dominant families of Seaweeds in Goa coast.

Sl. No.	Family	Genera	Species
1.	DICTYOTACEAE	6	16
2.	ULVACEAE	1	8
3.	CLADOPHORACEAE	2	6
4.	SARGASSACEAE	1	6
5.	CAULERPACEAE	1	6

Table 6. Dominant genera of Seaweeds in Goa coast.

Sl. No.	Genera	Species
1.	<i>Ulva</i>	8
2.	<i>Caulerpa</i>	6
3.	<i>Dictyota</i>	6
4.	<i>Sargassum</i>	6
5.	<i>Chaetomorpha</i>	5
6.	<i>Padina</i>	5
7.	<i>Hypnea</i>	5

New additions

During the present floristic study on seaweed flora of Goa coast, 19 taxa, consisting of 7 green seaweeds, 7 brown seaweeds and 5 red seaweeds are recorded as new additions to the state (Table 7).

Table 7. List of new additions to seaweed flora of Gao coast.

Sl. No.	Order	Family	Genus	Species name
CHLOROPHYCEAE (GREEN SEaweEDS)				
1	ULOTRICHALES	MONOSTROMATACEAE	Monostroma (1)	Monostroma latissimum Witt.
2	ULVALES	ULVACEAE	Ulva	Ulva fasciata Delile
3				Ulva prolifera O.F.Muell.
4	ACROSIPHONIALES	ACROSIPHONIACEAE	Acrosiphonia	Acrosiphonia orientalis (J. Agardh) P.C. Silva
5	CLADOPHORALES	CLADOPHORACEAE	Chaetomorpha	Chaetomorpha aerea (Dillwyn) Kuetz.
6				Chaetomorpha crassa (C. Agardh) Kuetz.

7	BRYOPSIDALES	CAULERPACEAE	Caulerpa	<i>Caulerpa racemosa</i> (Forssk.) J. Agardh var. turbinata (J. Agardh) Eubank
PHAEOPHYCEAE (BROWN SEaweEDS)				
8	ECTOCARPALES	ECTOCARPACEAE	Ectocarpus	<i>Ectocarpus siliculosus</i> (Dillwyn) Lyngb.)
9	DICTYOTALES	DICTYOTACEAE	Dictyota	<i>Dictyota pinnatifida</i> Kuetz.
10			Padina	<i>Padina boergesenii</i> Allender & Kraft
11			Zonaria	<i>Zonaria crenata</i> J. Agardh
12		SCYTOSIPHONACEAE	Rosenvingea	<i>Rosenvingea intricata</i> (J. Agardh) Boergesen
13		SARGASSACEAE	Sargassum	<i>Sargassum linearifolium</i> (Turner) C. Agardh
14				<i>Sargassum wightii</i> Grev.
RHODOPHYCEAE (RED SEaweEDS)				
15	GRACILARIALES			<i>Gracilaria corticata</i> (J. Agardh) J. Agardh var. <i>cylindrica</i> M.U. Rao
16				<i>Gracilaria textorii</i> (Suringar) De Toni
17	GIGARTINALES			<i>Hypnea esperi</i> Bory
18	RHODYMENIALES			<i>Gelidiopsis repens</i> (Kuetz.) Weber-Van Bory
19	CERAMIALES			<i>Ceramium flaccidum</i> (Kuetz.) Ardiss.

ECONOMICALLY IMPORTANT SEaweEDS

Among the various marine natural resources, seaweeds are one of the economically important resources used in the form of food, fodder and in various industries since times immemorial. In many of the south East Asian countries *i.e.* Japan, Philippines, China, Thailand, Korea etc. seaweeds are added with regular food. 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, algin, alginates etc.), textiles, pharmaceuticals, food industry, cosmetics, biofertilizers (SLF), paper industries, biofuel etc. Presently, 221 economically important seaweeds are reported from worldwide, of which 125 are from India (Sahoo, 2000). In Goa, totally 45 species of economically important seaweeds were recorded.

Other observations

An analysis of the field observation made during 2017-19 for botanical exploration along the Goa coast reveals that the abundance of the seaweeds shows much variation in pattern of seaweed distribution. Species like *Acanthophora spicifera*, *Amphiroa fragilissima*, *Acrosiphonia orientalis*, *Caulerpa taxifolia*,

Centroceras clavulatum, *Chaetomorpha antennina*, *Cladophora vagabunda*, *Cheilosporum spectabile*, *Gelidiopsis variabilis*, *Gelidium micropterum*, *Gracilaria corticata*, *Grateloupita filicina*, *G. lithophila*, *Dictyota ciliolata*, *Padina boergesenii*, *Padina boryana*, *Padina tetrastromatica*, *Stoechospermum marginatum*, *Sargassum cinereum*, *Sargassum wightii*, *Sargassum polycystum*, *Hypnea nmusciformis*, *Ulva compressa*, *U. fasciata*, *U. flexuosa*, *U. prolifera* are commonly found and distributed widely. Similarly, species like *Amphiroa anceps*, *Bryopsis plumosa*, *Caulerpa peltata*, *Dictyota ceylanica*, *Dictyota dichotoma*, *Ectocarpus siliculosus*, *Padina pavonica*, *Caloglossa leprieurii*, *Polysiphonia platycarpa*, *Gracilaria foliifera*, *Porphyra vietnamensis*, *Monostroma latissimum*, *Ulva lactuca* etc. were moderately distributed at most of the places.

Whereas species like *Champia compressa*, *Chaetomorpha spiralis*, *Caulerpa scalpelliformis*, *C. sertularioides*, *Dictyota cervicornis*, *Dictyopteris delicatula*, *Hypnea valentiae*, *Chaetomorpha crassa*, *Ulva rigida* etc. were found scantily distributed.

SYSTEMATIC TREATMENT

The seaweed taxa enumerated from the Goa 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, 6 orders are represented in Goa coast and its taxonomic keys 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 |
| 3a. | Thallus foliose, small, up to 30 cm long | Ulotriconales |
| 3a. | 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 (Krishnamurthy, 2000) and only one genus in Goa.

1. *Monostroma* Thur.

Thallus membranous, foliose, forming a saccate shape in young stage, variable in length. Anatomically, cells usually isodiametric, monostromatic. Presently, 32 taxa in world (Guiry & Guiry, 2019), 2 in India (Rao & Gupta, 2015) and 1 species in Goa.

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, 1-5 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, $8.50 \times 12.6 \mu\text{m}$ across, thick walled, uninucleate, chloroplast laminate with one to many pyrenoids.

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

Distribution: Goa: Vagator. **India**: Goa, Gujarat and Karnataka.

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here. In habitat, it 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: Goa coast: Vagator beach, *Palanisamy & Yadav* 139824, 08.10.2017.

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 a single genus *Ulva* L. in India as well as in Goa.

Note: *Ulva* is one of the most common and widely distributed taxa in India. Morphologically, it shows wide range of variation in size, ranging from few cm to several metres and thallus is tubular to leafy in nature. Anatomically, it has mono- or dia-stromatic thallus with quadrate to polygonal cells. In most of the literature,

this genus is treated under two distinct genera *i.e.* *Enteromorpha* and *Ulva*, based on the variation in morphological and anatomical characters (like tubular, membranous, foliose thallus, number of layer(s) of cells such as mono- or diastromatic nature etc.). However, Hayden & al. (2003) based on the molecular study opined that the two genera *Ulva* and *Enteromorpha* are not distinct and have similar molecular orientation. Therefore, they merged the genus *Enteromorpha* under *Ulva* and the same is now followed worldwide.

Globally, ca 130 taxa are found under this genus (Guiry & Guiry, 2018), of which 32 are in India (Rao & Gupta, 2015) and 8 in Goa.

Key to species

- | | | |
|-----|---|---------------------------|
| 1a. | Thallus tubular, small, anatomically monostromatic | 2 |
| 1b. | Thallus leafy, flat, anatomically diastromatic | 5 |
| 2a | Fronds intestine like, contorted, coiled, simple | 5. U. intestinalis |
| 2b | Fronds not intestine like, simple or branched | 3 |
| 3a. | Thallus up to 6 cm long, fronds tapering below and gradually expanded above | 1. U. compressa |
| 3b. | Thallus up to 20 cm long, fronds hairy, almost uniform throughout | 4 |
| 4a. | Fronds simple, flexuous or twisted, inflated | 4. U. flexuosa |
| 4b. | Fronds sparsely branched upwards | 7. U. prolifera |
| 5a. | Fronds ribbon like, up to 1.5 m long, simple or lobed; lobes linear, usually uniformly flattened, up to 5 cm wide; margins entire to undulate | 3. U. fasciata |
| 5b. | Fronds not ribbon like, rounded, obovate to lanceolate or slightly lobed | 3 |
| 6a. | Thallus small, upto 5 cm long, Fronds usually undivided | 2. Ulva conglobata |
| 6b. | Thallus upto 10 cm long, Fronds usually multilobed, divided | 7 |
| 7a. | Thallus small, up to 10 cm long and 15 cm broad, rounded to obovate or irregularly proliferated into small lobes, delicate to transparent | 6. U. lactuca |
| 7b. | Thallus large, up to 15 cm long, usually ovate-round in young stage and becomes orbicular to slightly lobed, rigid, thick, tufted | 8. U. rigida |

1. *Ulva compressa* L., Sp. Pl. 2: 1163. 1753; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014.

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-dark green in colour, 1.5-8 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, $1-7 \times 0.2-1.3$ mm, surface smooth, margins entire, apex obtuse to round, slightly transparent. *Microscopic*: Cells in surface view squarish-elongate or irregular, $15-30 \mu\text{m}$ across, $8-16 \mu\text{m}$ across in basal region, irregularly arranged, cell wall thin; cells in cross section $15-32 \times 10-13 \mu\text{m}$, sheath with equal thickness, up to $2 \mu\text{m}$ thick; uninucleate; chloroplast plate like with single pyrenoid (Plate: VII-a)

Occurrence: Throughout the year. Common.

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

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

Specimen Examined: Goa coast: Patnam Coast, *Palanisamy & Yadav* 142407, 24.06. 2018; Agonda Coast, *Palanisamy & Yadav* 142425, 24.06. 2018; Calangute beach, *Palanisamy & Yadav* 139992, 12.12.2017; Valsao coast, *Palanisamy & Yadav* 142233, 18.02.2018; Neum coast, *Palanisamy & Yadav* 142263, 21.02.2018; Colomb coast, *Palanisamy & Yadav* 142315, 23.02.2018; Nyex Coast, *Palanisamy & Yadav* 143838, 26.10.2018; Valsao coast, *Palanisamy & Yadav* 143873, 29.10.2018; Polem Coast, *Palanisamy & Yadav* 143931, 01.10.2018.

2. *Ulva conglobata* Kjellman, Bih. Kongl. Svensk. Vetensk. –Akadem. Handlingar, Afd. III 23(11): 1-44, 7 figs, 7 plates; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 152. 2001; Jha & al., Seaweeds Gujarat: 14. 2009; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014; P.S.N. Rao & Gupta, Algae India 3: 3. 2015.

Thallus light-bright green in colour, usually 1.5-5 cm long, leafy, undivided and forming tufted globular mass, mostly gregarious, lithophilic. Holdfast small, rhizoidal, firmly attached. Stipe small, foliaceous, simple. Fronds leafy, undivided, firmly contorted; blades 1-3 cm wide, surface smooth, cartilaginous below and gradually membranous above; margins entire to frequently undulate; apex acute to obtuse. *Microscopic*: Cells in surface view polygonal - squarish, $8-16 \mu\text{m}$ across, irregularly arranged; in cross section thallus surface $80-110 \mu\text{m}$ thick towards base and $60-105 \mu\text{m}$ towards apex; cells palisade like, distromatic, compactly arranged, $30-50 \times 8-15 \mu\text{m}$; separated with $6-14 \mu\text{m}$ thick middle layer, uninucleate, chloroplast cup like (Plate: VII-b).

Occurrence: Throughout the year. Common.

Distribution: Throughout Goa coast. **India**: Andaman & Nicobar Islands; Gujarat; Maharashtra.

Notes: This is one of the economically important marine algae and used in aqua culture. In China, it is widely used in Fodder, food and pharmaceutical substances (Jha & al., 2009).

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 139852, 08.10.2017; Betul fort coast, *Palanisamy & Yadav* 139932, 12.10.2017; Nyex coast, *Palanisamy & Yadav* 137634, 14.12.2017; Sinqerim fort beach *Palanisamy & Yadav* 137645, 15.12.2017; Siridao coast, *Palanisamy & Yadav* 137678, 16.12.2017; Sinqerim coast, *Palanisamy & Yadav* 142216, 17.02.2018; Bambolim coast, *Palanisamy & Yadav* 142225, 18.02.2018; Cabo-de-Rama coast, *Palanisamy & Yadav* 142275, 21.02.2018; Palolem coast, *Palanisamy & Yadav* 142313, 22.02.2018; Bogmallo coast, *Palanisamy & Yadav* 142250, 20.02.2018; Xandrem coast, *Palanisamy & Yadav* 142341, 23.02.2018.

3. *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; 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, usually 5-40 (-60) cm long, leafy, ribbon shaped, gregarious, tufted, lithophilic. Holdfast small, rhizoidal, tufted, firmly attached. Stipe small, foliaceous, simple or branched, up to 25 cm long and 1 cm wide. Fronds leafy, deeply divided into several linear blades; blades 0.8-4 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, 10-18 μm across, irregularly arranged; in cross section thallus surface 80-110 μm thick towards base and 75-105 μm towards apex; cells palisade like, distromatic, compactly arranged, 30-40 \times 8-15 μm ; separated with 8-13 μm thick middle layer, uninucleate, chloroplast plate like, concentrated mainly towards cell wall (Plate: VII-c).

Occurrence: Throughout the year. Common.

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

Notes: This species is recorded here as an addition to the Goa coast. Although it is one of the most common species in the west coast, it was not reported previously from here. In habitat, it is usually 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 poultry animals (Jha & al., 2009).

Specimen Examined: Goa coast: Querim beach, *Palanisamy & Yadav* 139801, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139851, 08.10.2017; Baga beach, *Palanisamy & Yadav* 139881, 07.10.2017; Sinqerim fort beach, *Palanisamy & Yadav* 139886, 09.10.2017; Vagator beach, *Palanisamy & Yadav* 139821, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139847, 08.10.2017;

Baina beach, *Palanisamy & Yadav* 139909, 09.10.2017; Bagmalo coast, *Palanisamy & Yadav* 139924, 11.10.2017; Neum beach, *Palanisamy & Yadav* 139944, 12.10.2017; Talpona beach, *Palanisamy & Yadav* 139966, 13.10.2017; Galgibaga beach, *Palanisamy & Yadav* 139969, 13.10.2017; Querim beach, *Palanisamy & Yadav* 140014, 13.12.2017; Querim beach, *Palanisamy & Yadav* 140016, 13.12.2017; Arambol beach, *Palanisamy & Yadav* 140038, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140064, 14.12.2017; Patnem beach, *Palanisamy & Yadav* 139956, 13.10.2017; Banaulium beach, *Palanisamy & Yadav* 139929, 11.10.2017; Anjuna beach, *Palanisamy & Yadav* 137607, 14.12.2017; Candolim coast, *Palanisamy & Yadav* 137642, 15.12.2017; Coco beach, *Palanisamy & Yadav* 137659, 15.12.2017; Reis Magos coast, *Palanisamy & Yadav* 137665, 15.12.2017; Bambolim coast, *Palanisamy & Yadav* 137676, 16.12.2017; Zalore beach, *Palanisamy & Yadav* 137699, 17.12.2017; Arambol coast, *Palanisamy & Yadav* 140201, 14.02.2018; Ashwim coast, *Palanisamy & Yadav* 140214, 15.02.2018; Ashwim coast, *Palanisamy & Yadav* 140237, 15.02.2018; Anjuna coast, *Palanisamy & Yadav* 140269, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140280, 16.02.2018; Patnem coast, *Palanisamy & Yadav* 142338, 23.02.2018; Polem coast, *Palanisamy & Yadav* 142342, 24.02.2018; Valsao coast, *Palanisamy & Yadav* 142231, 18.02.2018; Baga beach, *Palanisamy & Yadav* 142432, 23.10.2018; Querim coast, *Palanisamy & Yadav* 142436, 24.10.2018; Morjim, *Palanisamy & Yadav* 142493, 25.10.2018; Vagator coast, *Palanisamy & Yadav* 143806, 26.10.2018; Nyex Coast, *Palanisamy & Yadav* 143836, 26.10.2018; Coco Beach, *Palanisamy & Yadav* 143842, 27.10.2018; Bambolium Coast, *Palanisamy & Yadav* 143855, 28.10.2018; Bogmalo coast, *Palanisamy & Yadav* 143869, 28.10.2018; Cabo De Rama Coast, *Palanisamy & Yadav* 143883, 30.10.2018; Cola Coast, *Palanisamy & Yadav* 143888, 30.10.2018; Galgibag Coast, *Palanisamy & Yadav* 143916, 31.10.2018.

4. *Ulva flexuosa* Wulfen, Crypt. Aquat. 3: 1. 1803; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014. *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; P.S.N. Rao & Gupta, Algae India 3: 1. 2015.

Thallus light-dark green in colour, usually 4-15 (-25) cm long, tubular, 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, 3-6 μm long. Fronds hairy in young stage and becoming somewhat flat at maturity, 4-15 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, 10-20 μm across; arranged in linear series towards base and irregularly towards apex; cells in cross section thallus 18-25 μm thick, cells usually rectangular, 15-22 \times 12-20 μm wide; uninucleate; chloroplast completely filling almost entire cell, pyrenoids spherical (Plate: VII-d).

Occurrence: Throughout the year. Common.

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

Notes: This is one of the common species in Goa coast and grows luxuriantly during the monsoon and post monsoon seasons.

Uses: This alga is economically very important. 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 polyunsaturated fatty acids, minerals, vitamins, antioxidants and proteins (Jha & al., 2009).

Specimen Examined: Goa coast: Vagator beach, *Palanisamy & Yadav* 139822, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139831, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139841, 08.10.2017; Baina beach, *Palanisamy & Yadav* 139907, 09.10.2017; Valsao coast, *Palanisamy & Yadav* 139914, 10.10.2017; Hollant coast, *Palanisamy & Yadav* 139927, 11.10.2017; Patnem beach, *Palanisamy & Yadav* 139959, 13.10.2017; Bania Coast, *Palanisamy & Yadav* 14239, 23.06. 2018; Sinquerim fort beach, *Palanisamy & Yadav* 137643, 15.12.2017; Nyex coast, *Palanisamy & Yadav* 140281, 16.02.2018; Baga coast, *Palanisamy & Yadav* 142218, 17.02.2018; Valsao coast, *Palanisamy & Yadav* 142232, 18.02.2018; Cavellosim coast, *Palanisamy & Yadav* 142258, 20.02.2018; Palolem coast, *Palanisamy & Yadav* 142311, 22.02.2018; Palolem coast, *Palanisamy & Yadav* 142311, 22.02.2018; Mandrim Coast, *Palanisamy & Yadav* 142363, 21.06. 2018; Vagator Coast, *Palanisamy & Yadav* 142369, 21.06. 2018; Nyex Coast, *Palanisamy & Yadav* 142371, 21.06. 2018; Sinquerim Coast, *Palanisamy & Yadav* 142374, 22.06. 2018; Reis Magos Coas, *Palanisamy & Yadav* 142381, 22.06. 2018; Mormugao Coast, *Palanisamy & Yadav* 142389, 23.06. 2018; Bania Coast, *Palanisamy & Yadav* 142390, 23.06. 2018; Galgibag Coast, *Palanisamy & Yadav* 142412, 24.06.2018; Polem Coast, *Palanisamy & Yadav* 142423, 25.06. 2018; Agonda Coast, *Palanisamy & Yadav* 142424, 24.06.2018; Baga beach, *Palanisamy & Yadav* 142433, 23.10.2018; Anjuna Coast, *Palanisamy & Yadav* 143824, 26.10.2018; Cabo De Rama Coast, *Palanisamy & Yadav* 143885, 30.10.2018, Cola Coast, *Palanisamy & Yadav* 143889, 30.10.2018.

5. *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; Palanisamy & al. in Rajendran & Aravindhan (eds.), Biodiver.Conserv.: Asp. Prosp.: 28. 2015.

Thallus light-dark green in colour, long, up to 15 cm long and 2-5 mm wide, tubular, contorted, filaments intestine like in mature stage, lithophilic. Holdfast minute, discoid, attached loosely to the substratum but later free floating; Stipe simple, small, up to 2 cm long. Fronds usually simple, 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, 7-18 μ m across, irregularly arranged; in cross section 10-22 \times 9-16 μ m, sheath with equal thickness, 5-8 μ m thick; uninucleate; chloroplast cup shaped, ulmost complete, with several pyrenoids (Plate: VIII-a).

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

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

Notes: In habitat, this species can be recognised with its characteristic unbranched, intestine like fronds. 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: Goa coast: Ashwim beach, *Palanisamy & Yadav* 139815, 08.10.2017; Baina beach, *Palanisamy & Yadav* 139908, 09.10.2017; Hollant coast, *Palanisamy & Yadav* 139928, 11.10.2017; Polem Coast, *Palanisamy & Yadav* 142418, 25.06. 2018.

6. *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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014; P.S.N. Rao & Gupta, Algae India 3: 3. 2015.

Thallus light-dak green in colour, usually 3-8 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, 6-14 μ m across, thick walled, irregularly arranged; in cross section cells usually rectangular, uninucleate; chloroplast cup shaped, with one or two pyrenoids (Plate: VIII - b).

Occurrence: Monsoon and post-monsoon seasons. Moderate.

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

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

Specimen Examined: Goa coast: Vagator coast, *Palanisamy & Yadav* 140259, 6.02.2018.

7. *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; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 749. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 151. 2001; Palanisamy & al. in Rajendran & Aravindhan (eds.), Biodiver.Conserv.Asp.Prospect. 33. 2015. *Enteromorpha polyclados* (Kuetz.) Kuetz. Tab. Phycol. 6: 13. 1856.

Thallus dark-yellowish green in colour, usually 4-18 (-25) cm long, usually proliferated, growing in densely intricated masses, regularly tubular throughout. Holdfast small. Stipe slender, small, simple or branched. Fronds tubular, 0.4-1.5 cm width across, simple below and prominently proliferated above 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, 8-15 μm across, linear to irregularly arranged; in cross section oblong, 9-24 \times 5-10 μm wide, sheath up to 4 μm thick; uninucleate; chloroplast complete, filling almost entire cell, pyrenoids one to many (Plate: VIII- c).

Occurrence: Throughout the years. Common.

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

Notes: This species is recorded here as an addition to the Goa coast. In habitat, it is usually growing luxuriantly during the monsoon and post-monsoon seasons.

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

Specimen Examined: Goa coast: Nuem Coast, *Palanisamy & Yadav* 142400, 24.06. 2018; Patnam Coast, *Palanisamy & Yadav* 142408, 24.06. 2018; Agonda Coast, *Palanisamy & Yadav* 142426, 24.06. 2018; Querim coast, *Palanisamy & Yadav* 142448, 24.10.2018; Cola Coast, *Palanisamy & Yadav* 143899, 30.10.2018; Polem Coast, *Palanisamy & Yadav* 143928, 01.10.2018.

8. *Ulva rigida* C. Agardh, Spec. Alg. 1(2): 410. 1823; Untawale & al., List Mar. Alg. India: 7 1983; V. Krishnam., Alg. India Neighb. Countr. Chlorophycota 1: 94. 2000; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 155. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014; 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, 2-15 cm long, leafy, rigid, 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, 6-20 μm across, irregularly

arranged; in cross section, cells palisade like or elongate, $18-42 \times 10-22 \mu\text{m}$, compactly arranged, separated by $4-8 \mu\text{m}$ thick middle layer; cell cuticle upto $4 \mu\text{m}$ thick; uninucleate; chloroplast cup shaped with 1-2 pyrenoids (Plate: VIII- d).

Occurrence: Monsoon and post-monsoon seasons. Moderate.

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

Specimen Examined: Goa coast: Vagator beach, *Palanisamy & Yadav* 139850, 08.10.2017; Querim beach, *Palanisamy & Yadav* 140007, 13.12.2017; Querim Coast, *Palanisamy & Yadav* 140095, 21.06.2018; Querim Coast, *Palanisamy & Yadav* 142350, 21.06.2018; Mandrim Coast, *Palanisamy & Yadav* 142362, 21.06.2018; Agonda Coast, *Palanisamy & Yadav* 142427, 24.06.2018; Morjim coast, *Palanisamy & Yadav* 142477, 25.10.2018; Vagator coast, *Palanisamy & Yadav* 143801, 26.10.2018; Cola Coast, *Palanisamy & Yadav* 143893, 30.10.2018.

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 Goa.

Acrosiphonia J. Agardh

Generic characters are similar to family characters.

Presently, 13 taxa in world (Guiry & Guiry, 2019), 2 In India (Rao & Gupta, 2015) and 1 in Goa.

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, usually 2-8 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 0.7-2.5 mm long, 100-300 μm broad, apical cells 200-990 \times 85-250 μm , uniseriately arranged; in cross section cell wall up

to 40 μm thick; multinucleate, chloroplast reticulate with numerous pyrenoids (Plate: IX-a).

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

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

Note: This species is recorded here as an addition to the Goa coast. Although it is one of the most common species in the west coast, it was not reported previously from here. 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 Syndrome Virus (WPSV). Thus it can be utilised as a prophylactic drug in shrimp disease management.

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 139879, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 137605, 14.12.2017; Capehao beach, *Palanisamy & Yadav* 137727, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137751, 18.12.2017; Agonda beach, *Palanisamy & Yadav* 137768, 18.12.2017; Arambol beach, *Palanisamy & Yadav* 140018, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140082, 14.12.2017; Galgibag coast, *Palanisamy & Yadav* 140129, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140159, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140172, 14.02.2018; Arambol coast, *Palanisamy & Yadav* 140204, 14.02.2018; Ashwim coast, *Palanisamy & Yadav* 140217, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140257, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140274, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140282, 16.02.2018; Patnem coast, *Palanisamy & Yadav* 142335, 23.02.2018; Querim coast, *Palanisamy & Yadav* 142453, 24.10.2018; Morjim coast, *Palanisamy & Yadav* 142476, 25.10.2018.

3. CLADOPHORALES

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 Goa.

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, 70 taxa in world (Guiry & Guiry, 2019), 14 of them in India (Rao & Gupta, 2015) and 5 in Goa.

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 μ m thick | 1. <i>C. aerea</i> |
| 2b. | Thallus dark green in colour, up to 15 cm long; cells cylindrical - barrel shaped, cell wall up to 100 μ m thick | 2. <i>C. antennina</i> |
| 3b. | Thallus spirally twisted or curled in apical region, cells rectangular-squarish or moniliform, up to 700 μ m long | 5. <i>C. spiralis</i> |
| 3b. | Thallus spirally zig-zag, or curled, usually entangles with other masses, cells cylindrical - quadrangular or moniliform, up to 700 μ m long | 4 |
| 4a. | Filaments dark green in colour, spirally curled, thick; cells cylindrical to barrel shaped | 3. <i>C. crassa</i> |
| 4b. | Filaments usually dark green in colour; cells cylindrical to rectangular or squarish, slightly constricted at nodes | 4. <i>C. linum</i> |

1. *Chaetomorpha aerea* (Dillwyn) Kuetz. in Sp.Al.,379. 1849; 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, usually 4-12 (-30) cm long, subclavate basal cell which has a disklike base lobed or fimriate at the margins; basal cell 130-150 μ diam. At the top, 7-11 diameters long, and about 2.5-4.5 times as long as the suprabasal cell; filaments slender towards the base, above to 150-360 μ 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: IX-b).

Occurrence: During post-monsoon season. Rare.

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

Notes: This species is recorded here as an addition to the Goa coast. Although it is one of the most common species in the west coast, it was not reported previously from here.

Specimen Examined: Goa coast: Reis Magos Coast, *Palanisamy & Yadav* 142378, 22.06. 2018.

2. *Chaetomorpha antennina* (Bory) Kuetz. in Bot. Zeitung 5: 166. 1847; 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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014; 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, 4-15 cm long, filamentous, brush like, caespitose, tufted, erect, gregarious, lithophilic. Holdfast small, rhizoidal, 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 45-95 μm thick; chloroplast reticulate with several pyrenoids (Plate: IX-c).

Occurrence: Throughout the year. Common.

Distribution: Throughout Goa coast. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Goa, Gujarat, Karnataka, 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 an economically important marine alga and used as raw material for paper manufacturing industries in some countries (Jha & al., 2009).

Specimen Examined: Goa coast: Querim beach, *Palanisamy & Yadav* 139802, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139823, 08.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139887, 09.10.2017; Siridao beach, *Palanisamy & Yadav* 139902, 09.10.2017; Bagmalo coast, *Palanisamy & Yadav* 139919, 11.10.2017; Patnem beach, *Palanisamy & Yadav* 139955, 13.10.2017; Polem beach, *Palanisamy & Yadav* 139975, 14.10.2017; Vagator beach, *Palanisamy & Yadav* 140066, 14.12.2017; Anjuna beach, *Palanisamy & Yadav* 137606, 14.12.2017; Sinquerim fort beach, *Palanisamy & Yadav* 137644, 15.12.2017; Ashwim coast, *Palanisamy & Yadav* 140238, 15.02.2018; Anjuna coast, *Palanisamy & Yadav* 140270, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140283, 16.02.2018; Reis Magos coast, *Palanisamy & Yadav* 140300, 17.02.2018; Cabo-de-Rama coast, *Palanisamy & Yadav* 142282, 21.02.2018.

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, usually 2-10 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, $300-610 \times 250-410 \mu\text{m}$; cell wall $30-100 \mu\text{m}$ thick; chloroplast reticulately arranged with several pyrenoids (Plate: IX-d).

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: **Goa**: Anjuna, Ashwim, Vagator and Morjim. **India**: Gujarat, Karnataka, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Notes: This species is recorded here as an addition to the Goa coast. Although it is one of the most common species in the west coast, it was not reported previously from here. It can easily be identified by coiled and entangled thalli. It is usually found growing with species of *Chaetomorpha*, *Sargassum* and *Ulva* in intertidal zone and occasionally offshore.

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137608, 14.12.2017; Ashwim coast, *Palanisamy & Yadav* 140215, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140256, 16.02.2018; Morjim coast, *Palanisamy & Yadav* 142465, 25.10.2018.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 662. 2014; 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, $50-180 \times 75-175 \mu\text{m}$; cell wall usually $10-18 \mu\text{m}$ thick, mucilagenous; chloroplast reticulatey arranged, pyrenoids several (Plate: X - a).

Occurrence: Usually during monsoon and post - Monsoon season. Rare.

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

Specimen Examined: Goa coast:Betul fort coast, *Palanisamy & Yadav* 142260, 21.02.2018; Neum coast, *Palanisamy & Yadav* 142262, 21.02.2018; Mandrem coast, *Palanisamy & Yadav* 142455, 24.10.2018.

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; P.S.N. Rao & Gupta, Algae India 3: 5. 2015.

Thallus light-dark green in colour, usually 2-5 (-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, 470-780 μm long; other cells usually rectangular-squarish, spherical or moniliform in appearance, isodiametric, slightly constricted in nodal regions, 250-700 \times 300-420 μm ; cell wall 50-100 μm thick; chloroplast elongate, densely arranged; pyrenoids several (Plate: X - b).

Occurrence: Monsoon and post-monsoon seasons. Moderate.

Distribution: Goa: Anjuna and Arambol. **India:** Gujarat, Karnataka, Kerala and Tamil Nadu.

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137609, 14.12.2017; Arambol coast, *Palanisamy & Yadav* 140211, 14.02.2018.

1. 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-several pyrenoids.

Presently, 195 taxa in world (Guiry & Guiry, 2019, 28 of them in India (Rao & Gupta, 2015) and only 1 in Goa.

1. Cladophora vagabunda (L.) C. Hoek, Rev. Eur. *Cladophora*: 144. 1963; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 782. 1996; 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 or dark green in colour, filamentous, usually 4-12 (-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, $550-1400 \times 160-310 \mu\text{m}$; cells of the secondary branches almost similar to main axis, $250-1100 \times 100-200 \mu\text{m}$; cells of the ultimate branches cylindrical and slightly curved, $110-490 \times 35-100 \mu\text{m}$ (Plate: X - c).

Occurrence: Monsoon and post-monsoon seasons. Common.

Distribution: Goa: Talpona and Polem. **India**: Andhra Pradesh, Gujarat, Karnataka, 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 other algae like *Bryopsis*, *Chaetomorpha*, *Gracilaria*, *Grateloupia* and *Ulva* in shallow intertidal regions.

Specimen Examined: Goa coast: Talpona coast, *Palanisamy & Yadav* 140158, 13.02.2018; Polem Coast, *Palanisamy & Yadav* 143921, 01.10.2018.

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 tenaculum 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 Goa.

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, 2019), 2 in India (Oza & Zaidi, 2001) and 1 in Goa.

Cladophoropsis sundanensis Reinbold in Naova Notarisia 16: 147. 1905; 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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; P.S.N. Rao & Gupta, Algae India 3: 8. 2015.

Thallus light-dark green in colour, filamentous, forming spongy and moss like small clumps, usually 4-7 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, 36-100 (-140) μm in diameter; cell wall conspicuous (Plate:XI - a).

Occurrence: Usually Post-monsoon season. Rare.

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

Specimen Examined: Goa coast: Reis Magos coast, *Palanisamy & Yadav* 142201, 17.02.2018; Mormugao coast, *Palanisamy & Yadav* 142244, 20.02.2018; Bogmallo coast, *Palanisamy & Yadav* 142251, 20.02.2018; Betul fort coast, *Palanisamy & Yadav* 142259, 21.02.2018; Cabo-de-Rama coast, *Palanisamy & Yadav* 142274, 21.02.2018; Cola coast, *Palanisamy & Yadav* 142301, 21.02.2018.

2. *Phyllocladon*. J.E.Gray

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, 2019), 2 in India (Rao & Gupta, 2015) and 1 in Goa.

Phyllocladon anastomosans (Harvey) Kraft & M.J.Wynne, Phycol. Res. 44: 139, figs 16-25. 1996; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; P.S.N. Rao & Gupta, Algae India 3: 8. 2015. *Struvea anastomosans* (Harv.) Picc. & Grunov ex Picc., Crociera Corsaro Alg., 20. 1884; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 798. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 168. 2001.

Thallus light-dark green in colour, small, 1-5 cm long, branched, interconnected, forming net like 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, 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 300-1450 \times 120-210 μm , secondary branches 210-1100 \times 80-160 μm ; Cell wall thin, transparent in apical region, chloroplast numerous, reticulate (Plate: XI - b).

Occurrence: Monsoon and post-monsoon seasons. Rare.

Distribution: Goa: Anjuna and Vagator. **India:** Andhra Pradesh, Gujarat, Karnataka, Kerala, Lakshadweep Island, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Anjuna coast, *Palanisamy & Yadav* 140271, 16.02.2018; Vagator coast, *Palanisamy & Yadav* 140258, 16.02.2018.

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 1 genera in Goa.

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, 2019), 1 in India (Rao & Gupta, 2015) and 1 in Goa.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; 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, 5-8 cm thick and 6-15 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 210-510 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:X - d).

Occurrence: usually post-monsoon seasons. Rare.

Distribution: Goa: Vagator. **India:** Andaman & Nicobar Islands, Gujarat, Karnataka, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Vagator beach, *Palanisamy & Yadav* 139846, 08.10.2017.

5. BRYOPSIDALES

Key to families

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

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 Goa.

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, 2019), 7 in India (Rao & Gupta, 2015) and 2 in Goa.

Key to species

- 1a. Thallus main axis usually densely and pinnately branched **2. B. pennata**
- 1b. Thallus main axis pinnately, distichously, radially or irregularly branched **2**
- 2a. Thallus light-dark pale green in colour, main axis radially branched; plumules almost uniformly cylindrical, without any constriction at base **1. B. hypnoides**
- 2b. Thallus light-olive green in colour, main axis pinnately or distichously branched; pinnules gradually or irregularly becoming shorter upwards, distinctly constricted at base **3. B. plumosa**

1. Bryopsis hypnoides J.V. Lamour. in Nouv. Bull. Sci. Soc. Philom. Paris 1: 333. 1809; Untawale & al., List Mar. Alg. India: 11. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 170. 2001; Jha & al., Seaweeds Gujarat: 34. 2009; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; P.S.N. Rao & Gupta, Algae India 3: 9. 2015.

Thallus light-pale or dark green in colour, tubular, remiform with radially ranged branches, usually 4-10 cm long, gregarious, siphonous, tufted, epilithic. Holdfast rhizoidal, firmly attached. Stipe stalked cylindrical, 90-200 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 $280-850 \times 40-140 \mu\text{m}$; cells of the main axis and branches siphonous, usually transparent towards apex, multinucleate, with numerous leonticular plastids (Plate: XI - c).

Occurrence: Usually post - Monsoon season. Rare

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

Specimen Examined: Goa coast: Vagator beach, *Palanisamy & Yadav* 140097, 14.12.2017.

2. *Bryopsis pennata* J.V. Lamour. in *Nouv. Bull. Sci. Soc. Philom. Paris* 1: 333. 1809; V. Krishnam. & H.V. Joshi, *Checkl. Ind. Mar. Alg.*: 5. 1970; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 171. 2001; Palanisamy & al. in *Seaweed Res. Utiln.* 36(1&2): 4. 2014; Pereira & Almeida in *Indian J. Mar. Sci.* 42 (4): 663. 2014; P.S.N. Rao & R.K. Gupta, *Algae India* 3: 9. 2015. *Bryopsis plumosa* (Huds.) C. Agardh var. *pennata* (J.V. Lamour.) Boergesen, *Bot. Tidssk.* 31: 147. 1911.

Thallus light-dark green in colour, feathery, usually 2-8 cm long, tufted, gregarious, erect, siphonous, tufted, epilithic. Holdfast rhizoidal, stoloniferous, attached firmly on rocky substrata. Stipe stalked, cylindrical, $320-600 \mu\text{m}$ in diameter. Fronds usually numerous, tubular with feathery appearance, main axis cylindrical to terete, $170-560 \mu\text{m}$ in diameter, progressively tapering towards apex, usually densely branched; branches often dense and closely arranged in middle and less or absent towards apex, pinnately divided; pinnules linear-lanceolate, facing upwards and gradually becoming shorter with round to acute apices. *Microscopic*: Pinnules $200-1510 \times 120-180 \mu\text{m}$; cells of the main axis and branches siphonous, usually transparent towards apex and periphery, multinucleate with numerous leonticular plastids.

Occurrence: Throughout the year. Moderate.

Distribution: Goa: Cabo-de-Rama **India**: Andaman & Nicobar Islands, Andhra Pradesh, Gujarat, Karnataka, Kerala and Tamil Nadu.

Specimen Examined: Goa coast: Cabo-de-Rama coast, *Palanisamy & Yadav* 142273, 21.02.2018.

3. *Bryopsis plumosa* (Huds.) C. Agardh, *Spec. Alg.* 1(2): 448.1823; 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; Pereira & Almeida in *Indian J. Mar. Sci.* 42 (4): 663. 2014; 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, usually 3-10 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, 45-650 \times 45-95 μm ; cells of the main axis and branches siphonous, multinucleate, with numerous plastids.

Occurrence: Usually post - Monsoon season. Moderate.

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

Specimen Examined: Goa coast: Querim coast, *Palanisamy & Yadav* 142454, 24.10.2018.

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 well as in Goa.

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 5 in Goa.

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, scalpelliform-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 | 1. C. peltata |
| 2b. | Thallus up to 20 cm long; assimilators 2-8 cm long, ramuli highly variable, spherical, pearshaped, grapes like, turbinate, 2-5 mm in diameter, racemosely arranged | 2. C. racemosa |
| 3a. | Assimilators leafy, much flattened, up to 2 cm broad; ramuli scalpelliform to linear and curved upward, tufted | 3. C. scalpelliformis |
| 3b. | Assimilators leafy or feathery, flattened up to 1.2 cm; ramuli linear, sickle or needle shaped, flexible or curved upward | 4 |
| 4a. | Assimilators feathery; ramuli linear, needle like, flexible, densely packed and conical at apex | 4. C. sertularioides |

- 4b. Assimilators leafy, flattened or slightly feathery; ramuli linear to sickle shaped and curved upward, tufted, densely packed and usually forked at apex

5. *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; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 828. 1996; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; 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, usually 6-15 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 4 (-8) cm long; ramuli radially arranged, peltate, disc like, smooth, entire, 1-5 mm in diameter; rachis 1-2.4 × 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, trabeculae 6-15 μm in diameter, thicker in basal region and gradually tapering towards apex (Plate: XI - c).

Occurrence: Throughout the year. Moderate.

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

Notes: This species can be identified easily by its peltate and disc like ramuli on the assimilators. It 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.

Specimen Examined: Goa coast: Polem beach, *Palanisamy & Yadav* 139984, 14.10.2017; Nyex coast, *Palanisamy & Yadav* 140285, 16.02.2018; Anjuna beach, *Palanisamy & Yadav* 137602, 14.12.2017.

2. *Caulerpa racemosa* (Forssk.) J. Agardh, Algern. Syst. 9 (8): 35. 1873; 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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; 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, usually 5-15 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 1-4 cm long, simple, cylindrical-terete, up to 8 (-10) cm long with densely and racemosely arranged ramuli; ramuli spherical, pear or grapes shaped, entire, 1-4 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 18-30 μm thick, lightly lamellated, trabeculae thin, 3.5- 7 μm in diameter (Plate: XII - a).

Key to varieties

- | | | |
|-----|--|---------------------------|
| 1a. | Thallus usually 5-15 cm long; ramuli spherical, pear shaped or grapes like | 2a. var. racemosa |
| 1b. | Thallus usually 3-6 long; ramuli distinctly turbinate or trumpet shaped | 2b. var. turbinata |

2a. Caulerpa racemosa (Forssk.) J. Agardh var. **racemosa**

Characters as above.

Occurrence: During post-monsoon season. Moderate.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137601, 14.12.2017; Anjuna beach, *Palanisamy & Yadav* 137601, 14.12.2017; Ashwim coast, *Palanisamy & Yadav* 142459, 24.10.2018.

2b. Caulerpa racemosa (Forssk.) J. Agardh var. **turbinata** (J. Agardh) Eubank in Univ. Calif. Publ. Bot. 18: 420. 1946; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 835. 1996; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 179. 2001; P.S.N. Rao & R.K. Gupta, Algae India 3: 12. 2015. *Caulerpa clavifera* (Turner) C. Agardh var. *turbinata* J. Agardh, Mus. Senckenberg. 2: 173. 1837.

Thallus often dark green in colour, rhizomatous, 4-8 cm long, prostrate, lithophilic, tufted, coenocytic, siphonous, stoloniferous, epilithic. Holdfast rhizoidal, colourless, stout. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender, small, up to 5 cm long and 1.5 mm thick, colourless tufted, branched. Assimilators cylindrical, short, 2-6 cm long, usually branched with several densely arranged ramuli; ramuli distinctly turbinate or trumpet shaped and facing upwards, smooth, entire, up to 5 mm long and 2 mm broad.

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Goa: Cabo-de-Rama. **India**: Gujarat, Kerala and Tamil Nadu.

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here.

Specimen Examined: Goa coast: Cabo-de-Rama coast, *Palanisamy & Yadav* 142271, 21.02.2018.

3. *Caulerpa scalpelliformis* (R. Br. ex Turner) C. Agardh, Syn. Alg. Scand. 22. 1817; 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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; P.S.N. Rao & Gupta, Algae India 3: 12. 2015. *Fucus scalpelliformis* R. Br. ex Turner in Fuci.3: 95, pl. 174. 1809.

Thallus pale-dark green in colour, rhizomatous, usually 5-15 cm long, prostrate, stoloniferous, epilithic. Holdfast rhizoidal, numerous, colourless. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender, 1-2.5 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 0.1-2 cm broad, usually with marginally lobed ramuli; ramuli compressed, scalpelliform, linear and slightly curved upward with an acute to spinous apex, densely arranged, entire, 1.5-4.5 × 0.5-2 mm. *Microscopic:* In cross section, thallus siphonous, coenocytic, traversed internally by a network of trabeculae (Plate: XII - b).

Occurrence: Post-monsoon and summer seasons. Rare.

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

Specimen Examined: Goa coast: Cabo-de-Rama coast, *Palanisamy & Yadav* 142272, 21.02.2018.

4. *Caulerpa sertularioides* (S.G. Gmel.) M. Howe in Bull. Torrey Bot. Club 32: 576. 1905; Untawale & al., List Mar. Alg. India: 12. 1983; 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 light-yellow green in colour, rhizomatous, up to 15 cm long, prostrate, growing as patches, stoloniferous, epilithic. Holdfast rhizoidal, numerous, colourless, loosely attached on rocky substrata. Fronds consist of creeping stolons and erect assimilators. Stolon stalked, slender, 0.5-3 mm in diameter, colourless, tufted, bearing several upright assimilators. 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 (Plate: XII - c).

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

Distribution: Goa: Capegao. **India:** Andhra Pradesh, Gujarat, Karnataka, 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: Goa coast: Capegao, *Palanisamy & Yadav* 137717, 18.12.2017.

5. *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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 663. 2014; 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, usually 5-12 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, 0.6-2 mm in diameter, colourless to light green in older regions, tufted, branched. Assimilators usually arranged at intervals of 0.5-2.8 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, 0.5-5 × 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, trabeculae thin, filamentous, 2-4.5 μm in diameter (Plate: XII - d).

Occurrence: Post monsoon season. Common.

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

Specimen Examined: Goa coast: Neum beach, *Palanisamy & Yadav* 139941, 12.10.2017; Anjuna beach, *Palanisamy & Yadav* 137611, 14.12.2017; Arambol beach, *Palanisamy & Yadav* 140039, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140098, 14.12.2017; Arambol coast, *Palanisamy & Yadav* 140202, 14.02.2018; Ashwim coast, *Palanisamy & Yadav* 140218, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140260, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140273, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140284, 16.02.2018; Agonda coast, *Palanisamy & Yadav* 142306, 22.02.2018; Colomb coast, *Palanisamy & Yadav* 142314, 23.02.2018.

CLASS: PHAEOPHYCEAE

Under the class Phaeophyceae, a total of 6 orders are represented in India (Oza & Zaidi, 2001), of which 5 are available in Goa coast. Therefore, keys to these 4 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, fronds flat, blade like | Dictyotales |
| 2b. | Thallus shows trichothalic growth, fronds usually heterotrichous, filamentous | 3 |
| 3a. | Thallus heterotrichous, filamentous, rarely pseudoparenchymatous | Ectocarpales |
| 3b. | 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 or 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 2 in Goa.

Key to genera

- | | | |
|-----|---|----------------------|
| 1a. | Thallus filamentous, heterotrichous, without a distinct and well defined meristematic zones | 1. Ectocarpus |
| 1b. | Thallus sac like, consists of well defined meristematic zones | 2. 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, 100 taxa in world (Guiry & Guiry, 2019), 6 in India (Rao & Gupta, 2015) and 1 in Goa.

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, usually 1-5 cm long, caespitose, heterotrichous, profusely branched forming a dense subglobose tuft, epilithic, occasionally epiphytic on other seaweeds. 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, 6-32 × 5-16 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 (Plate: XIII - a).

Occurrence: Throughout the year. Moderate.

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

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here. 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: Goa coast: Anjuna beach, *Palanisamy & Yadav* 139862, 08.10.2017; Agonda jail coast, *Palanisamy & Yadav* 137656, 15.12.2017; Siridao coast, *Palanisamy & Yadav* 137680, 16.12.2017; Capegao beach, *Palanisamy & Yadav* 137733, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137757, 18.12.2017; Agonda beach, *Palanisamy & Yadav* 137767, 18.12.2017; Querim Coast, *Palanisamy & Yadav* 142360, 21.06. 2018.

2. *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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014. *Rosenvingea stellata*, Boergesen, Dansk Bot. Ark., 5 (6): 1.1928.

Thallus light-yellowish brown in colour, sack like, usually 4-10 cm long, spongy, delicate, usually epilithic, occasionally free floating. Holdfast minute, rhizoidal, loosely attached on rocky substrata in intertidal regions. Fronds spongy, usually globular in young stage and regularly dichotomously branched in mature stage, multilobed; surface smooth, tapering towards apex.

Occurrence: Summer season. Rare.

Distribution: Goa: Anjuna. **India:** Tamil Nadu, Kerala, Karnataka.

Specimen Examined: Goa coast: Anjuna, *Palanisamy & Yadav* 139873, 88.10.2017.

2. 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 entire 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 5 in Goa.

Key to genera

- | | | |
|-----|---|--------------------------|
| 1a. | Thallus with rhizomatous holdfast, fronds fan shaped or foliose | 2 |
| 1b. | Thallus without rhizomatous holdfast, fronds foliose | 4 |
| 2a. | Fronds fan shaped, dichotomously branched | 3. 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. | Apical margins circinate inrolled, dichotomously branched towards apex | 5. Stoechospermum |
| 4b. | Apical margins not circinate inrolled, irregularly and palmately branched towards apex | 4. 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, 2019), 6 in India (Krishnamurthy & Baluswami, 2010) and 2 in Goa.

Key to species

- | | | |
|-----|---------------------------------|-------------------------|
| 1a. | Thallus large, up to 30 cm long | 1. D. australis |
| 1b. | Thallus small, up to 5 cm long, | 2. D. delicatula |

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 21. 2015.

Thallus light – dark brown in colour, foliose, shaped, usually 5-18 (-35) cm long, epilithic. Holdfast minute, discoid, firmly attached on substrata. Stipe flat, up to 1.8 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 (Plate: XIII - b).

Occurrence: Usually Post monsoon and summer seasons. Moderate.

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

Specimen Examined: Goa coast: Cola coast, *Palanisamy & Yadav* 42289, 21.02.2018.

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; V. Krishnam.& Baluswami, Phaeophyceae India Neighb. 1: 97.2010; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 21.2015.

Thallus light brown in colour, flat, strap shaped, usually 1-6 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, 7-25 μ m 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: Goa: Galgibag. **India:** Karnataka, Kerala and Tamil Nadu.

Specimen Examined: Goa coast: Galgibag coast, *Palanisamy & Yadav* 140121, 13.02.2018.

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, 2019), 16 in India (Krishnamurthy & Baluswami, 2010) and 6 in Goa.

Key to species

1a.	Froned margins serrate to dentate or proliferated	4. <i>D. ciliolata</i>
1b.	Froned margins entire	2
2a.	Thallus small, usually less than 8 cm long	3
2b.	Thallus large, usually more than 8 cm long	4

- 3a. Thallus usually olive green in colour, 2-3cm long **3. D. ceylanica**
 3b. Thallus dark-yellowish brown in colour, up to 10 cm long **5. 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 10-28 cm long and 1-2 mm wide, usually
 slightly twisted **2. D. cervicornis**

1. Dictyota bartayresiana 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; V. Krishnam.& Baluswami, Phaeophyceae India Neighb.1: 89.2010; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 22.2015. *Dictyota bartayresensis* J.V. Lanour. in Nouv. Bull. Sci. Soc. Philom, Paris 1: 331. 1809.

Thallus light-dark brown in colour, foliose, 8-12 (-20) cm long, ribbon or strap like, bushy, tufted, epilithic. Holdfast discoid, conspicuous, firmly attached on rocky substrata. Stipe flat, up to 2.4 cm long and 2-4 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, 30-100 μ m across; antheridia usually club shaped, oogonia spherical; tetrasporangia scattered on thallus surface, solitary or in groups.

Occurrence: Summer and post-monsoon seasons. Moderate.

Distribution: Goa: Agonda and Mormugao. **India**: Andaman & Nicobar Islands, Gujarat, Karnataka, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast. Agonda beach, *Palanisamy & Yadav* 137772, 18.12.2017; Mormugao coast, *Palanisamy & Yadav* 142239, 20.02.2018.

2. Dictyota cervicornis Kuetz. Tab. Phycol. 9(1): 11, Pl. 25, fig. 1. 1859; P.C.Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 587. 1996; V. Krishnam.& Baluswami, Phaeophyceae India Neighb.1: 86. 2010; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 22.2015.

Thallus light to olive green in colour, frondose, 8-18 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

Occurrence: Summer and post-monsoon seasons. Rare.

Distribution: Throughout Goa coast. **India**: Gujarat and Karnataka.

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137618, 14.12.2017; Capegao beach, *Palanisamy & Yadav* 137734, 18.12.2017; Palolem beach, *Palanisamy & Yadav* 137786, 19.12.2017; Agonda beach, *Palanisamy & Yadav* 137773, 18.12.2017; Querim coast, *Palanisamy & Yadav* 140188, 14.02.2018; Arambol beach, *Palanisamy & Yadav* 140032, 13.12.2017; Cola coast, *Palanisamy & Yadav* 142290, 21.02.2018; Vagator coast, *Palanisamy & Yadav* 143803, 26.10.2018; Anjuna Coast, *Palanisamy & Yadav* 143814, 26.10.2018.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 22. 2015.

Thallus light to olive green in colour, frondose, small, 1-3 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 (Plate: XIII - c)

Occurrence: Post-monsoon season. Rare.

Distribution: Goa: Oxdel, Nyex, Neum and Polem. **India**: Gujarat. Karnataka, Kerala and Tamil Nadu.

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: Goa coast: Oxdel coast, *Palanisamy & Yadav* 137670, 16.12.2017; Nyex Coast, *Palanisamy & Yadav* 143834, 26.10.2018; Neum Coast, *Palanisamy & Yadav* 143879, 30.10.2018; Polem Coast, *Palanisamy & Yadav* 143932, 01.10.2018.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 22. 2015. *Dictyota ciliata* J. Agardh in Linnaea 15(2): 5. 1841.

Thallus light-dark brown in colour, becomes dark brown after drying, 4-12 (-20) cm long and 0.4-1.5 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 1.5 cm wide, width gradually increases from base towards apex, membranous, regularly dichotomously branched in upper portion, irregular towards apex; branches flat, lobed; 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, 40-110 μm across, usually found in group, mostly concentrated in middle and subapical parts, occasionally towards the margins, non involucrate (Plate:XIII-d).

Occurrence: Post-monsoon season. Moderate.

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

Notes: Agardh (1882) opined that *Dictyota ciliata* and *D. ciliolata* are conspecific. However, he wrongly retained *D. ciliata* *nom. illeg.* being, a later homonym of *D. ciliata* J.V. Lamour. which in its turn is an illegitimate new name for *Fucus pseudociliatus* J.V. Lamour. (Silva & al., 1996). Therefore, *Dictyota ciliata* J. Agardh stands an illegitimate name (Silva & al., 1996). In field, this species can be easily distinguished from the others in having characteristically ciliate / proliferated margins.

Specimen Examined: Goa coast: Polem beach, *Palanisamy & Yadav* 139976, 14.10.2107; Ashwim coast, *Palanisamy & Yadav* 140222, 15.02.2018; Talpona coast, *Palanisamy & Yadav* 140166, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140193, 14.02.2018; Arambol coast, *Palanisamy & Yadav* 140199, 14.02.2018; Anjuna Coast, *Palanisamy & Yadav* 143809, 26.10.2018; Polem Coast, *Palanisamy & Yadav* 143924, 01.10.2018.

5. *Dictyota dichotoma* (Huds.) J.V. Lamour. in J. Bot. (Desvaux) 2: 42. 1809; J.N. Misra, Phaeophyceae India: 132, fig. 66, 1966; Untawale & al., Natl. Inst. Ocenogr., Goa, 581. 1983; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 589. 1996; 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014;

P.S.N. Rao & Gupta, *Algae India* 3: 22. 2015. *Ulva dichotoma* Huds., Fl. Angl. 476. 1762.

Thallus dark-yellowish brown in colour, usually 2-8 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, 0.5-1.5 cm long. Fronds foliose, up to 8 cm long, membranous, regularly dichotomously branched; 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, 8-18 μ m 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, 6-20 μ m across, thin walled, compact, chromatophore content more; medullary cells single layered, comparatively large, squarish to rectangular, 25-80 μ m across, thick walled, compact, chromatophore content less. Sporangia develop in sori on surface, usually associated with clusters of paraphyses; antheridial sori (sporangia) whitish.

Occurrence: Throughout the year. Moderate.

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

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

Specimen Examined: Goa coast: Candolim coast, *Palanisamy & Yadav* 137640, 15.12.2017; Agonda jail coast, *Palanisamy & Yadav* 137654, 15.12.2017; Galgibag coast, *Palanisamy & Yadav* 140123, 13.02.2018; Cola beach, *Palanisamy & Yadav* 137755, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137756, 18.12.2017; Vagator beach, *Palanisamy & Yadav* 139836, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139870, 08.10.2017; Siquerim fort beach, *Palanisamy & Yadav* 139892, 09.10.2017; Aguada jail coast, *Palanisamy & Yadav* 142207, 17.02.2018; Aguada jail coast, *Palanisamy & Yadav* 142210, 17.02.2018; Bambolim coast, *Palanisamy & Yadav* 142224, 18.02.2018; Valsao coast, *Palanisamy & Yadav* 142229, 18.02.2018; Mormugao coast, *Palanisamy & Yadav* 142240, 20.02.2018; Agonda coast, *Palanisamy & Yadav* 142310, 22.02.2018; Patnem coast, *Palanisamy & Yadav* 142336, 23.02.2018; Querim beach, *Palanisamy & Yadav* 140008, 13.12.2017; Patnem coast, *Palanisamy & Yadav* 142336, 23.02.2018; Querim coast, *Palanisamy & Yadav* 140189, 14.02.2018; Arambol coast, *Palanisamy & Yadav* 140198, 14.02.2018; Polem Coast, *Palanisamy & Yadav* 143933, 01.10.2018.

6. *Dictyota pinnatifida* Kuetz.in Tab. Phycol. 16: Pl. 39, fig. 1. 1859; J.N. Misra, *Phaeophyceae India*: 140. 1966; Untawale & al., *Natl. Inst. Ocenogr.*, Goa, 596. 1983; P.C.Silva & al., *Cat. Benth. Mar. Alg. Ind. Ocean*: 596. 1996; P.S.N. Rao & Gupta, *Algae India* 3: 22.2015.

Thallus yellowish or greenish brown in colour, frondose, usually 4 - 10 cm long, tufted, epilithic. Holdfast minute, discoid, firmly attached on rocky substrata. Frond foliose, almost ribbon like, irregularly flattened, 1-4 mm wide, internodal segments 1-5 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: Goa coast. **India**: Maharashtra, Karnataka and Kerala.

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here.

Specimen Examined: Goa coast: Sinkerim fort beach, *Palanisamy & Yadav* 137650, 15.12.2017.

3. *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 54 taxa in world (Guiry & Guiry, 2019), 9 of them in India (Krishnamurthy & Baluswami, 2010) and 5 in Goa.

Key to species

- | | | |
|-----|---|-------------------------------------|
| 1a. | Thallus surface prominently calcified | 2 |
| 1b. | Thallus surface moderately or uncalcified | 4 |
| 2a. | Thallus large, up to 15 cm long | 3. <i>P. gymnospora</i> |
| 2b. | Thallus small, up to 8 cm long | 3 |
| 3a. | Calcification thin and uniform on both surfaces;
mature thallus 2-3-layered | 2. <i>P. boryana</i> |
| 3b. | Calcification heavy on lower surface and light on upper
surface; mature thallus always more than 3-layered | 4. <i>P. pavonica</i> |
| 4a. | Thallus with 3 layers of cells in mature portion | 1. <i>P. boergesenii</i> |
| 4b. | Thallus with 3-6 layers of cells in mature portion | 5. <i>P. tetrastromatica</i> |

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; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 111. 2001; V. Krishnam. & Baluswami, *Phaeophyceae India Neighb.* 1: 111.2010; P.S.N. Rao & Gupta, *Algae India* 3: 55.

2015. Misapplied name: *Padina gymnospora* (Kuetz.) Vickers vide: Krishnamurthy & Baluswami, 2010.

Thallus light- dark brown in colour, frondose, circular to fan shaped, 4-10 × 4-12 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, 2-5 × 0.2-0.5 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 70-160 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, 20-50 × 12-40 μm across, thin walled, chromatophore content more; cells in the centre and lower region large, rectangular, 40-70 × 20-45 μm across, thick walled. 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: XIV-a).

Occurrence: Monsoon and post-monsoon season. Rare.

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

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here.

Specimen Examined: Goa coast: Mormugao coast, *Palanisamy & Yadav* 137693, 16.12.2017; Mandrim Coast, *Palanisamy & Yadav* 142366, 21.06. 2018; Dona Paula coast, *Palanisamy & Yadav* 142385, 22.06. 2018; Arambol beach, *Palanisamy & Yadav* 140035, 13.12.2017; Vagator coast, *Palanisamy & Yadav* 140248, 16.02.2018; Oxdel coast, *Palanisamy & Yadav* 142222, 18.02.2018; Cabo-de-Rama coast, *Palanisamy & Yadav* 142278, 21.02.2018; Patnem coast, *Palanisamy & Yadav* 142332, 23.02.2018.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 23. 2015. *Padina commersonii* Bory, Voy. Coquille: 144, pl. 21, fig. 2-J. 1828.

Thallus light to dark brown in colour, frondose, circular to fan shaped, 4-8 × 2-5 cm broad, lightly calcified on both surfaces of thallus, whitish with occasional blue tinge, epilithic. Holdfast small, thick, rhizomatous or bulbous, 2-5 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 70-110 μm thick, usually 2(-3)-layered; cells of the upper superficial layer small, rectangular, 25-60 \times 25-40 μm , thin walled, chromatophore content more; cells in lower region large, rectangular, 30-74 \times 20-38 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: XIV - b).

Occurrence: Throughout the year. Moderate.

Distribution: Goa: Vagator and Polem. **India**: Karnataka, Kerala, Gujarat and Tamil Nadu.

Specimen Examined: Goa coast: Vagator coast, *Palanisamy & Yadav* 143805, 26.10.2018; Polem Coast, *Palanisamy & Yadav* 143923, 01.10.2018.

3. *Padina gymnospora* (Kuetz.) Sonder in Abh. Naturwiss. Ver Hamburg 5(2): 47. 1871; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 112. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 23. 2015. *Zonaria gymnospora* Kuetz., Tab. Phycol. IX: 29, pl. 71. 1859;

Thallus dark brown in colour, circular to fan shaped, 5-15 \times 3-8 cm broad, usually heavily calcified on lower surface with whitish patches, tufted, epilithic. Holdfast small, bulbous or discoid, 3-8 mm across, attached firmly on rocky substrata. Stipe small, stalked, up to 1.6 cm long and 2-8 mm wide. Fronds leafy, spreading, forming fan shaped structure, surface membranous, younger fronds usually simple, mature fronds usually multilobed into several cleft; lobes flat, circular to fan shaped; 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 60-180 μm thick, usually 2 (-3)-layered towards apex and 4-layered in basal region; cells of the upper superficial layer small, rectangular or polygonal; cells in lower region large, rectangular to squarish. Reproductive structures develop mainly near piliferous zones on dorsal surface of frond; sporangia develop in sori (Plate: XIV - c).

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Goa: Bambolim and Palolem. **India**: Andaman Islands, Andhra Pradesh, Gujarat, Karnataka, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Bambolim coast, *Palanisamy & Yadav* 137677, 16.12.2017; Palolem beach, *Palanisamy & Yadav* 137784, 19.12.2017.

4. *Padina pavonica* (L.) Thivyin W.R. Taylor, Mar. Alg. East. Trop. Americas: 234. 1960; Untawale & al., List Mar. Alg. India: 21. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 113. 2001; Pereira & Almeida in Indian J. Mar. Sci.

42 (4): 660. 2014; 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, 2-8 × 2-5 cm broad, heavily calcified on lower surface and light on upper surface of mature thallus, whitish, tufted, epilithic. Holdfast small, bulbous or discoid, 2-6 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 70-150µm 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 × 15-30µm, 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: XIV - d).

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Throughout Goa coast. **India**: Andaman Islands, Andhra Pradesh, Gujarat, Karnataka, 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: Goa coast: Oxdel coast, *Palanisamy & Yadav* 137671, 16.12.2017; Bambolim coast, *Palanisamy & Yadav* 137674, 16.12.2017; Capegao beach, *Palanisamy & Yadav* 137736, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137754, 18.12.2017; Anjuna beach, *Palanisamy & Yadav* 139864, 08.10.2017; Arambol beach, *Palanisamy & Yadav* 140034, 13.12.2017; Talpona coast, *Palanisamy & Yadav* 140164, 13.02.2018; Arambol coast, *Palanisamy & Yadav* 140197, 14.02.2018; Vagator beach, *Palanisamy & Yadav* 140070, 14.12.2017; Cola coast, *Palanisamy & Yadav* 142288, 21.02.2018; Polem coast, *Palanisamy & Yadav* 142345, 24.02.2018; Vagator beach, *Palanisamy & Yadav* 139833, 08.10.2017; Valsao coast, *Palanisamy & Yadav* 142230, 18.02.2018; Resi Magos Coast, *Palanisamy & Yadav* 143849, 27.10.2018; Bogmalo Coast, *Palanisamy & Yadav* 143870, 28.10.2018.

5. *Padina tetrastromatica* Hauck in Hedwigia 26: 43. 1887; Untawale & al., List Mar. Alg. India: 21. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 113. 2001; Palanisamy & al. in Seaweed Res. Utiln. 36 (1&2): 4. 2014; Pereira

& Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 23. 2015.

Thallus light to dark brown in colour, frondose, circular to fan shaped, 3-12 × 2-10 not calcified, tufted, epilithic. Holdfast small, thick, rhizomatous to bulbous, up to 5 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 2-8 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, 45-100 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, compact, spherical (Plate: XV - a).

Occurrence: Throughout the year. Common.

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

Specimen Examined: Goa coast: Candolim coast, *Palanisamy & Yadav* 137639, 15.12.2017; Sinquerim fort beach, *Palanisamy & Yadav* 137651, 15.12.2017; Sinquerim fort beach, *Palanisamy & Yadav* 137652, 15.12.2017; Bambolim coast, *Palanisamy & Yadav* 137673, 16.12.2017; Vagator beach, *Palanisamy & Yadav* 139834, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139835, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139865, 08.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139893, 09.10.2017; Cola coast, *Palanisamy & Yadav* 142287, 21.02.2018; Agonda coast, *Palanisamy & Yadav* 142309, 22.02.2018; Patnem coast, *Palanisamy & Yadav* 142331, 23.02.2018; Querim beach, *Palanisamy & Yadav* 140011, 13.12.2017; Arambol beach, *Palanisamy & Yadav* 140033, 13.12.2017; Galgibag coast, *Palanisamy & Yadav* 140119, 13.02.2018; Galgibag coast, *Palanisamy & Yadav* 140120, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140163, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140165, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140186, 14.02.2018; Arambol coast, *Palanisamy & Yadav* 140196, 14.02.2018; Querim Coast, *Palanisamy & Yadav* 142352, 21.06. 2018; Capeago beach, *Palanisamy & Yadav* 137735, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137753, 18.12.2017; Palolem beach, *Palanisamy & Yadav* 137783, 19.12.2017; Palolem beach, *Palanisamy & Yadav* 137792, 19.12.2017; Galgibaga beach, *Palanisamy & Yadav* 137799, 20.12.2017; Ashwim beach, *Palanisamy & Yadav* 140047, 13.12.2017; Mormugao coast, *Palanisamy & Yadav* 142238, 20.02.2018; Neum coast, *Palanisamy & Yadav* 142268, 21.02.2018; Morjim beach, *Palanisamy & Yadav* 140057, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140071,

14.12.2017; Ashwim coast, *Palanisamy & Yadav* 140221, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140247, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140277, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140289, 16.02.2018; Reis Magos coast, *Palanisamy & Yadav* 140297, 17.02.2018; Aguada jail coast, *Palanisamy & Yadav* 142205, 17.02.2018; Sinquerim coast, *Palanisamy & Yadav* 142214, 17.02.2018; Vagator Coast, *Palanisamy & Yadav* 143804, 26.10.2018; Anjuna Coast, *Palanisamy & Yadav* 143827, 26.10.2018; Coco Beach, *Palanisamy & Yadav* 143844, 27.10.2018; Mormugao coast, *Palanisamy & Yadav* 143864, 28.10.2018; Neum Coast, *Palanisamy & Yadav* 143876, 30.10.2018; Columb Coast, *Palanisamy & Yadav* 143902, 30.10.2018; Galgibag Coast, *Palanisamy & Yadav* 143913, 31.10.2018; Polem Coast, *Palanisamy & Yadav* 143934, 01.10.2018.

5. *Spatoglossum* Kuetz.

Thallus light-dark brown in colour, up to 35 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, 2019), 3 of them in India (Krishnamurthy & Baluswami, 2010) and 1 in Goa.

Spatoglossum asperum J. Agardh, Anal. Cont. 29(9): 36. 1894; Untawale & al., Natl. Inst. Ocenogr., Goa, 40. 1983; Dhargalkar & al., Indian J. Mar. Sci. 9: 297. 1980; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 114. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; P.S.N. Rao & Gupta, Algae India 3: 23. 2015.

Thallus light to dark brown in colour, usually 8-30 cm, 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, 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 210-320 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, 60-110 \times 30-80 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, 50-120 μm across (Plate: XV - c).

Occurrence: Throughout the year. Moderate.

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

Specimen Examined: Goa coast: Valsao coast, *Palanisamy & Yadav* 137702, 17.12.2017; Capegao beach, *Palanisamy & Yadav* 137719, 18.12.2017; Galgibag coast, *Palanisamy & Yadav* 140126, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140162, 13.02.2018; Querim coast *Palanisamy & Yadav* 140190, 14.02.2018; Querim beach, *Palanisamy & Yadav* 140010, 13.12.2017; Morjim beach, *Palanisamy & Yadav* 140058, 13.12.2017; Ashwim coast, *Palanisamy & Yadav* 140223, 15.02.2018; Mormugao coast, *Palanisamy & Yadav* 142237, 20.02.2018; Neum coast, *Palanisamy & Yadav* 142270, 21.02.2018; Cola coast, *Palanisamy & Yadav* 142283, 21.02.2018; Colomb coast, *Palanisamy & Yadav* 142321, 23.02.2018.

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, 2019), 1 in India (Krishnamurthy & Baluswami, 2010) and 1 in Goa.

Stoechospermum marginatum (C. Agardh) Kuetz., Phycol. General. 339. 1843; Untawale & al., Natl. Inst. Ocenogr., Goa, 40. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 115. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 660. 2014; 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, usually 8-20 cm and 1-5 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 spatulate, 40-80 × 10-38 μm wide, covered with thick indusium; tetrasporangia subspherical (Plate: XV - d).

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

Distribution: Throughout Goa coast. **India:** Goa, Gujarat, Karnataka, 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: Goa coast: Nyex coast, *Palanisamy & Yadav* 137632, 14.12.2017; Candolim coast, *Palanisamy & Yadav* 137638, 15.12.2017; Mormugao coast, *Palanisamy & Yadav* 137687, 16.12.2017; Dona paula coast, *Palanisamy & Yadav* 137694, 16.12.2017; Capehao beach, *Palanisamy & Yadav* 137721, 18.12.2017; Capehao beach, *Palanisamy & Yadav* 137722, 18.12.2017; Palolem beach, *Palanisamy & Yadav* 137777, 19.12.2017; Galgibag coast, *Palanisamy & Yadav* 140122, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140161, 13.02.2018; Arambol coast, *Palanisamy & Yadav* 140195, 14.02.2018; Valsao coast, *Palanisamy & Yadav* 137702, 17.12.2017; Capehao beach, *Palanisamy & Yadav* 137719, 18.12.2017; Anjuna beach, *Palanisamy & Yadav* 139866, 08.10.2017; Tilmati beach, *Palanisamy & Yadav* 139986, 14.10.2017; Querim beach, *Palanisamy & Yadav* 140001, 13.12.2017; Arambol beach, *Palanisamy & Yadav* 140031, 13.12.2017; Ashwim beach, *Palanisamy & Yadav* 140045, 13.12.2017; Morjim beach, *Palanisamy & Yadav* 140060, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140072, 14.12.2017; Ashwim coast, *Palanisamy & Yadav* 140219, 15.02.2018; Ashwim coast, *Palanisamy & Yadav* 140233, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140242, 16.02.2018; Vagator coast, *Palanisamy & Yadav* 140243, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140278, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140291, 16.02.2018; Aguada jail coast, *Palanisamy & Yadav* 142206, 17.02.2018; Mormugao coast, *Palanisamy & Yadav* 142236, 20.02.2018; Cola coast, *Palanisamy & Yadav* 142284, 21.02.2018; Colomb coast, *Palanisamy & Yadav* 142320, 23.02.2018; Galgibag coast, *Palanisamy & Yadav* 140126, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140162, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140190, 14.02.2018.

7. *Zonaria* C.Agardh, 1817, *nom. cons.*

Thallus light-dark brown in colour, up to 25 cm long, foliaceous, epilithic. Fronds leafy, irregularly branched, margins entire to slightly dentate.

Currently 18 taxa in world (Guiry & Guiry, 2019), 1 of them in India (Oza & Zaidi, 2001) and 1 in Goa.

Zonaria crenata J.Agardh, *Algern. Syst.* 9 (8): 48. 1873; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.:* 116. 2001; P.S.N. Rao & Gupta, *Algae India* 3: 24. 2015.

Thallus light to dark brown in colour, 5-20 cm, foliose, coriaceous, flattened, multilobed, epilithic. Holdfast small, rhizomatous, attached tightly on substratum. Stipe flat tened, occasionally stalked. Fronds foliaceous, thin,

usually simple below and irregularly branched into several broad lobes; surface glabrous, shining; base attenuate; margins entire to wavy; apical margins undulate or irregularly proliferated. *Microscopic*: Cryptostomata usually present on thallus surface; cells in surface view usually rectangular or elongate; in cross section, mature thallus usually 180-250 μ m thick in centre and up to 600 μ m in basal region, multilayered, consisting of single superficial layer enclosing 2-5-layered medulla; superficial cells usually elongate or palisade like, 50-100 \times 20-90 μ m, thin walled. Reproductive bodies scattered on both sides of the thallus surface (Plate: XV - b).

Occurrence: During post monsoon season. Rare.

Distribution: Goa: Arambol and Anjuna. **India**: Andaman & Nicobar Islands and Tamil Nadu.

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here.

Specimen Examined: Goa coast: Arambol coast, Palanisamy & Yadav 140036, 13.12.2017; Anjuna coast, Palanisamy & Yadav 137620, 14.12.2017.

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 Goa.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014; P.S.N. Rao & Gupta, Algae India 3: 25. 2015.

Thallus yellowish brown in colour, up to 12 cm long, globular, hollow, irregularly lobed, surface rough, irregular. Holdfast small, discoid, loosely attached, occasionally free floating. Fronds spongy, composed of pigmented layers of epidermis; apex acute or obtuse or irregular. *Microscopic*: Thallus multilayered, 5-6 layered. Reproductive bodies develop on epidermis; usually associated with paraphyses (Plate: XVI - a).

Occurrence: Post-monsoon season. Rare.

Distribution: Goa: Galgibag. **India**: Goa, Gujarat, Karnataka, Maharashtra, Nicobar Islands and Tamil Nadu.

Specimen Examined: Goa coast: Galgibag Coast, Palanisamy & Yadav 143915, 31.10.2018.

Rosenvingea Boergesen

Thallus yellowish-light brown in colour, up to 15 cm long, erect, cylindrical to compressed, tubular, lithophilic. Fronds hollow, surface with microscopic hairs, tapering towards the apex.

Currently 8 taxa in world (Guiry & Guiry, 2019), 6 in India (Krishnamurthy & Baluswami, 2010) and 1 in Goa.

Rosenvingea intricata (J. Agardh) Boergesen in *Dansk Botanisk Arkiv* 2(2): 27, 44 figs. 1914; P.C. Silva & al., *Cat. Benth. Mar. Alg. Ind. Ocean*: 633. 1996; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 121.2001; V. Krishnam. & Baluswami, *Phaeophyceae India Neighb.* 1: 135. 2010; P.S.N. Rao & R.K. Gupta, *Algae India* 3: 25. 2015. *Asperococcus intricatus* J. Agardh, *Spec. Gen. Ord. Alg.*: 7. 1847.

Thallus light-yellowish brown in colour, 5-12 cm long, erect, tubular or slightly flat, tufted, epilithic. Holdfast small, discoid, firmly attached on rocky substrata in intertidal zones. Stipe stalked, tubular. Fronds up to 12 cm long and 0.5-1.5 mm wide, older branches irregularly and intricately branched; apical dichotomies usually unequal, slightly curved; margins entire to hairy; apex acute or obtuse. Microscopic: Thallus up to 90 µm thick; consists of an outer 1-2-layered superficial cells and 3-4-layered medulla surrounding a central hollow portion; superficial cells usually spherical or polygonal, 5-10 µm across; medullary cells usually spherical to cuboidal, isodiametric, 15-55 µm across. Reproductive bodies develop in sori on frond surface; sori small, oval to spherical, up to 20 µm, plurilocular gametangia densely aggregated, not associated with paraphyses.

Occurrence: Post-monsoon season. Rare.

Distribution: Goa: Anjuna and Querim. **India**: Gujarat, Maharashtra, Nicobar Islands and Tamil Nadu.

Specimen Examined: Goa coast: Anjuna coast, *Palanisamy & Yadav* 140262, 16.02.2018; Querim coast, *Palanisamy & Yadav* 140181, 14.02.2018.

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here.

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 and only one genus in Goa.

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* 359 taxa in world (Guiry & Guiry, 2019), 83 of them in India (Rao & Gupta, 2015) and 6 in Goa.

Key to species

- | | | |
|-----|---|-----------------------------------|
| 1a. | Leaves wedge shaped or ovate to slightly elongate; receptacles racemosely branched | 2. <i>S. cinereum</i> |
| 1b. | Leaves not wedge shaped, usually elongate, linear to lanceolate or variable; receptacles furcated or irregularly branched | 2 |
| 2a. | Thallus large, up to 2 m long | 3. <i>S. linearifolium</i> |
| 2b. | Thallus small, upto 60 cm long | 3 |
| 3a. | Leaves linear, with entire to wavy margins; vesicles spherical-ellipsoidal | 6. <i>S. wightii</i> |
| 3b. | Leaves linear-lanceolate-ovate, with crenate to prominently dentate margins; vesicles round to oval or spherical | 4 |
| 4a. | Leaves coriaceous, thick with prominent midrib; vesicles round to spherical, obtuse to slightly mucronate | 5. <i>S. tenerrimum</i> |
| 4b. | Leaves usually thin, transparent; midrib prominent or inconspicuous; vesicles usually spherical, non mucronate | 6 |
| 5a. | Leaves linear- lanceolate or slightly ovate; margins serrate to sparsely dentate; vesicles few | 1. <i>S. cinctum</i> |
| 5b. | Leaves linear to narrowly lanceolate; margins dentate to broadly toothed; vesicles numerous, spherical to oval | 4. <i>S. polycystum</i> |

1. *Sargassum cinctum* J. Agardh, Spec. Gen. Ord. Alg.1: 324. 1848; K.S. Sriniv.in Phykos 5: 137. 1969; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.:127. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014; 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, 3-15 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 3-15 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, 0.5-4.4 × 0.5-1.6 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, 140-360 × 190-250 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 140-480 × 300-350 μm (Plate: XVI - b).

Occurrence: Summer and monsoon seasons. Moderate.

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

Specimen Examined: Goa coast: Candolim coast, *Palanisamy & Yadav* 137635, 15.12.2017; Agonda jail coast, *Palanisamy & Yadav* 137658, 15.12.2017; Capegao beach, *Palanisamy & Yadav* 137737, 18.12.2017; Morjim beach, *Palanisamy & Yadav* 139817, 08.10.2017; Marmugao coast, *Palanisamy & Yadav* 139904, 09.10.2017; Bagmalo coast, *Palanisamy & Yadav* 139921, 11.10.2017; Palolem beach, *Palanisamy & Yadav* 139953, 12.10.2017; Polem beach, *Palanisamy & Yadav* 139980, 14.10.2017; Nyex coast, *Palanisamy & Yadav* 140290, 16.02.2018; Oxdel coast, *Palanisamy & Yadav* 142220, 18.02.2018; Bambolim coast, *Palanisamy & Yadav* 142223, 18.02.2018; Mormugao coast, *Palanisamy & Yadav* 142245, 20.02.2018; Valsao coast, *Palanisamy & Yadav* 142252, 18.02.2018; Majorda coast, *Palanisamy & Yadav* 142255, 20.02.2018; Colomb coast, *Palanisamy & Yadav* 142323, 23.02.2018; Polem coast, *Palanisamy & Yadav* 142346, 24.02.2018; Talpona coast, *Palanisamy & Yadav* 140168, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140192, 14.02.2018; Baina beach, *Palanisamy & Yadav* 137703, 17.12.2017; Neum beach, *Palanisamy & Yadav* 137714, 18.12.2017; Valsao coast, *Palanisamy & Yadav* 143874, 29.10.2018; Polem Coast, *Palanisamy & Yadav* 143929, 01.10.2018.

2. *Sargassum cinereum* J. Agardh, Spec. Gen. Ord. Alg. 1: 305. 1848; Untawale & al., Natl. Inst. Ocenogr. Goa, 41. 1983; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 127. 2001; Jha & al., Seaweeds Gujarat: 89. 2009; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014; P.S.N. Rao & Gupta, Algae India 3: 27. 2015.

Thallus light-dark brown in colour, usually 5-20 (-30) 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 5-20 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 5 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 90-450× 245-350 μm; apex usually round to obtuse.

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

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

Specimen Examined: Goa coast: Agonda beach, *Palanisamy & Yadav* 137775, 18.12.2017; Colomb coast, *Palanisamy & Yadav* 137791, 19.12.2017; Siridao coast, *Palanisamy & Yadav* 137679, 16.12.2017; Mormugao coast, *Palanisamy & Yadav* 137689, 16.12.2017; Colva beach, *Palanisamy & Yadav* 137696, 17.12.2017; Anjuna beach, *Palanisamy & Yadav* 139862, 08.10.2017; Agonda jail coast, *Palanisamy & Yadav* 137656, 15.12.2017; Siridao coast, *Palanisamy & Yadav* 137680, 16.12.2017; Capehao beach, *Palanisamy & Yadav* 137733, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137757, 18.12.2017; Agonda beach, *Palanisamy & Yadav* 137767, 18.12.2017; Querim Coast, *Palanisamy & Yadav* 142360, 21.06. 2018; Baina beach, *Palanisamy & Yadav* 137705, 17.12.2017; Neum beach, *Palanisamy & Yadav* 137713, 18.12.2017; Anjuna Coast, *Palanisamy & Yadav* 143815, 26.10.2018; Siridao Coast, *Palanisamy & Yadav* 143857, 28.10.2018; Mormugao coast, *Palanisamy & Yadav* 143861, 28.10.2018; Mormugao coast, *Palanisamy & Yadav* 143867, 28.10.2018; Neum Coast, *Palanisamy & Yadav* 143875, 30.10.2018; Mormugao coast, *Palanisamy & Yadav* 143861, 28.10.2018; Mormugao coast, *Palanisamy & Yadav* 143867, 28.10.2018; Neum Coast, *Palanisamy & Yadav* 143875, 30.10.2018; Cola Coast, *Palanisamy & Yadav* 143887, 30.10.2018; Galgibag Coast, *Palanisamy & Yadav* 143917, 31.10.2018.

3. *Sargassum linearifolium* (Turner) C. Agardh, Syst. Alg.: 1 (1): 24. 1820; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 132. 2001; P.S.N. Rao & Gupta, Algae India 3: 28. 2015. *Fucus linearifolius* Turner Agardh, 105-106, pl. 111, 1808.

Thallus light-dark brown in colour, usually 20-80 cm long, bushy, foliose, tufted, erect, occasionally calcified in basal portion, epilithic. Holdfast discoid, large, 1.5 cm wide, attached tightly on rocky substrata. Stipe or main axis stalked,

dark, cylindrical to terete, tufted, up to 5 cm long and 1-4 mm wide, rough. Fronds well developed, bushy, differentiated into several primary and secondary branches; primary branches up to 70 cm long, cylindrical to terete, slightly flattened, glabrous; secondary branches cylindrical or terete, 5-17 cm long, ultimate branches small, leaves develop on lateral branches, simple, thick, turbinoid-spathulate or oblong to elliptical, stalked or sessile; base cuneate; surface coriaceous, rough; midrib distinct in basal region, gradually disappearing towards apex; margins irregularly 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, 3-6 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: Throughout Goa coast. **India**: Andaman & Nicobar Islands, Karnataka, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Mobor beach, *Palanisamy & Yadav* 137697, 17.12.2017; Capogao beach, *Palanisamy & Yadav* 137738, 18.12.2017; Palolem beach, *Palanisamy & Yadav* 137779, 19.12.2017; Cabo De Rama Coast, *Palanisamy & Yadav* 143881, 30.10.2018; Galgibag Coast, *Palanisamy & Yadav* 143912, 31.10.2018; Polem Coast, *Palanisamy & Yadav* 143930, 01.10.2018.

4. *Sargassum polycystum* C. Agardh, Syst. Alg.: 304. 1824; Kaliap. & al. in Seaweed Res. Utiln. 18: 85. 1996; P.C. Silva & al., Cat. Benth. Mar. Alg. Ind. Ocean: 694. 1996; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014; P.S.N. Rao & Gupta, Algae India 3: 30. 2015. *Sargassum ambiguuum* Sond. in Abh. Naturwiss. Ver Hamburg 5(2): 41. 1871.

Thallus light-dark brown in colour, usually 4-12 (-30) 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, 4-8 cm long, alternate, densely crowded towards apex; leaves simple, develop directly on primary laterals, small, linear to narrowly lanceolate, 0.5-4 × 0.4-2 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, 140-355 μm across, ostiolate with hairs. Air vesicles (bladders) and receptacles develop on lateral branches;

vesicles numerous, spherical to oval, small, 1-5 × 0.8-4mm 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: Throughout Goa coast. **India:** Andhra Pradesh, Goa, Karnataka, Kerala and Tamil Nadu.

Specimen Examined: Goa coast: Cola coast, *Palanisamy & Yadav* 142289, 21.02.2018; Galgibag coast, *Palanisamy & Yadav* 140124, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140167, 13.02.2018; Nyex coast, *Palanisamy & Yadav* 137631, 14.12.2017; Candolim coast, *Palanisamy & Yadav* 137636, 15.12.2017; Oxdel coast, *Palanisamy & Yadav* 137669, 16.12.2017; Valsao coast, *Palanisamy & Yadav* 137700, 17.12.2017.

5. *Sargassum tenerrimum* J. Agardh, Spec. Gen. Ord. Alg. 1: 305. 1848; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 139. 2001; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014; P.S.N. Rao & Gupta, Algae India 3: 31. 2015.

Thallus yellowish-dark brown in colour, usually 8-20 (-40) 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 10-25 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 sessile; base cuneate; surface usually smooth, thick, coriaceous; midrib prominent, thick towards base, occasionally inconspicuous; margins sinuate or dentate, wavy in young stage, dentation towards apex; 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 × 2.5-6 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: XVI - c).

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

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

Specimen Examined: Goa coast: Bambolim coast, *Palanisamy & Yadav* 137675, 16.12.2017; Mormugao coast, *Palanisamy & Yadav* 137688, 16.12.2017;

Dona paula coast, *Palanisamy & Yadav* 137695, 16.12.2017; Cavelossim beach, *Palanisamy & Yadav* 137698, 17.12.2017; Galgibag coast, *Palanisamy & Yadav* 140121, 13.02.2018; Galgibag coast, *Palanisamy & Yadav* 140125, 13.02.2018; Cola beach, *Palanisamy & Yadav* 137759, 18.12.2017; Candolim coast, *Palanisamy & Yadav* 137637, 15.12.2017.

6. *Sargassum wightii* Grev. in J. Agardh, Spec. Gen. Ord. Alg. 1: 329. 1848; Untawale & al., List Mar. Alg. India: 23. 1983; Kaladharan & al. in J. Mar. Biol. Ass. India 53 (1): 125. 2011; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 661. 2014; P.S.N. Rao & Gupta, Algae India 3: 31. 2015.

Thallus dark brown in colour, usually 12-30 cm long, erect, epilithic. Holdfast discoid, 1-3.5 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, 5-20 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, 2.3-8.5 × 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, 200-400 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 3.5 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 (Plate: XVI - d).

Occurrence: Monsoon season. Rare.

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

Specimen Examined: Goa coast: Agonda beach, *Palanisamy & Yadav* 137772, 18.12.2017; Mormugao coast, *Palanisamy & Yadav* 142239, 20.02.2018; Cola beach, *Palanisamy & Yadav* 137758, 18.12.2017; Talpona coast, *Palanisamy & Yadav* 140169, 13.02.2018; Neum Coast, *Palanisamy & Yadav* 143877, 30.10.2018; Anjuna Coast, *Palanisamy & Yadav* 143816, 26.10.2018.

CLASS: RHODOPHYCEAE

Under the class Rhodophyceae, 16 orders are represented in India (Oza & Zaidi, 2001), of which 8 are available in Goa coast. Therefore, key to these orders are 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	4
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	Gracilariales
4a.	Auxiliary cell formed only after fertilization	Ceramiales
4b.	Auxiliary cell formed before fertilization	5
5b.	Thallus usually calcified, tetrasporangia develop in conceptacles	Corallinales
5b.	Thallus usually not calcified, tetrasporangia do not develop in conceptacles	6
6a.	Auxiliary cells formed in special accessory branches	Cryptonemiales
6b.	Auxiliary cells not formed in special accessory branches or branch clusters	8
7a.	Cells formed from the supporting cell of a carpogonial branch acts as the auxiliary cell	Rhodymeniales
7b.	Intercalary cells of a vegetative filament act as the auxiliary cell	Gigartinales

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 only one genus in Goa.

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 laciniate, with or without microscopic spinous outgrowths. Cells with 1-2 stellate chloroplasts.

Currently 79 taxa in world (Guiry & Guiry, 2019), 10 in India (Rao & Gupta, 2015; Kavale & al., 2015) and 2 in Goa.

Key to species

- | | | |
|-----|---|---------------------------|
| 1a. | Thallus simple, elongate to oval or suborbiculate, margins without any microscopic spines | 1. P. crispata |
| 1b. | Thallus simple or branched, linear - elongate, margins with many microscopic spines | 2. P. vietnamensis |

Porphyra crispata Kjellm. in Bih. Kongl. Svenska Vetensk.-Akad. Handl. 23 (Afd. 3, 4): 15, pl. 1: figs. 4, 5; pl. 3: figs. 5-7; pl. 5: fig. 15. 1897; Anilkumar & Panikkar in Seaweed Res. Utiln. 17(1&2): 151. 1995; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 3. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 656.

2014; P.S.N. Rao & Gupta, *Algae India* 3: 34. 2015. *Phyllona crispata* (Kjellm.) Kuntze, *Rev. Gen. Pl.* 3(3): 420. 1898.

Thallus light-pale reddish pink in colour, foliaceous, flat, 2-8 cm longmembranous, transparent, fragile, mucilaginous, monostromatic, epilithic. Holdfast minute, discoid, up to 2 mm wide, loosely attached on rocky substrata in surf-exposed areas, forming a slippery surface. Stipe minute, stalked to subsessile or slightly flattened, sometimes indistinct. Fronds membranous, simple or lobed, elongate or oval to suborbiculate; surface smooth, slippery; base usually cuneate; margins entire in young stage, usually crispate, lacerate or decomposed in old thallus, without any microscopic spinulose processes; apex round to obtuse. Microscopic: Cells in surface view usually spherical, 7-24 μm across, thick walled, irregularly arranged. In cross section, thallus monostromatic, up to 45 μm thick in vegetative portions and up to 50 μm thick in fertile portions; heavily mucilaginous; mucilage up to 4 μm thick; cells usually elongate to slightly lanceolate, thick walled, usually sparsely arranged. Reproductive structures develop on thallus surface mostly along the margins, monoecious; fertile areas distinct, dark coloured, thickly mucilaginous; spermatangia develop in sori; spermatia 128; carpospores 32 (Plate: XVII - a).

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Goa: Cola coast. **India:** Kerala.

Notes: This species was first described by Kjellnam (1897) from the Goto-retti, Japan. Kurogi & Yamada (1986), however reported that the Type specimen of this taxon was not a red alga, but proved to be a green alga *Monostromanitidum* Wittrock. From India, this species was reported by Anilkumar & Panikkar (1995) from Kollam coast of Kerala.

Specimen Examined: Goa coast: Cola coast, *Palanisamy & Yadav* 143896, 30.10.2018.

2. *Porphyra vietnamensis* Tuy. Tanaka & P.H. Ho in *Mem. Fac. Fish. Kagoshima Univ.* 11: 34, figs 10, 11. 1961; Desikachary & al., *Rhodophyta*, 2 (2A): 36. 1990; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*:4. 2001; Pereira & Almeida in *Indian J. Mar. Sci.* 42 (4): 656. 2014; P.S.N. Rao & Gupta, *Algae India* 3: 34.2015.

Thallus light-dark purple red in colour, foliaceous, 2-8 \times 0.5-5 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 2-5 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, 10-20 μm across, thick walled, compactly arranged; spinulose processes 8-20 \times 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, 10-20 \times 6-12 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.

Occurrence: Throughout the year. Common.

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

Specimen Examined: Goa coast: Cola Coast, *Palanisamy & Yadav* 143896, 30.10.2018.

2. GELIDIALES

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 Goa.

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, 2019), 9 in India (Rao & Gupta, 2015) and 2 species in Goa.

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; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 15. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 656. 2014; P.S.N. Rao & Gupta, Algae India 3: 38. 2015.

Thallus dark-purple red in colour, flattened, tufted, erect, cartilaginous, usually 2-5 cm long, epilithic. Holdfast small, rhizoidal, branched, up to 2 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 0.3-3 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, 7-10 μ m across, thick walled; cells sparsely arranged. In cross section, thallus up to 180 μ m 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 μ m across (Plate: XVII - b).

Occurrence: Throughout the year. Common.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137612, 14.12.2017; Siquerim fort beach, *Palanisamy & Yadav* 137646, 15.12.2017; Aguada jail coast, *Palanisamy & Yadav* 137653, 15.12.2017; Coco beach, *Palanisamy & Yadav* 137661, 15.12.2017; Reis Magos coast, *Palanisamy & Yadav* 137666, 15.12.2017; Oxdel coast, *Palanisamy & Yadav* 137672, 16.12.2017; Mormugao coast, *Palanisamy & Yadav* 137685, 16.12.2017; Querim beach, *Palanisamy & Yadav* 139810, 08.10.2017; Morjim beach, *Palanisamy & Yadav* 139819, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139860, 08.10.2017; Baga beach, *Palanisamy & Yadav* 139882, 07.10.2017; Siquerim fort beach, *Palanisamy & Yadav* 139889, 09.10.2017; Bagmalo coast, *Palanisamy & Yadav* 139922, 11.10.2017; Betul fort coast, *Palanisamy & Yadav* 139935, 12.10.2017; Arambol beach, *Palanisamy & Yadav* 140025, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140080, 14.12.2017; Galgibag coast, *Palanisamy & Yadav* 140131, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140145, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140178, 14.02.2018; Arambol coast, *Palanisamy & Yadav* 140207, 14.02.2018; Ashwim coast, *Palanisamy & Yadav* 140235, 15.02.2018; Anjuna coast, *Palanisamy & Yadav* 140265, 16.02.2018; Reis Magos coast, *Palanisamy & Yadav* 140296, 17.02.2018; Aguada jail coast, *Palanisamy & Yadav* 142208, 17.02.2018; Siquerim coast, *Palanisamy & Yadav* 142215, 17.02.2018; Valsao coast, *Palanisamy & Yadav* 142234, 18.02.2018; Mormugao coast, *Palanisamy & Yadav* 142247, 20.02.2018; Neum coast, *Palanisamy & Yadav* 142266, 21.02.2018; Cola coast, *Palanisamy & Yadav* 142293, 21.02.2018; Ashvem Coast, *Palanisamy & Yadav* 142368, 21.06.2018; Siquerim Coast, *Palanisamy & Yadav* 142375, 22.06.2018; Valsao, *Palanisamy & Yadav* 137701, 17.12.2017; Baina beach, *Palanisamy & Yadav* 137704, 17.12.2017; Capehao beach, *Palanisamy & Yadav* 137715, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137742, 18.12.2017; Coco Beach, *Palanisamy & Yadav* 143843, 27.10.2018; Resi Magos Coast, *Palanisamy & Yadav* 143851, 27.10.2018; Mormugao coast, *Palanisamy & Yadav* 143862, 28.10.2018.

2. *Gelidium pusillum* (Stackh.) Le Jolis in Mem. Soc. Imp. Sci. Nat. Cherbourg 10: 139. 1863; Desikachary & al., Rhodophyta, 2 (2A): 197. 1990; Oza

& Zaidi, Rev. Checkl. Ind. Mar. Alg.: 16. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 656. 2014; P.S.N. Rao & Gupta, Algae India 3: 38.2015.

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

Thallus dark-purple red in colour, flattened, tufted, erect, cartilaginous, small, 1-3.5 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 0.5 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 160 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: XVII - b).

Occurrence: Monsoon and post-monsoon seasons. Moderate.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137613, 14.12.2017; Sinqerim fort beach, *Palanisamy & Yadav* 137647, 15.12.2017; Vagator beach, *Palanisamy & Yadav* 139845, 08.10.2017; Sinqerim fort beach, *Palanisamy & Yadav* 139897, 09.10.2017; Bagmalo coast, *Palanisamy & Yadav* 139923, 11.10.2017; Neum beach, *Palanisamy & Yadav* 139942, 12.10.2017; Querim beach, *Palanisamy & Yadav* 140003, 13.12.2017; Arambol beach, *Palanisamy & Yadav* 140026, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140081, 14.12.2017; Reis Magos coast, *Palanisamy & Yadav* 140298, 17.02.2018; Neum coast, *Palanisamy & Yadav* 142267, 21.02.2018; Agonda coast, *Palanisamy & Yadav* 142308, 22.02.2018; Patnem coast, *Palanisamy & Yadav* 142337, 23.02.2018; Polem coast, *Palanisamy & Yadav* 142343, 24.02.2018; Talpona coast, *Palanisamy & Yadav* 140144, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140179, 14.02.2018; Querim Coast, *Palanisamy & Yadav* 142355, 21.06. 2018; Aguada Jail coast, *Palanisamy & Yadav* 142376, 22.06. 2018; Bogmallo Coast, *Palanisamy & Yadav* 142396, 23.06. 2018; Neum beach, *Palanisamy & Yadav* 137709, 18.12.2017; Capehao beach, *Palanisamy & Yadav* 137731, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137743, 18.12.2017; Agonda beach, *Palanisamy & Yadav* 137766, 18.12.2017; Nyex Coast, *Palanisamy & Yadav* 143837, 26.10.2018; Bogmalo Coast, *Palanisamy & Yadav* 143872, 28.10.2018; Cabo De Rama Coast, *Palanisamy & Yadav* 143884, 30.10.2018; Galgibag Coast, *Palanisamy & Yadav* 143920, 31.10.2018.

3. 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 Goa.

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. Anatomically, thallus multilayered, consisting of cortex and medullary cells. Thallus mono- or dioecious.

Currently 186 taxa in world (Guiry & Guiry, 2019), 35 in India (Rao & Gupta, 2015) and 3 in Goa.

Key to species

- | | | |
|-----|--|------------------------|
| 1a. | Thallus uniformly flat, regularly dichotomous branched | 1. G. Corticata |
| 1b. | Thallus irregularly flattened, irregularly or irregularly branched | 2 |
| 2a. | Fronds, coriaceous, much flattened towards apex, densely branched towards apex, branches with lacinate end | 2. G. foliifera |
| 2a. | Fronds foliose, irregularly flattened throughout, densely branched towards apex, branches hairy or without lacinate or pointed end | 3. G. textorii |

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; Palanisamy & al. in Seaweed Res. Utiln. 36(1&2): 4. 2014; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 656. 2014; P.S.N. Rao & Gupta, Algae India 3: 40. 2015. *Rhodymenia corticata* J. Agardh in Linnaea, 15: 14. 1841.

Thallus light-dark red in colour, flattened, usually 5-20 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 6 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, 3-12 μ m across, thick walled, sparsely arranged. In cross section, thallus up to 0.5-2 mm thick, multilayered, differentiated into outer cortical layers and central medulla layers. Spermatangia develop in cavity like structures, 460-540 μ m 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 based.

Key to varieties

- | | | |
|-----|---|----------------------------|
| 1a. | Fronds uniformly flattened, cartilaginous, branching regularly 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 (Plate: XVII - d).

Occurrence: Throughout the year. Common.

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

Specimen Examined: Goa coast: Querim beach, *Palanisamy & Yadav* 139808, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139825, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139839, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139840, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139858, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139867, 08.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139890, 09.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139898, 09.10.2017; Arambol beach, *Palanisamy & Yadav* 140029, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140086, 14.12.2017; Vagator coast, *Palanisamy & Yadav* 140252, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140268, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140292, 16.02.2018; Reis Magos coast, *Palanisamy & Yadav* 140293, 17.02.2018; Cabo-de-Rama coast, *Palanisamy & Yadav* 142276, 21.02.2018; Cola coast, *Palanisamy & Yadav* 142291, 21.02.2018.

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; 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, 5-18 cm long, bushy, tufted, cartilaginous, rigid, epilithic. Holdfast small, discoid, firmly attached on rocky substrata in intertidal zones. Stipe flattened to slightly terete, rigid, 0.5-1.5 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: XVIII - a).

Occurrence: Summer season. Rare.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137624, 14.12.2017; Anjuna beach, *Palanisamy & Yadav* 137625, 14.12.2017; Reis Magos coast, *Palanisamy & Yadav* 137664, 15.12.2017; Mormugao coast, *Palanisamy & Yadav* 137686, 16.12.2017; Anjuna beach, *Palanisamy & Yadav* 139867, 08.10.2017; Arambol beach, *Palanisamy & Yadav* 140028, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140085, 14.12.2017; Querim coast, *Palanisamy & Yadav* 140175, 14.02.2018; Querim Coast, *Palanisamy & Yadav* 142353, 21.06. 2018; Capehao beach, *Palanisamy & Yadav* 137716, 18.12.2017;

Cola beach, *Palanisamy & Yadav* 137744, 18.12.2017; Vagator Coast, *Palanisamy & Yadav* 143805, 26.10.2018; Cola Coast, *Palanisamy & Yadav* 143892, 30.10.2018; Anjuna Coast, *Palanisamy & Yadav* 143819, 26.10.2018.

3. *Gracilaria foliifera* (Forssk.) Boergesen in Dansk Bot. Ark. 8(2): 7. 1932; Desikachary & al., Rhodophyta 2 (2B): 120. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 27. 2001; 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, usually 5-20 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 flattened, rigid, up to 4 cm long and 3 mm wide. Fronds cartilaginous, narrowly flattened towards base and much flattened towards apex, regularly (sub)dichotomously or polychotomously branched, dense towards apex, ultimate branches lacinate (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 1.6 mm thick, multilayered, differentiated into single layered cortex and central medulla layers; cortex cells usually elongated, radially arranged, 5-12 × 6-7 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.

Occurrence: During Monsoon and post-monsoon seasons. Moderate (Plate: XVIII - b).

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

Specimen Examined: Goa coast: Arambol coast, *Palanisamy & Yadav* 140210, 14.02.2018; Galgibag coast, *Palanisamy & Yadav* 140137, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140142, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140176, 14.02.2018; Capehao beach, *Palanisamy & Yadav* 137729, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137745, 18.12.2017; Coco Beach, *Palanisamy & Yadav* 143840, 27.10.2018; Mormugao Coast, *Palanisamy & Yadav* 143863, 28.10.2018.

3. *Gracilaria textorii* (Suringar) De Toni in Memorie Reale Istitut. Veneto Scien. 25(5): 78, II plates. 1895; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 29. 2001; Jha & al., Seaweeds Gujarat: 123. 2009; P.S.N. Rao & Gupta, Algae India 3: 41. 2015. *Sphaerococcus textorii* Suringar Annales Mus. 3: 259.1868.

Thallus light-yellowish red in colour, foliose, compressed, usually 6-25 cm long, bushy, tufted, cartilaginous, epilithic. Holdfast discoid, tufted, up to 4

mm in diameter, firmly attached on rocky substrata. Stipe flattened, rigid, 1-4 cm long and up to 3 mm wide. Fronds cartilaginous, flattened, irregularly branched, branching dense towards apex, ultimate branches usually irregular; surface usually smooth; margins entire to irregularly proliferated; apex mostly acute-acuminate.

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

Distribution: Goa: Ashwim, Vagator and Talpona. **India:** Andaman & Nicobar Islands, Andhra Pradesh, Gujarat, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Ashwim coast, *Palanisamy & Yadav* 140232, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140251, 16.02.2018; Talpona coast, *Palanisamy & Yadav* 140141, 13.02.2018.

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 Goa.

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 96 taxa in world (Guiry & Guiry, 2019), 9 in India (Rao & Gupta, 2015) and 3 species in Goa.

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. 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; Palanisamy & al. in Seaweed Res. Utiln. 36(1&2): 4. 2014; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 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 5-15 cm long, bushy, tufted, mucilaginous, epilithic. Holdfast small, discoid, up to 5 mm in diameter, dark, firmly attached on rocky substrata in intertidal regions. Stipe small, subcylindrical to slightly flattened. Fronds foliose, linear-elongate, up to 15 cm long and 1-6 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 140-210 μm thick, multilayered, differentiated into outer cortical and central medullary layers. Cystocarps usually irregularly scattered and immersed on fronds surface, sub-spherical, 160-200 μm across, ostiolate.

Occurrence: Throughout the year. Moderate.

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

Specimen Examined: Goa coast: Candolim coast, *Palanisamy & Yadav* 137641, 15.12.2017; Siridao coast, *Palanisamy & Yadav* 137681, 16.12.2017; Querim beach, *Palanisamy & Yadav* 139805, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139830, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139844, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139848, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139855, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139856, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139857, 08.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139891, 09.10.2017; Patnem beach, *Palanisamy & Yadav* 139957, 13.10.2017; Querim beach, *Palanisamy & Yadav* 140005, 13.12.2017; Ashwim beach, *Palanisamy & Yadav* 140049, 13.12.2017; Morjim beach, *Palanisamy & Yadav* 140059, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140067, 14.12.2017; Patnem coast, *Palanisamy & Yadav* 142339, 23.02.2018; Capogao beach, *Palanisamy & Yadav* 137739, 18.12.2017; Palolem beach, *Palanisamy & Yadav* 137782, 19.12.2017; Galgibag coast, *Palanisamy & Yadav* 140133, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140184, 14.02.2018; Anjuna Coast, *Palanisamy & Yadav* 143813, 26.10.2018; Resi Magos Coast, *Palanisamy & Yadav* 143852, 27.10.2018; Cola Coast, *Palanisamy & Yadav* 143890, 30.10.2018; Columb Coast, *Palanisamy & Yadav* 143910, 30.10.2018.

2. *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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 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, 3-20 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 0.3-1.5 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, 2-5 μm across, sparsely arranged. In cross section, thallus up to 350 μm thick, multilayered, differentiated into outer cortical region and central medullary region; cortex 2-6-layered, cells round or oval to slightly elongate, 3-12 μm across, compact in outer layer and gradually become loose inwards; medulla usually hollow or loosely interwoven by rhizoidal filaments of 3.4-7 μm width, cells stellate, 10-15 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: XVIII - c).

Occurrence: Throughout the year. Common.

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

Specimen Examined: Goa coast: Vagator beach, *Palanisamy & Yadav* 139827, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139875, 08.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139885, 09.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139899, 09.10.2017; Patnem beach, *Palanisamy & Yadav* 139954, 13.10.2017; Polem beach, *Palanisamy & Yadav* 139974, 14.10.2017; Querim Coast, *Palanisamy & Yadav* 142356, 21.06. 2018; Anjuna Coast, *Palanisamy & Yadav* 143822, 26.10.2018; Columb Coast, *Palanisamy & Yadav* 14390, 30.10.2018.

5. CORALLINALES

CORALLINACEAE

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

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

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. Conceptacles latero-apical on the wings of the intergeniculata, mainly confined to the winged processes **2. Cheilosporum**
- 2b. Conceptacles terminal on the wings of the intergeniculata; fertile segments often larger than sterile ones **3. 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, 56 taxa in world (Guiry & Guiry, 2019), 7 in India (Rao & Gupta, 2015) and 3 in Goa.

Key to species

- 1a. Thallus purple red in colour, flat, much branched, heavily calcified **1. *A. anceps***
- 1b. Thallus dark-muddy pinkish red in colour, usually cylindrical, less branched, lightly calcified **2**
- 2a. Thallus 2-5 cm long, more fragile; Intergenicula smooth, up to 400 μ m in diameter **2. *A. fragilissima***
- 2b. Thallus 3-6 cm long, rigid, less fragile; Intergenicula rough, up to 480 μ m in diameter **3. *A. rigida***

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 2014; 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 in color; usually 3 – 8 cm tall, erect articulate, stongly calcified segments. Holdfast crustose, 2–10 mm across, bearing numerous fronds; epilithic. Fronds erect, cylindrical to terete, often tufted and much branched dichotomously (rarely with small proliferations) from the upper end of each intergeniculum, intergenicula more or less terete near the base, compressed to flat above and 3–12 mm long, 1–3 mm broad and 400–1000 μ m thick centrally, edges thinner and more or less sharp-edged, margins parallel to slightly broader above, calcification over genicula closer near the margins. *Microscopic*: 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: XVIII - d).

Occurrence: Usually Post-Monsoon season. Moderate.

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

Specimen Examined: Goa coast: Polem beach, *Palanisamy & Yadav* 139978, 14.10.2017; Ashwim coast, *Palanisamy & Yadav* 140228, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140254, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140264, 16.02.2018; Cola coast, *Palanisamy & Yadav* 142297, 21.02.2018; Colomb coast, *Palanisamy & Yadav* 142319, 23.02.2018; Colomb coast, *Palanisamy & Yadav* 142325, 23.02.2018; Polem coast, *Palanisamy & Yadav* 142348, 24.02.2018; Sinquerim fort beach, *Palanisamy & Yadav* 137648, 15.12.2017; Mormugao coast, *Palanisamy & Yadav* 137690, 16.12.2017; Cola Coast, *Palanisamy & Yadav* 143892, 30.10.2018.

2. *Amphiroa fragilissima* (L.) J.V. Lamour., Hist. Polyp. Corall. 298. 1816; Untawale & al., List Mar. Alg. India: 29. 1983; Desikachary & al., Rhodophyta, 2 (2B):60.1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 40.2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 2014; 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, usually 2-5 cm long, calcified, solid, fragile, caespitose, usually epilithic. Holdfast minute, discoid, sometimes indistinct, brittle, 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 400 μm in diameter, characteristically marked with pad like swellings of up to 410 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: XIX - a).

Occurrence: Post-monsoon and summer seasons. Rare.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137604, 14.12.2017; Vagator beach, *Palanisamy & Yadav* 140076, 14.12.2017; Nyex coast, *Palanisamy & Yadav* 140288, 16.02.2018; Agonda coast, *Palanisamy & Yadav* 142307, 22.02.2018; Patnem coast, *Palanisamy & Yadav* 142340, 23.02.2018; Palolem beach, *Palanisamy & Yadav* 137779, 19.12.2017; Palolem beach, *Palanisamy & Yadav* 137780, 19.12.2017; Anjuna Coast, *Palanisamy & Yadav* 143818, 26.10.2018; Cola Coast, *Palanisamy & Yadav* 143891, 30.10.2018.

3. *Amphiroa rigida* J.V. Lamour., Hist. Polyp. Corall. 297. 1816; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 40.2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 2014; P.S.N. Rao & Gupta, Algae India 3: 44. 2015.

Thallus dark-muddy pinkish in colour, cylindrical-terete, usually 3-6 cm long, heavily calcified, solid, fragile, caespitose, usually epilithic. Holdfast minute, discoid, brittle, lightly 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. *Microscopic*: Intergenicula cylindrical, calcified, margins usually rough due to calcification; apex usually round to obtuse, up to 480 μm in diameter, characteristically marked with pad like swellings of up to 500 μm length; geniculata usually linear, extremely thin. Conceptacles prominently developed throughout on frond surface, densely crowded in mature thallus (Plate: XIX - b).

Occurrence: Post-monsoon and summer seasons. Rare.

Distribution: Goa: Cola, Agonda, Polem and Columb coasts. **India**: Andaman & Nicobar Islands, Gujarat, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Cola coast, *Palanisamy & Yadav* 142298, 21.02.2018; Agonda beach, *Palanisamy & Yadav* 137765, 18.12.2017; Polem Coast, *Palanisamy & Yadav* 143925, 01.10.2018; Columb Coast, *Palanisamy & Yadav* 143903, 30.10.2018.

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 1 taxa in world (Guiry & Guiry, 2019), India (Rao & Gupta, 2015) and Goa.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 2014; P.S.N. Rao & Gupta, Algae India 3: 45. 2015.

Thallus light purple red in colour, calcareous, bushy, fragile, erect, articulated, caespitose, epilithic. Holdfast minute, rhizoidal, brittle. Stipe minute, stalked, up to 0.5 mm long, sometimes indistinct. Fronds erect, filamentous, usually 2-5 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, 230-9600 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. Genticulata represented by a thin stripe between the intergenicular

segments, 10-25 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, 6-12 μm across.

Occurrence: Post-monsoon and summer seasons. Rare.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137603, 14.12.2017; Mormugao coast, *Palanisamy & Yadav* 137691, 16.12.2017; Polem coast, *Palanisamy & Yadav* 142347, 24.02.2018; Anjuna beach, *Palanisamy & Yadav* 139859, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139871, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 140077, 14.12.2017; Vagator beach, *Palanisamy & Yadav* 140229, 14.12.2017; Vagator coast, *Palanisamy & Yadav* 140255, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140263, 16.02.2018; Nyex coast, *Palanisamy & Yadav* 140287, 16.02.2018; Cola coast, *Palanisamy & Yadav* 142296, 21.02.2018; Polem coast, *Palanisamy & Yadav* 142347, 24.02.2018; Galgibag coast, *Palanisamy & Yadav* 140140, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140147, 13.02.2018; Capehao beach, *Palanisamy & Yadav* 137724, 18.12.2017; Cola beach, *Palanisamy & Yadav* 137748, 18.12.2017; Agonda beach, *Palanisamy & Yadav* 137764, 18.12.2017; Anjuna Coast, *Palanisamy & Yadav* 143830, 26.10.2018; Cola Coast, *Palanisamy & Yadav* 143894, 30.10.2018; Polem Coast, *Palanisamy & Yadav* 143926, 01.10.2018.

3. *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, 2019), 5 in India (Rao & Gupta, 2015) and 1 in Goa.

Jania rubens (L.) J.V. Lamour., *Hist. Polyp. Corall.* 271. 1816; Desikachary & al., *Rhodophyta* 2(2B): 71. 1998; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*: 43. 2001; Pereira & Almeida in *Indian J. Mar. Sci.* 42 (4): 657. 2014; 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, usually 2-5 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 cm long and 90-310 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 uniformly elongate, $50-100 \times 5-10 \mu\text{m}$; cortex cells usually circular or flattened to isodiametric, $6-20 \mu\text{m}$ 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, $200-280 \mu\text{m}$ in diameter, antenniferous with a single apical pore (Plate: XIX - c).

Occurrence: Monsoon and post-monsoon seasons. Rare.

Distribution: Goa: Cola, Capegao, Palolem. **India**: Andaman Islands, Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Cola coast, *Palanisamy & Yadav* 142299, 21.02.2018; Capegao beach, *Palanisamy & Yadav* 137725, 18.12.2017; Palolem beach, *Palanisamy & Yadav* 137781, 19.12.2017.

HYDROLITHACEAE

Hydrolithon (Foslie) Foslie

Thallus crustose, lithophilic, dark pinkish- purple red in colour, warty, non-geniculate, epilithic. Anatomically, thallus dimerous; cortex with trichocytes.

Currently 22 taxa in world (Guiry & Guiry, 2019), 8 in India (Rao & Gupta, 2015) and 1 in Goa.

Hydrolithon reinboldii (Weber Bosse & Foslie) Foslie, *Algologisk.* 55. 1909; Oza & Zaidi, *Rev. Checkl. Ind. Mar. Alg.*:42. 2001; Pereira & Almeida in *Indian J. Mar. Sci.* 42 (4): 657. 2014. *Lithophyllum reinboldii* Weber Bosse & Foslie, *Det Kong.*: 5. 1901

Thallus light pinkish red in colour, warty, crustose, firmly attached on rocky substrata. Fronds indistinct, hard and forming a pinkish layer on rocky surface.

Occurrence: Usually Post-monsoon season. Moderate.

Distribution: Goa: Neum beach. **India**: Andaman & Nicobar Islands, Gujarat, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Neum beach, *Palanisamy & Yadav* 137711, 18.12.2017.

4. GIGARTINALES

Key to families

- | | | |
|-----|---|-------------------------|
| 1a. | Thallus multiaxial, tetrasporangia zonate or cruciate | 1. Gigartinaceae |
| 1b. | Thallus uniaxial, tetrasporangia zonate | 3. Hypneaceae |

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.

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

Chondracanthus Kuetz.

Thallus dark-purple red in colour, cylindrical-terete or slightly compressed, up to 15 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 28 taxa in world (Guiry & Guiry, 2019), 2 in India (Desikachary & al., 1998) and 1 in Goa.

Chondracanthus acicularis (Roth) Fredericq in *Hydrobiologia* 26: 117. 1993; Desikachary & al., *Rhodophyta* 2 (2B): 128. 1998; Pereira & Almeida in *Indian J. Mar. Sci.* 42 (4): 657. 2014; 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, usually 4-12 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 mm long and 180-360 μm broad. *Microscopic:* Cells in surface view oval-spherical, small, 2-8 μm across. In cross section, thallus multilayered, 280-510 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, 300-340 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: XIX - d).

Occurrence: Monsoon and post-monsoon seasons. Moderate.

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

Specimen Examined: Goa coast: Siquerim fort beach, Palanisamy & Yadav 137623, 09.10.2017; Anjuna beach, Palanisamy & Yadav 139872,

08.10.2017; Querim beach, *Palanisamy & Yadav* 140004, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140091, 14.12.2017; Ashwim coast, *Palanisamy & Yadav* 140230, 15.02.2018; Siridao coast, *Palanisamy & Yadav* 137683, 16.12.2017; Talpona coast, *Palanisamy & Yadav* 140149, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140180, 14.02.2018; Querim Coast, *Palanisamy & Yadav* 142357, 21.06.2018; Mandrim Coast, *Palanisamy & Yadav* 142364, 21.06.2018.

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 nemathecium.

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

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 nemathecium or sori on swollen portion of ultimate branchlets.

Currently 58 taxa in world (Guiry & Guiry, 2019), 10 in India (Rao & Gupta, 2015) and 5 in Goa.

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. <i>H. spinella</i> |
| 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. <i>H. musciformis</i> |
| 3b. | Thallus large, up to 15 cm long; ramuli densely arranged and forming thick tomentose appearance | 2. <i>H. flagelliformis</i> |
| 4a. | Thallus large; fronds cylindrical to distinctly compressed, moderately covered with ramuli; ramuli large | 1. <i>H. esperi</i> |
| 4b. | Thallus small; fronds cylindrical to terete, densely covered with minute ramuli | 5. <i>H. valentiae</i> |

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; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Thallus light -dark greenish red in colour, bushy, terete or cylindrical to slightly flat, usually 10-30 cm long, tufted, usually forming thick mat like layer in suitable condition, epilithic. Holdfast small, usually discoid, up to 0.5 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 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, 0.3-10 mm long and 90-200 μ m 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: XX - a).

Occurrence: Post-monsoon and summer seasons. Moderate.

Distribution: Goa: Sinkerim. **India**: Gujarat, Lakshadweep Islands Karnataka, Kerala and Tamil Nadu.

Specimen Examined: Goa coast: Sinkerim fort beach, *Palanisamy & Yadav* 139900, 09.10.2017.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 2014; P.S.N. Rao & Gupta, Algae India 3: 49. 2015.

Thallus purple to dark reddish in colour, usually 4-15 cm long, bushy, tufted, epilithic. Holdfast minute, rhizoidal or discoid, firmly attached. Fronds bushy, usually 4-15 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 forming tomentose appearance.

Occurrence: November to April

Distribution: Goa: Agonda and Anjuna. **India**: Indian coast (Rao & Gupta, 2015), Karnataka and Tamil Nadu (Cape Comorin).

Specimen Examined: Goa coast: Agonda beach, *Palanisamy & Yadav* 137761, 18.12.2017; Anjuna Coast, *Palanisamy & Yadav* 143812, 26.10.2018.

3. *Hypnea musciformis* (Wulfen) J.V. Lamour. in Ann. Mus. Hist. Nat. 20: 131. 1813; Desikachary & al., Rhodophyta 2(2B): 156. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 51. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 657. 2014; 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, usually 5-30 cm long, tufted, epilithic. Holdfast small, usually discoid, up to 5 mm in diameter, firmly attached, occasionally free floating. Stipe up to 1.5 cm long and 0.8-2 mm wide, usually clothed with minute ramuli. Fronds cylindrical to slightly flattened, 4-25 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, 4-12 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, 80-140 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.

Occurrence: Throughout the year. Common.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137615, 14.12.2017; Anjuna beach, *Palanisamy & Yadav* 137616, 14.12.2017; Querim beach, *Palanisamy & Yadav* 139803, 08.10.2017; Morjim beach, *Palanisamy & Yadav* 139820, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139837, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139868, 08.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139894, 09.10.2017; Betul fort coast, *Palanisamy & Yadav* 139937, 12.10.2017; Neum beach, *Palanisamy & Yadav* 139939, 12.10.2017; Patnem beach, *Palanisamy & Yadav* 139961, 13.10.2017; Polem beach, *Palanisamy & Yadav* 139977, 14.10.2017; Tilmati beach, *Palanisamy & Yadav* 139987, 14.10.2017; Arambol beach, *Palanisamy & Yadav* 140040, 13.12.2017; Ashwim beach, *Palanisamy & Yadav* 140050, 13.12.2017; Morjim beach, *Palanisamy & Yadav* 140055, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140075, 14.12.2017; Vagator beach, *Palanisamy & Yadav* 140079, 14.12.2017; Arambol coast, *Palanisamy & Yadav* 140209, 14.02.2018; Coco beach, *Palanisamy & Yadav* 137660, 15.12.2017; Galgibag coast, *Palanisamy & Yadav* 140134, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140174, 14.02.2018; Capegao beach, *Palanisamy & Yadav* 137730, 18.12.2017; Rajbag beach, *Palanisamy & Yadav* 137794, 20.12.2017; Ashwim coast, *Palanisamy & Yadav* 140225, 15.02.2018; Vagator coast, *Palanisamy & Yadav* 140250, 16.02.2018; Anjuna coast, *Palanisamy & Yadav* 140261, 16.02.2018; Bambolim coast, *Palanisamy & Yadav* 142226, 18.02.2018; Mormugao coast, *Palanisamy & Yadav* 142241, 20.02.2018; Cabo-de-Rama coast, *Palanisamy & Yadav* 142277, 21.02.2018; Cola coast, *Palanisamy & Yadav* 142294, 21.02.2018; Colomb coast,

Palanisamy & Yadav 142317, 23.02.2018; Patnem coast, *Palanisamy & Yadav* 142334, 23.02.2018; Anjuna Coast, *Palanisamy & Yadav* 143810, 26.10.2018; Anjuna Coast, *Palanisamy & Yadav* 143817, 26.10.2018; Coco Beach, *Palanisamy & Yadav* 143845, 27.10.2018; Bogmalo Coast, *Palanisamy & Yadav* 143871, 28.10.2018; Columb Coast, *Palanisamy & Yadav* 143904, 30.10.2018; Columb Coast, *Palanisamy & Yadav* 143908, 30.10.2018; Polem Coast, *Palanisamy & Yadav* 143927, 01.10.2018.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 658. 2014; 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-light purple red in colour, sometimes light-yellowish green, bushy, cylindrical to terete, small, usually 2-4.5 cm long, tufted, pulvinate, intricately branched, occasionally cushioned, caespitose, epilithic. Holdfast small, usually discoid, loosely attached, occasionally free floating. Stipe small, up to 4 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, 0.4-2.5 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.

Occurrence: Monsoon season. Rare.

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

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137617, 14.12.2017; Anjuna coast, *Palanisamy & Yadav* 140276, 16.02.2018; Talpona coast, *Palanisamy & Yadav* 140150, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140173, 14.02.2018; Querim Coast, *Palanisamy & Yadav* 142359, 21.06. 2018; Agonda beach, *Palanisamy & Yadav* 137763, 18.12.2017.

5. *Hypnea valentiae* (Turner) Mont. in Ann. Sci. Nat. Bot. 2(16): 161. 1841; Untawale & al., List Mar. Alg. India: 31. 1983; Desikachary & al., Rhodophyta 2 (2B): 159. 1998; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 658. 2014; 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 4-15 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 12 cm long and 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 2-4-layered, usually circular to round. Thallus usually dioecious; cystocarps develop on branchlets, round or globular, conspicuous, sessile; tetrasporangia usually develop in swollen nemathecium near the base of branchlets, zonately divided (Plate: XX - b).

Occurrence: Throughout the year. Moderate.

Distribution: Goa: Mormugao, Vagator, and Coco. **India**: Andhra Pradesh, Goa, Gujarat, Karnataka, Kerala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Mormugao coast, *Palanisamy & Yadav* 142242, 20.02.2018; Vagator beach, *Palanisamy & Yadav* 139843, 08.10.2017; Coco Beach, *Palanisamy & Yadav* 143846, 27.10.2018.

5. RHODYMENIALES

Key to families

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

1. 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 Goa.

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 44 taxa in world (Guiry & Guiry, 2019), 8 in India (Rao & Gupta, 2015) and 1 in Goa.

Champia compressa Harv., Gen. Afr. Pl.: 402. 1838; Boergesen in J. Indian Bot. Soc. 16: 332, fig. 8. 1937; Desikachary & al., Rhodophyta 2 (2B):187.

1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 58. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 658. 2014; 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, 2-8 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 0.5-1.4 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, 40-50 μm across, irregularly or sparsely arranged. In cross section, thallus thin, single layered, cells usually squarish, 30-45 μm across. Cystocarps scattered on frond segments, sessile, usually conical; tetrasporangia scattered or aggregated on thallus surface or embedded, zonately divided (Plate: XX - c).

Occurrence: Post-monsoon season. Rare.

Distribution: Goa: Arambol, Coco and Polem. **India**: Goa, Gujarat, Karnataka, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Agonda beach, *Palanisamy & Yadav* 137760, 18.12.2017; Coco Beach, *Palanisamy & Yadav* 143847, 27.10.2018; Polem Coast, *Palanisamy & Yadav* 143922, 01.10.2018.

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 1 genus in Goa.

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, 2019), 4 in India (Rao & Gupta, 2015) and 2 in Goa.

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; Desikachary & al., Rhodophyta 2 (2B):176. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 62.2001; 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, usually 3-10 cm long, regularly dichotomously branched, cartilaginous, flexible, epilithic. Holdfast minute, usually rhizoidal, branches up to 1.2 cm long, firmly attached on rocky substrata in intertidal region. Stipe stalked, cylindrical, up to 1 cm long and 0.8 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; medulla cells spherical to elongate, variable in sizes, hyaline. Cystocarps borne on upper branches, spherical-ovoid (Plate: XX - d).

Occurrence: Throughout the year. Moderate.

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

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here.

Specimen Examined: Goa coast: Mandrim Coast, *Palanisamy & Yadav* 142365, 21.06.2018; Reis Magos coast, *Palanisamy & Yadav* 137668, 15.12.2017; Galgibag coast, *Palanisamy & Yadav* 140132, 13.02.2018; Cola beach, *Palanisamy & Yadav* 137746, 18.12.2017; Anjuna Coast, *Palanisamy & Yadav* 143823, 26.10.2018; Columb Coast, *Palanisamy & Yadav* 143905, 30.10.2018; Galgibag Coast, *Palanisamy & Yadav* 143914, 31.10.2018.

2. *Gelidiopsis variabilis* (J. Agardh) F. Schmitz in Bot. Jahrb. Syst. 21: 148. 1895; Untawale & al., List Mar. Alg. India: 32. 1983; Desikachary & al., Rhodophyta 2 (2B):176. 1998; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 658. 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, usually 3-12 cm long, branched, erect, cartilaginous, epilithic. Holdfast discoid or rhizoidal, firmly attached. Stipe stalked, cylindrical, up to 0.5 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, 5-24 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 Goa coast. **India**: Andhra Pradesh, Gujarat, Karnataka, Kerala, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Anjuna beach, *Palanisamy & Yadav* 137614, 14.12.2017; Arambol beach, *Palanisamy & Yadav* 140021, 13.12.2017; Arambol beach, *Palanisamy & Yadav* 140041, 13.12.2017; Morjim beach, *Palanisamy & Yadav* 140054, 13.12.2017; Vagator beach, *Palanisamy & Yadav* 140093, 14.12.2017; Arambol coast, *Palanisamy & Yadav* 140212, 14.02.2018; Ashwim coast, *Palanisamy & Yadav* 140231, 15.02.2018; Anjuna coast, *Palanisamy & Yadav* 140266, 16.02.2018; Mormugao coast, *Palanisamy & Yadav* 142243, 20.02.2018; Cola coast, *Palanisamy & Yadav* 142292, 21.02.2018; Colomb coast, *Palanisamy & Yadav* 142316, 23.02.2018; Patnem coast, *Palanisamy & Yadav* 142333, 23.02.2018; Arambol beach, *Palanisamy & Yadav* 140021, 13.12.2017; Mormugao coast, *Palanisamy & Yadav* 142243, 20.02.2018; Cola coast, *Palanisamy & Yadav* 142292, 21.02.2018; Colomb coast, *Palanisamy & Yadav* 142316, 23.02.2018.

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 Goa.

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 18 taxa in world (Guiry & Guiry, 2019), 1 in India (Rao & Gupta, 2015) and 1 in Goa.

Centroceras clavulatum (C. Agardh) Mont., Fl. Algerie: 140. 1846; Untawale & al., List Mar. Alg. India: 34. 1983; Desikachary & al., Rhodophyta, 2 (2B): 215. 1998; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 658. 2014; 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, usually 2-8 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 90-400 × 100-160 μm, ultimate branches forcipate, slightly curved, 90-660 × 40-110 μm, cells in surface view rectangular to squarish, cells 7-14 × 6-10 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 20-50 × 10-30 μm; dichotomy on filaments usually with 5-12 segments (Plate: XXI - a).

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

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

Specimen Examined: Goa coast: Querim beach, *Palanisamy & Yadav* 139807, 08.10.2017; Vagator beach, *Palanisamy & Yadav* 139828, 08.10.2017; Anjuna beach, *Palanisamy & Yadav* 139877, 08.10.2017; Sinquerim fort beach, *Palanisamy & Yadav* 139888, 09.10.2017; Siridao beach, *Palanisamy & Yadav* 139903, 09.10.2017; Betul fort coast, *Palanisamy & Yadav* 139936, 12.10.2017; Neum beach, *Palanisamy & Yadav* 139947, 12.10.2017; Vagator beach, *Palanisamy & Yadav* 140084, 14.12.2017; Arambol coast, *Palanisamy & Yadav* 140206, 14.02.2018; Ashwim coast, *Palanisamy & Yadav* 140236, 15.02.2018; Cola coast, *Palanisamy & Yadav* 142300, 21.02.2018; Colomb coast, *Palanisamy & Yadav* 142326, 23.02.2018; Galgibag coast, *Palanisamy & Yadav* 140135, 13.02.2018; Talpona coast, *Palanisamy & Yadav* 140146, 13.02.2018; Querim coast, *Palanisamy & Yadav* 140177, 14.02.2018; Querim Coast, *Palanisamy & Yadav* 142354, 21.06. 2018; Anjuna Coast, *Palanisamy & Yadav* 143825, 26.10.2018; Coco Beach, *Palanisamy & Yadav* 143841, 27.10.2018;

Siridao Coast, *Palanisamy & Yadav* 143858, 28.10.2018; Cabo De Rama Coast, *Palanisamy & Yadav* 143886, 30.10.2018; Columb Coast, *Palanisamy & Yadav* 143907, 30.10.2018; Galgibag Coast, *Palanisamy & Yadav* 143918, 31.10.2018.

2. *Ceramium* Roth

Thallus dark-light red in colour, filamentous, up to 20 cm long, erect or prostrate, monosiphonous, epilithic or epiphytic, attached with minute discoidal holdfast. Frond filamentous, cylindrical-terete, pseudodichotomously 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, 2019), 17 in India (Rao & Gupta, 2015) and 1 in Goa.

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 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-forcinate, occasionally slightly incurved. *Microscopic*: Nodes and internodes conspicuous, internodes 8-34 μm long, ecorticated, larger in lower portion and gradually reducing upwards, slightly compressed; nodes corticated, gradually shorter towards down and gradually increasing upwards, dark or purple coloured; Spermatangia usually adaxial, whorled; cystocarps terminal, 20-30 μm across (Plate: XXI - b).

Occurrence: Post-monsoon season. Moderate

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

Notes: This species is recorded here as an addition to the Goa coast as it was not reported previously from here.

Specimen Examined: Goa coast: Reis Magos coast, *Palanisamy & Yadav* 142202, 17.02.2018; Aguada jail coast, *Palanisamy & Yadav* 142209, 17.02.2018; Baga coast, *Palanisamy & Yadav* 142219, 17.02.2018; Colomb coast, *Palanisamy & Yadav* 142318, 23.02.2018; Aguada jail coast, *Palanisamy & Yadav* 137657, 15.12.2017; Siridao coast, *Palanisamy & Yadav* 137682, 16.12.2017; Talpona coast, *Palanisamy & Yadav* 140152, 13.02.2018; Betul Coast, *Palanisamy & Yadav* 142399, 24.06. 2018; Aguada jail coast, *Palanisamy & Yadav* 137657,

15.12.2017; Siridao coast, *Palanisamy & Yadav* 137682, 16.12.2017; Talpona coast, *Palanisamy & Yadav* 140152, 13.02.2018; Betul Coast, *Palanisamy & Yadav* 142399; 24.06. 2018.

3. *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, 2019), 7 in India (Rao & Gupta, 2015) and 1 in Goa.

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; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; 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, usually 2-8 cm long bushy, gregarious, tufted, epilithic. Holdfast minute, usually rhizoidal, firmly attached. Stipe small or indistinct. Frond remiform, usually 3-4 cm long, cylindrical to slightly flattened, in basal region, pinnately branched, covered with numerous ramuli; ramuli erect, spinous, up to 1 cm long, usually sub-distichously branched, densely arranged at distal end. Cystocarps develop on ramuli, usually subterminal in position (Plate: XXI - c).

Occurrence: Post-monsoon season. Moderate

Distribution: Goa: Arambol, Anjuna and Ashwim. **India:** Andhra Pradesh, Gujarat, Karnataka, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Arambol beach, *Palanisamy & Yadav* 140030, 13.12.2017; Ashwim beach, *Palanisamy & Yadav* 140051, 13.12.2017; Ashwim coast, *Palanisamy & Yadav* 140224, 15.02.2018; Anjuna coast, *Palanisamy & Yadav* 140267, 16.02.2018.

2. 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 Goa.

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, midrib absent, net like structure present | 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 29 taxa in world (Guiry & Guiry, 2019), 5 in India (Rao & Gupta, 2015) and 1 in Goa.

Caloglossa lepreurii (Mont.) G. Martens in Flora 52: 234. 1869; Untawale & al., List Mar. Alg. India: 35. 1983; Desikachary & al., Rhodophyta 2 (2B): 254. 1998; 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: 58. 2015. *Delesseria lepreurii* Mont. in Ann. Sci. Nat. Bot. 13: 196, pl. 5: fig. 1. 1840.

Thallus brownish-dark red in colour, foliose, flattened, usually 1-5 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 5 cm long, dichotomously branched, branches dense towards apex, differentiated into nodes and internodes; nodes 70-230 μm wide; internodal segments flat, linear to lanceolate, usually compressed at base and expanded towards apex, $0.4-3 \times 0.1-0.5$ 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, 5-20 μm across, compact, midrib cells 35-75 \times 5-20 μm . Spermatangia in sori on both sides of midribs; cystocarps sessile, develop in midrib region on terminal part of mature thallus (Plate: XXI - d).

Occurrence: Throughout the year. Moderate.

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

Specimen Examined: Goa coast: Kiranpani, *Palanisamy & Yadav* 139811, 08.10.2017; Colomb coast, *Palanisamy & Yadav* 142327, 23.02.2018; Vagator Coast, *Palanisamy & Yadav* 143802, 26.10.2018; Resi Magos Coast, *Palanisamy & Yadav* 143853, 28.10.2018; Resi Magos Coast, *Palanisamy & Yadav* 143854, 28.10.2018; Columb Coast, *Palanisamy & Yadav* 143906, 30.10.2018.

2. *Martensia* K. Hering

Thallus dark to pinkish red in colour, foliaceous, fan shaped with flabellae blades, up to 30 cm long, usually fragile epilithic. Frond flat, irregularly lobed into several lobes.

Currently 29 taxa in world (Guiry & Guiry, 2018), 3 in India (Rao & Gupta, 2015) and 1 in Goa.

Martensia fragilis Harv.in Hook. J. Bot. 6; 145. 1854; Desikachary & al., Rhodophyta 2 (2B): 272, figs. 76 a-d. 1998; Oza & Zaidi, Rev. Checkl.Ind. Mar. Alg.: 80. 2001;Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; 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 stalked to slightly flattened upwards. Fronds thin, foliaceous, 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 (Plate: XXII - a).

Occurrence: Usually Monsoon season. Rare.

Distribution: Goa: Cola and Agonda coast. **India**: Goa, Karnataka, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast:Cola coast, *Palanisamy & Yadav* 142295, 21.02.2018; Agonda coast, *Palanisamy & Yadav* 142305, 22.02.2018.

3. RHODOMELACEAE

Thallus light-dark or purple red in colour, bushy, filamentous, polysiphonous or pseudo parenchymatous, epiphytic, epilithic or epizoid. 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 Goa.

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, 2019), 4 in India (Rao & Gupta, 2015) and 1 in Goa.

1. *Acanthophora muscoides* (L.) Bory, Botaniq. Cryptog., 156. 1828; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.:83. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; P.S.N. Rao & Gupta, Algae India 3: 2. 2015. *Fucus muscoides* L. Sp. Pl. 1161. 1753.

Thallus dark-muddy purple red in colour, remiform, bushy, cylindrical to terete, usually 5-20 cm long, tufted, epilithic. Holdfast small, rhizoidal, clustered, colourless, branched, firmly attached. Stipe small, stalked, up to 1.7 cm long and 0.4-3 mm wide, rigid. Fronds bushy, consists of main axis and lateral branches; main axis usually cylindrical to terete, up to 20 cm long, spines prominently present; branches usually alternate or irregular; branchlets densely arranged, ultimate branchlets determinate, $150-980 \times 140-320 \mu\text{m}$, densely covered with spines; spines short, broadly subulate, $135-230 \times 80-160 \mu\text{m}$. *Microscopic*: Cells of the main axis pseudoparenchymatous, polysiphonous, axial cell with 5 pericentral cells, connected by thick cortical cells; spermatangia develop in clusters on trichoblasts; cystocarps conical, usually with a lateral spine (Plate: XXII - b).

Occurrence: Usually Post-monsoon seasons. Moderate.

Distribution: Goa: Cola beach. **India**: Andaman & Nicobar Islands, Gujarat, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Cola beach, *Palanisamy & Yadav* 137741, 18.12.2017.

2. *Acanthophora spicifera* (Vahl) Boergesen, Bot. Tidsskr. 30: 201. 1910; Desikachary & al., Rhodophyta 2 (2B): 332. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.:83. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; 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, usually 3-15 (-25) cm long, tufted, epilithic. Holdfast small, rhizoidal, clustered, colourless, branched, firmly attached. Stipe small, stalked, up to 1.5 cm long and 0.4-2.5 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, $180-950 \times 150-310 \mu\text{m}$, densely covered with spines; spines short, broadly subulate, $125-220 \times 80-150 \mu\text{m}$. *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.

Occurrence: Monsoon and post-monsoon seasons. Moderate.

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

Specimen Examined: Goa coast: Arambol beach, *Palanisamy & Yadav* 140017, 13.12.2017; Reis Magos coast, *Palanisamy & Yadav* 140295, 17.02.2018; Talpona coast, *Palanisamy & Yadav* 140151, 13.02.2018; Coco beach, *Palanisamy & Yadav* 137662, 15.12.2017; Cola beach, *Palanisamy & Yadav* 137740, 18.12.2017.

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 40 taxa in world (Guiry & Guiry, 2019), 3 in India (Desikachary & al., 1998) and 1 in Goa.

Bostrychia tenella (J.V. Lamour.) J. Agardh, Spec. Gen. Ord. Alg. 2(3): 869. 1863; Untawale & al., List Mar. Alg. India: 38. 1983; Desikachary & al., Rhodophyta 2 (2B): 315. 1998; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; P.S.N. Rao & Gupta, Algae India 3: 59.2015. *Plocamium tenellum* J.V. Lamour., Ann. Mus. 20: 138. 1813.

Thallus dark-muddy or brownish purple in colour, prostrate, decumbent, bushy, usually 1-5 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 1.2 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 100-340 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 \times 6-16 μm , thick walled, cells interconnected by means of pit connections; cells of the ultimate laterals always monosiphonous, 6-20 \times 6-14 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: XXII - c).

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

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

Specimen Examined: Goa coast: Nyex coast, *Palanisamy & Yadav* 137630, 14.12.2017; Betul fort coast, *Palanisamy & Yadav* 139934, 12.10.2017; Neum beach, *Palanisamy & Yadav* 139946, 12.10.2017; Ashwim beach, *Palanisamy & Yadav* 140048, 13.12.2017; Valsao coast, *Palanisamy & Yadav* 142228, 18.02.2018; Betul fort coast, *Palanisamy & Yadav* 142261, 21.02.2018;

Neum coast, *Palanisamy & Yadav* 142264, 21.02.2018; Siridao coast, *Palanisamy & Yadav* 137684, 16.12.2017; Reis Magos Coast, *Palanisamy & Yadav* 142384, 22.06. 2018; Dona Paula coast, *Palanisamy & Yadav* 142387, 22.06. 2018; Odxel Coast, *Palanisamy & Yadav* 142388, 22.06. 2018; Bania Coast, *Palanisamy & Yadav* 142391, 23.06. 2018; Betul Coast, *Palanisamy & Yadav* 142398, 24.06. 2018; Betul fort coast, *Palanisamy & Yadav* 137706, 18.12.2017; Neum beach, *Palanisamy & Yadav* 137710, 18.12.2017.

3. *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 136 taxa in world (Guiry & Guiry, 2019), 22 in India (Rao & Gupta, 2015) and 1 in Goa.

Laurencia obtusa (Huds.) J.V. Lamour. in Ann. Mus. Hist. Nat. Paris 20: 130. 1813; Desikachary & al., Rhodophyta 2 (2B): 350. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 91. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; 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, usually 3-12 cm long, caespitose, tufted, epilithic. Holdfast small, usually discoidal, firmly attached. Stipe small, stalked, tufted, up to 3.5 mm in diameter. Fronds terete to compressed towards apex, profusely branched; branches usually pinnate to verticillate or opposite decussate, cylindrical to terete or compressed, 3-12 × 0.8-2.8 mm, upper branches usually shorter 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 lenticular thickenings. Reproductive structures develop on branches and ramuli; spermatangia develop in apical cup shaped sunken region, trichoblasts present.

Occurrence: Summer season Rare

Distribution: Goa: Coco beach. **India**: Andaman & Nicobar Islands, Andhra Pradesh, Gujarat, Karnataka, Keala, Lakshadweep Islands, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Coco beach, *Palanisamy & Yadav* 137663, 15.12.2017.

4. *Polysiphonia* Grev.

Thallus light to dark or brownish 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 190 taxa in world (Guiry & Guiry, 2019), 13 in India (Rao & Gupta, 2015) and 2 in Goa.

Key to species

- 1a. Thallus large, up to 8 cm long, usually dichotomously branched; filaments with 6-8 pericentral cells **1. *P. denudata***
- 1b. Thallus large, up to 5 cm long, irregularly branched, filaments with 4 per central cells **2. *P. platycarpa***

1. *Polysiphonia denudata* (Dillwyn) Grev. ex Harvey in Hooker, Brit. Fl. 2(1): 332. 1833; Desikachary & al., Rhodophyta 2 (2B): 302, figs. 80 E-F. 1998; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 96. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; P.S.N. Rao & R.K. Gupta, Algae India 3: 62. 2015. *Conferva denudata* Dillwyn, Brit. Conf. Suppl.: 85: 1809.

Thallus dark red in colour, filamentous, usually usually 2-10 cm long, bushy, erect, caespitose, densely tufted, sub-globose in appearance, usually epilithic, occasionally epiphytic. Holdfast minute, rhizoidal, not ramified, irregularly lobed, firmly or loosely attached on substrata, rarely free floating. Stipe small, filamentous, usually conspicuous. Frond filamentous, usually up to 10 cm long and 43-185 µm in diameter, dichotomously branched; branches usually thick in basal region and gradually becoming slender upwards, divaricate. Microscopic: Pericentral cells 6-8, elongate to cylindrical in basal region and usually rectangular to squarish towards apex, 18-50 × 8-25 µm. Cystocarps usually develop in the middle portion of filaments, globose to ovate, stalked, ostiolate; tetrasporangia often solitary, rarely in series (Plate: XXII - d).

Occurrence: Monsoon season. Rare.

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

Specimen Examined: Goa coast: Querim beach, *Palanisamy & Yadav* 139809, 08.10.2017; Arambol beach, *Palanisamy & Yadav* 139813, 08.10.2017; Baga beach, *Palanisamy & Yadav* 139884, 07.10.2017; Arambol beach, *Palanisamy & Yadav* 140020, 13.12.2017; Colomb coast, *Palanisamy & Yadav* 142328, 23.02.2018.

2. *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; Oza & Zaidi, Rev. Checkl. Ind. Mar. Alg.: 97. 2001; Pereira & Almeida in Indian J. Mar. Sci. 42 (4): 659. 2014; 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-puple red in colour, filamentous, usually 2-6 cm long, bushy, erect, caespitose, usually epilithic. Holdfast minute, rhizoidal, loosely attached, occasionally free floating. Stipe small, filamentous, occasionally inconspicuous.

Fronde filamentous, up to 5 cm long and 120-210 μm in diameter, irregularly branched, distinctly differentiated into segments; segments 30-55 \times 20-30 μm in basal region, gradually becoming shorter and attenuating upwards; apices narrowly obtuse to acute. *Microscopic*: Pericentral cells 4, elongate to cylindrical, 25-50 \times 6-14 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: Goa: Galgibag. **India**: Andhra Pradesh, Gujarat, Karnataka, Maharashtra and Tamil Nadu.

Specimen Examined: Goa coast: Galgibag coast, *Palanisamy & Yadav* 140136, 13.02.2018.

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