



## Coastal and marine floral biodiversity along the Karnataka coast

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### Abstract

Assessment of floral biodiversity along the Karnataka coast carried out during 2005-2006 revealed the occurrence of 53 phytoplankton, 78 seaweed and 2 seagrass species from estuary, intertidal, open sea and island ecosystems. Phytoplankton from Karnataka coast was dominated by diatoms and five species of toxic forms. The phytoplankton diversity was found to be the richest in estuarine areas than in sea and intertidal regions. Among the 78 species of seaweeds belonging to 52 genera and 28 families, exploitable quantity of commercially important seaweeds were algin yielding *Sargassum ilicifolium* from grids 8 and 9 and agaroid yielding *Gracilariopsis lemaneiformis* from grids 3 and 4. Seagrasses were represented by *Ruppia maritima* and *Halophila beccarii* from the Swarna - Sita, Chakra, Haladi and Kollur estuarine systems including Venkatapur. The study is the first comprehensive account of the floral biodiversity occurring along the entire Karnataka coast. Occurrence of red seaweed *Gracilariopsis lemaneiformis* in certain estuarine areas indicates the possibility of its farming in the estuary.

**Keywords:** Coastal and marine floral diversity, phytoplankton, standing crop, seaweeds, seagrasses

### Introduction

Karnataka state is situated between 11° 31' and 18° 45' N lat. and 74° 12' and 78° 40' E long. and lies in the west-central part of the peninsular India. More than one dozen rivers originating from the Western Ghats open into the Arabian Sea along the Karnataka coast, rendering the inshore waters rich in nutrients and plankton. Netravati, Gurupur, Gangoli, Sitanadi, Aghanasini, Kali and Sharavati are the important rivers. The estuaries formed by these rivers are important from the ecological and biological points of view. Karnataka has a coastline of about 300 km starting from Talapadi in the south to Karwar in the north. Distribution of marine algae in the littoral zone of the entire Karnataka coast was first studied in detail by Agadi (1985) and is found to be of 43 species. Ecology of tidal pond in Mavinahole estuarine creek,

Karwar was studied in 1979 by Bopaiah and Neelakantan (1982). NAAS (2003) reported 39 species of seaweeds from Karnataka coast, whereas Untawale *et al.* (1989) observed 65 species belonging to 42 genera from the northern Karnataka coast alone. Venkataraman and Wafar (2005) listed 39 species of seaweeds from Karnataka coast.

Pioneering study on the phytoplankton of Karnataka coast was made by Subrahmanyam (1959). Later Naik *et al.* (1990) made some attempts to understand the seasonal distribution of phytoplankton from the coastal waters of Karwar. The monthly variation in total biomass of phytoplankton in the surface waters of selected rivers and estuaries of Dakshina Kannada district was studied in detail by Ramesh *et al.* (1992). Karolina *et al.* (2009) investigated the phytoplankton assemblages in

relation to hydrographic factors from the area near the old port in Mangalore. In the present communication we report the coastal flora of Karnataka coast comprising planktonic algae (phytoplankton), macroalgae (seaweeds) and submerged flowering plants (seagrass) collected from estuaries, sea, intertidal regions and islands spread over 9 grids from Mangalore to Karwar.

## Material and Methods

For sample collection, the Karnataka coastline is divided into nine sampling grids of  $0.25^\circ$  (Fig. 1) and the geo-locations of the sampling sites are given in Table 1. Phytoplankton samples were collected

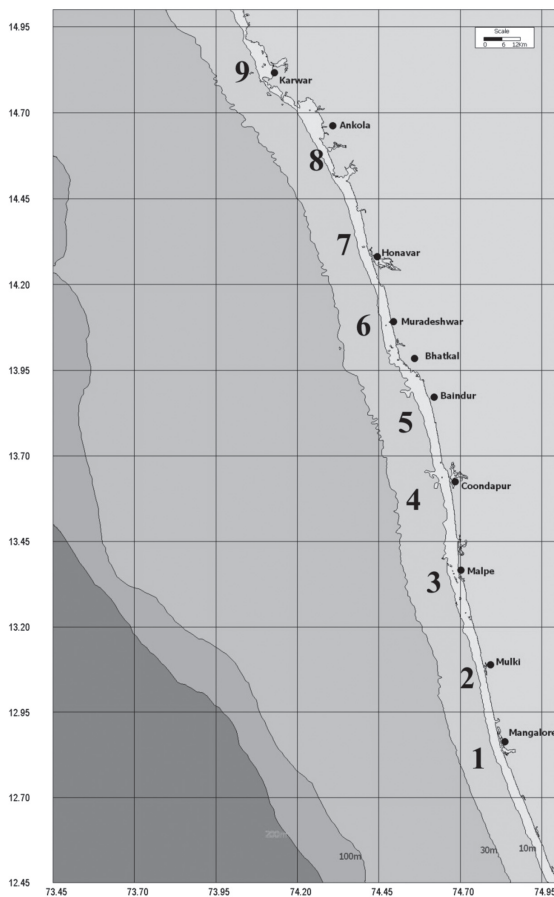


Fig. 1. Map showing the study area along the Karnataka coast with nine sampling grids of  $0.25^\circ$

from 56 sites spanning estuaries, intertidal and island ecosystems along the nine grids. One litre of water collected from the surface was fixed with 2.0 ml Lugol's iodine solution, mixed thoroughly and allowed to settle overnight in measuring jars. Upper layer was siphoned out leaving 100 ml containing phytoplankton cells, which settled to the bottom. The cell suspension were saved in separate bottles and preserved with a few drops of glycerine and 5% formalin for qualitative and quantitative analysis.

Seaweeds were collected from 48 intertidal as well as estuarine stations and 12 stations from the island ecosystems along the Karnataka coast during low tide period. From the island ecosystems, seaweeds from the reef slope and subsurface were collected using mask and snorkel or SCUBA diving. Seagrasses were collected during the low tide using random sampling method. The present investigation on the assessment of floral biodiversity along the Karnataka coast was carried out during 2005-2006.

## Results and Discussion

**Phytoplankton:** A total of 53 phytoplankton species was observed along the Karnataka coast (Table 2) and out of which 5 species were toxic dinoflagellates, capable of producing paralytic shell fish poisoning (PSP) if they bloom. Intertidal area from the Malpe coast (Grid 3) was the richest area in terms of phytoplankton diversity representing 35 species out of the total 53 species observed. Mulki and Pavanje estuaries (Grid 2) were having the second highest phytoplankton diversity followed by Venkatapur estuary (Grid 5). The diatoms, *Chaetoceros affinis* registered wide distribution along the Karnataka coast spanning 36 stations spread over the entire grid and *Skeletonema costatum* and *Thalassiosira subtilis* occupied second and third positions, respectively.

Toxic phytoplankton cells *Gonyaulax* sp. and *Peridinium directum* but not in blooming density, were encountered from the intertidal waters between Baindur and Murdeshwar (Grid 5-6). Abundance of phytoplankton blooms such as *Fragilaria oceanica*, *Coscinodiscus* spp. and *Pleurosigma* spp. cause

Table 1. Geo-location of sampling sites in different ecosystems

Grid No.	Intertidal	(°N) lat.	(°E) long.	Sampling Code
G1	Mangalore	12°89'889"	74°79'389"	IT1
G2	Mulki	13°02'917"	74°78'861"	IT2
G3	Malpe	13°36'556"	74°69'750"	IT3
G4	Kundapura	13°60'778"	74°67'611"	IT4
G5	Baindur	13°87'333"	74°61'528"	IT5
G6	Murdeshwar	14°09'806"	74°49'083"	IT6
G7	Kumta	14°43'778"	74°38'583"	IT7
G8	Ankola	14°65'889"	74°28'306"	IT8
G9	Karwar	14°88'878"	74°10'278"	IT9
<b>Estuary</b>				
G1	Netravati-Gurupur	12°83'972"	74°82'889"	E1
G2	Mulki	13°07'361"	74°78'222"	E2
G3	Swarna-Sita	13°330972"	74°71'056"	E3
G4	Chakra-Haladi-Kollur	13°64'306"	74°65'861"	E4
G5	Vankatapur	13°98'333"	74°56'167"	E5
G7	Saravati-Badgani	14°28'139"	74°44'333"	E6
G8	Aganashini	14°50'056"	74°31'528"	E7
G9	Kali	14°80'444"	74°12'000"	E8
<b>Sea/subtidal</b>				
G1	Mangalore	12°92'000"	74°80'111"	S1
G2	Mulki	13°70'111"	74°76'889"	S2
G3	Malpe	13°33'972"	74°70'889"	S3
G4	Kundapura	13°63'278"	74°13'500"	S4
G5	Baindur	13°98'417"	74°56'167"	S5
G6	Murdeshwar	14°08'861"	74°33'389"	S6
G7	Kumta	14°29'861"	74°38'500"	S7
G8	Ankola	14°50'694"	74°31'639"	S8
G9	Karwar	14°73'361"	74°01'556"	S9
<b>Island</b>				
G3	St.Mary's	13°38'194"	74°68'250"	IS1
G6	Netrani	14°01'500"	74°33'278"	IS2
G8	Kukre	14°70'611"	74°24'583"	IS3
G9	Devgad	14°82'250"	74°06'444"	IS4
G9	Kurmagad	14°84'833"	74°10'111"	IS5

significant fluctuations in fish production in association with the ocean currents from year to year in the west coast (Gary, 2004). Estuaries registered the highest biodiversity when compared to the sea and island ecosystems. Generally, the entire Karnataka coast was dominated by diatoms during the study period.

**Seaweeds:** A total of 78 species of seaweeds was observed along the Karnataka coast (Table 3) belonging to 52 genera and 28 families (Table 4). According to Untawale *et al.* (1983), there are 624 species of marine algae belonging to 215 genera and 64 families in India. Of these, nearly 60 species are commercially important. In a revised checklist of marine algae (Oza and Zaidi, 2001) 844 species were

Table 2. Species list of phytoplankton recorded along the Karnataka coast

Sl.No	Types/Order	Suborder	Family	Species		
	<b>Diatoms</b>					
1	Pennales	Araphidineae	Fragilarioidea	<i>Asterionella japonica</i>		
2				<i>Climacosphenia</i> sp.		
3				<i>Fragilaria oceanica</i>		
4				<i>Grammatophora undulata</i>		
5				<i>Raphoneis</i> sp.		
6				<i>Rhabdonema</i> sp.		
7				<i>Synedra formosa</i>		
8				<i>Thalassiothrix longata</i>		
9				<i>Thalassiothrix longissima</i>		
10				<i>Thalassionema nitzschioides</i>		
11		Biraphideae	Naviculoidea	<i>Amphiphora</i> sp.		
12				<i>Diploneis puella</i>		
13				<i>Diploneis splendica</i>		
14				<i>Gyrosigma</i> sp.		
15				<i>Navicula lcanceolate</i>		
16				<i>Navicula</i> sp.		
17				<i>Pleurosigma directum</i>		
18				<i>Pleurosigma nitzschioides</i>		
19					Nitzschiaceae	<i>Bacillaria paradoxa</i>
20						<i>Nitzschia pungens</i>
21				<i>Nitzschia frigida</i>		
22		Centrales	Monoraphideae	Achanthoidea	<i>Coconeis littoralis</i>	
23	Biddulphioidea		Biddulphieae	<i>Biddulphia mobilensis</i>		
24				<i>Biddulphia pulchella</i>		
25				<i>Biddulphia sinensis</i>		
26				<i>Climacodium frauenfeldianum</i>		
27				<i>Ditylum brightwelli</i>		
28				<i>Eucampia</i> sp.		
29				<i>Triceratium</i> sp.		
30				<i>Chaetoceros affinis</i>		
31				<i>Chaetoceros lorenzianus</i>		
32				<i>Ceratulina</i> sp.		
33				<i>Hemiaulus</i> sp.		
34			Discoidea	Actinodisceae	<i>Aulacodiscus</i> sp.	
35			Discoidea	Coscinodisceae	<i>Coscinodiscus rothi</i>	
36					<i>Cyclotella meneghinians</i>	
37					<i>Melosira striata</i>	
38				<i>Skeletonema costatum</i>		
39				<i>Stephanophysix</i> sp.		
40				<i>Thalassiosira subtilis</i>		
41		Solenioidea	Solenieae	<i>Coryetheron hystix</i>		
42				<i>Lauderia annulata</i>		
43				<i>Leptocylindrus danicus</i>		
44				<i>Rhizosolenia alata</i>		
45				<i>Rhizosolenia robusta</i>		
46				<i>Rhizosolenia setigra</i>		
47				<i>Rhizosolenia stoeletforthii</i>		
48				<i>Rhizosolenia striata</i>		
	<b>Dinoflagellates</b>					
49	Gonyaulacales	-	Gonyaulacaceae	<i>Gonyaulax</i> sp.		
50	Gymnodiniales	-	Gymnodiniaceae	<i>Gymnodinium breve</i>		
51	Peridinales	-	Peridinaceae	<i>Peridinium directum</i>		
52		-	Podolampaceae	<i>Podolampus</i> sp.		
53	Porocentrales	-	Porocentraceae	<i>Porocentrum micans</i>		

Table 3. Species list of seaweeds identified from Karnataka coast

Sl. No	Class	Order	Family	Species		
1	<b>Chlorophyceae</b>	Ulvales	Ulvaceae	<i>Enteromorpha intestinalis</i>		
2				<i>E. clathrata</i>		
3				<i>E. flexuosa</i>		
4				<i>Ulva reticulata</i>		
5				<i>U. fasciata</i>		
6				<i>U. lactuca</i>		
7				<i>U. rigida</i>		
8					<i>Monostroma</i> sp.	
9		Cladophorales	Cladophoraceae	<i>Chaetomorpha antennina</i>		
10				<i>C. linum</i>		
11				<i>C. media</i>		
12				<i>Cladophora fascicularis</i>		
13				<i>Spongomorpha</i> sp.		
14					Codiaceae	<i>Codium decarticatum</i>
15					Anadyomenaceae	<i>Microdictyon</i> sp.
16					Valoniaceae	<i>Ernodesmis verticillata</i>
17				Bryopsidales	Caulerpaceae	<i>Caulerpa peltata</i>
18						<i>C. racemosa</i>
19		<i>C. sertularioides</i>				
20		<i>C. scalpelliformis</i>				
21		<i>C. prolifera</i>				
22		<i>C. taxifolia</i> ,				
23			Bryopsidaceae			<i>Bryopsis plumosa</i>
24			Struviaceae			<i>Struvea</i> sp.
25			Udoteacea			<i>Chlorodesmis hildebrandtii</i>
26						<i>Avrainvillea amadelpha</i>
27	<b>Phaeophyceae</b>	Ectocarpales	Ectocarpaceae	<i>Giffordia mitchellae</i>		
28				<i>Ectocarpus</i> sp.		
29		Sphacelariales	Sphacelariaceae	<i>Sphacelaria frucigera</i>		
30		Fucales	Sargassaceae	<i>Sargassum ilicifolium</i>		
31				<i>S. tenerrimum</i>		
32				<i>S. myriocystem</i>		
33				<i>S. wightii</i>		
34				<i>S. cinereum</i>		
35				<i>Turbinaria ornate</i>		
36				Dictyotales	Dictyotaceae	<i>Stoechospermum marginatum</i>
37						<i>Spathoglossum asperum</i>
38						<i>Dictyota bartayresiana</i>
39						<i>D. dichotoma</i>
40		<i>D. dumosa</i>				
41		<i>Padina gymnospora</i>				
42				<i>P. tetrastromatica</i>		

43			<i>Dictyopteris australis</i>
44			<i>Dilophus fasciola</i>
45			<i>Lobophora variegata</i>
46		Ralfsiales	Ralfsiaceae
			<i>Ralfsia</i> sp.
47		Scytosiphonales	Punctariaceae
			<i>Colpomenia sinuosa</i>
48	<b>Rhodophyceae</b>	Bangiales	Bangiaceae
			<i>Porphyra vietnamensis</i>
49		Cryptonemiales	Halymeniaceae
			<i>Grateloupia filicina</i>
50			<i>Grateloupia lithophila</i>
51			<i>Cheliosporum spectabile</i>
52		Gelidiales	Gelidiaceae
			<i>Gelidium pusillum</i>
53			Gelidiellaceae
			<i>Gelidiella acerosa</i>
54			Gracilariaceae
			<i>Gracilaria corticata</i>
55			<i>G. foliifera</i>
56			<i>G. edulis</i>
57			<i>Gracilariopsis lemaneiformis</i>
58		Rhodymeniales	Rhodymeniaceae
			<i>Gelidiopsis variabilis</i>
59			<i>Rhodymenia australis</i>
60			Champiaceae
			<i>Champia parvula</i>
61		Corallinales	Corallinaceae
			<i>Amphiroa fragilissima</i>
62			<i>Amphiroa</i> sp.
63			<i>Jania adherence</i>
64			<i>Melobasia</i> sp.
65		Gigartinales	Hypneaceae
			<i>Hypnea musciformis</i>
66			<i>H. pannosa</i>
67			<i>H. cervicomis</i>
68		Ceramiales	Ceramiaceae
			<i>Centroceros clavulatum</i>
69			<i>Ceramium fastigatum</i>
70			<i>Antithamnion</i> sp.
71			<i>Chondria armata</i>
72			Delesseriaceae
			<i>Caloglossa leprieuri</i>
73			Rhodomelaceae
			<i>Acanthophora spicifera</i>
74			<i>Laurencia papillosa</i>
75			<i>Polysiphonia</i> sp.
76			<i>Polysiphonia macrocarpa</i>
77	<b>Cyanophyceae</b>	Oscillatoriales	Oscillatoriaceae
			<i>Lyngbya majuscula</i>
78			<i>Schizothrix</i> sp.

Table 4. Distribution of green, brown, red and blue green algae along the Karnataka coast

Taxonomic groups	Chlorophyceae	Phaeophyceae	Rhodophyceae	Cyanophyceae	Total
Order	3	7	7	1	18
Families	9	6	12	1	28
Genera	14	14	22	2	52
Species	26	21	29	2	78

Table 5. Number of phytoplankton, seaweed and seagrass species observed from different ecosystems from each sampling grid along Karnataka coast

Name of Grid & No	Estuary			Intertidal			Sea			Island		
	Sea grass	Sea weed	Phyto plankton	Sea grass	Sea weed	Phyto plankton	Sea grass	Sea weed	Phyto plankton	Sea grass	Sea weed	Phyto plankton
G1 Mangalore	0	6	14	0	8	10	0	1	27	0	-	-
G2 Mulki	0	5	35	0	8	11	0	0	29	0	-	-
G3 Malpe	2	12	28	0	14	13	0	2	35	0	20	14
G4 Kundapur	2	7	17	0	12	16	0	0	8	0	-	-
G5 Byndoor	2	6	14	0	6	12	0	0	11	0	-	-
G6 Murdeswar	-	-	-	0	14	11	0	0	8	0	12	16
G7 Kumta	0	8	22	0	7	11	0	0	10	0	-	-
G8 Ankola	0	10	20	0	10	12	0	0	10	0	13	14
G9 Karwar	0	11	26	0	16	14	0	0	11	0	21	16

reported from India, comprising 216 species of Chlorophyta, 191 species of Phaeophyta, 434 species of Rhodophyta and 3 species of Xanthophyta indicating a considerable increase in the species recorded from India. Generally, seaweed vegetation was found sparsely populated along the coast. Intertidal rocks in the Islands registered fairly good flora of brown seaweeds dominated by *Sargassum ilicifolium*, having economic importance in extracting algin. The density of seaweeds ranged from zero to 250 g wet weight/ sq. m during the study period and the standing crop of seaweeds was estimated to be 800 t wet weight. The standing stock of seaweeds in India is determined to be 2.6 lakh tonnes (Chennubhotla, 1992) comprising 6% agarophytes, 8% carrageenophytes, 16% alginophytes and the remaining 70% green and other non commercial seaweeds (Devaraj *et al.*, 1999).

Occurrence of red seaweed *Gracilariopsis*

*lemaniformis* in the estuarine areas of Grid 3 and 4 indicates the possibility of its farming in the estuary. Occurrence of *G. lemaneiformis* is also reported from the backwaters of Kerala (Kaladharan, 2005) and from Rameswaram coast and Visakhapatnam (Rao, 1972).

**Seagrasses:** Sea grasses are submerged flowering plants generally found in the marine environment. Sea grasses were observed only from the estuarine systems (Table 5) of the Karnataka coast (Swarna-Sita, Chakra, Haladi and Kollur estuarine system including Venkatapur estuary). Only two species were recorded *Ruppia maritima* L and *Halophila beccarii* (Asch). *H. beccarii* is known to occur from Mandovi estuary, Goa (Untawale and Jagtap, 1977) and from Kumbala estuary, Kerala (Kaladharan, 2006). As they tolerate wide range of salinity, they are not true seagrasses. *R. maritima* popularly known as beaked tassel-weed belongs to Class Alismatidae;

Order Najadales and Family Ruppiaceae. *H. beccarii* belongs to Class Liliopsidae, Order Hydrocharitales and Family Hydrocharitaceae. *R. maritima* is an excellent sand binder and can prevent coastal erosion. The seeds and other parts too are eaten by waterfowls. There is immense scope for gene transfer studies using this salt tolerant seagrass growing very rarely in certain estuaries of Karnataka.

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