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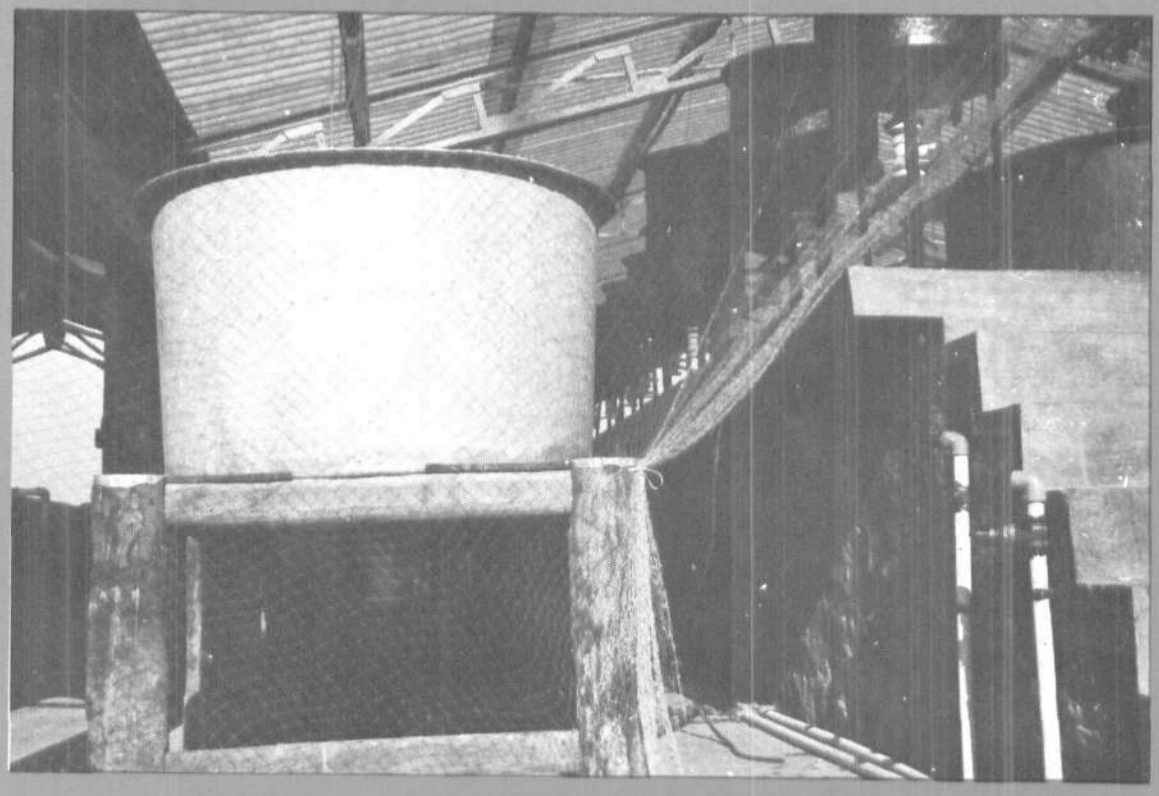

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केन्द्रीय समुद्री मात्स्यिकी अनुसंधान संस्थान कोचिन, भारत
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भारतीय कृषि अनुसंधान परिषद
INDIAN COUNCIL OF AGRICULTURAL RESEARCH

COMMERCIALLY IMPORTANT SEAWEEDS OF INDIA, THEIR OCCURRENCE, CHEMICAL PRODUCTS AND USES

V. S. K. CHENNUBHOTLA*, N. KALIAPERUMAL, S. KALIMUTHU AND J. R. RAMALINGAM

Regional Centre of CMFRI, Mandapam Camp

The seaweeds form one of the important marine living resources. They are primitive type of plants growing in the intertidal or sub-tidal regions of the sea. They flourish wherever rocky or coral substratum is available for their attachment with the help of the rhizoids or holdfast. Some of the seaweeds grow in the estuaries and backwaters too. They are visible to the naked eye and are recognizable when found growing or cast ashore on the beach. Depending upon the type of pigment present and the other morphological and anatomical structures, the seaweeds are broadly grouped into green, brown, red and blue-green algae. Marine algae contain more than 60 trace elements in a concentration much higher than in land plants. They also contain protein, iodine, bromine, vitamin and certain antibiotic substances. The chemical constituents of commonly occurring seaweeds are given in Tables 1 and 2.

Seaweeds are used as human food, live stock feed and fertilizer for land crops in many countries. Phycocolloids such as agar-agar and carrageenan are obtained from red seaweeds. Algin (Sodium alginate), mannitol and iodine are extracted from brown seaweeds. These phytochemicals are used in food, confectionary, pharmaceutical, dairy, textile, paper, paint and varnish industries as gelling, stabilizing and thickening agents. Several protein rich green algae are used as food . In Japan, Malaysia and Philippines, seaweeds such as *Ulva*, *Enteromorpha*, *Caulerpa*, *Codium* and *Monostroma* (green algae); *Sargassum*, *Hydroclathrus*, *Laminaria*, *Undaria*, *Macrocystis* (brown algae); *Porphyra*, *Gracilaria*, *Eucheuma*, *Laurencia* and *Acanthophora* (red algae) are consumed as vegetables in salads, soup, porridge and pickles.

* Present Address : Research Centre of CMFRI, Minicoy, U.T. of Lakshadweep.

In India, the seaweeds are now used mostly as raw materials for the production of agar-agar and sodium alginate. The most common seaweeds of India yielding agar, agaroid and algin of India, the places of their occurrence, the yield and quality of their phycocolloids are presented in Tables 3 and 4. The maximum values on the yield and properties of phycocolloids in the laboratory scale method are also given in the tables. All the seaweeds listed in the tables grow in the intertidal and sub tidal regions up to 6 m depth. Some species of seaweeds such as *Gracilaria*, *Sargassum*, *Spatoglossum*, *Padina* and *Dictyota* occur in depths varying from 6 to 25 m.

At present *Gelidiella acerosa*, *Gracilaria edulis* and *G. crassa* are exploited from Tamil Nadu coast for the production of agar-agar and *Sargassum* (*S. wightii*, *S. ilicifolium*, *S. tenerrimum* and *S. myriocystum*) and *Turbinaria* (*T. conoides* and *T. ornata*) for sodium alginate. These and other agar and algin yielding seaweeds from other localities of the Indian coast and also from Lakshadweep and Andaman-Nicobar Islands may be exploited to meet the raw material requirements of the seaweeds based industries in our country.

TABLE 1. *Mineral constituents in seaweed (mg/100 g of dry weed)*

Sl. No.	Seaweed	Sodium	Potassium	Calcium	Magnesium	Chloride	Nitrogen	Sulphate	Iron	Copper	Manganese	Boron	Zinc	Phosphorus
	GREEN ALGAE													
1.	*Enteromorpha intestinalis*	1160.0	710.0	510.0	410.0	2400.0	380.0	4000.0	14.0	0.3	13.0	0.6	4.4	—
2.	*Ulva lactuca*	1710.0	1580.0	630.0	1640.0	790.0	—	12100.0	0.4	0.9	8.2	15.6	0.7	277.6
3.	*U. rigida*	1110.0	680.0	340.0	980.0	270.0	—	7740.0	257.2	4.7	38.4	10.0	1.6	286.3
4.	*Chaetomorpha linoides*	—	—	—	—	—	—	—	21.7	0.5	38.5	0.4	3.0	—
5.	*Cladophora fascicularis*	570.0	3590.0	520.0	70.0	2900.0	—	2410.0	144.5	0.5	6.2	23.5	2.3	116.2
6.	*Codium dwarkense*	10740.0	2350.0	1190.0	180.0	15630.0	—	5990.0	60.6	0.7	2.3	1.1	2.0	205.7
7.	*Boodlea composita*	4820.0	4090.0	410.0	120.0	5190.0	—	4430.0	468.6	1.1	17.6	4.5	1.9	258.4
	BROWN ALGAE													
8.	*Padina australis*	1280.0	930.0	500.0	500.0	2400.0	600.0	1800.0	50.4	1.1	45.0	1.1	4.4	—
9.	*P. gymnospora*													
10.	*Colpomenia sinuosa*	1400.0	1060.0	160.0	20.0	870.0	—	1390.0	456.1	2.0	24.8	3.2	3.5	28.6
11.	*Rosenvingea intricata*	560.0	8850.0	120.0	40.0	530.0	—	1330.0	249.7	1.5	0.1	4.0	0.1	98.4
12.	*Cystoseira* sp.	—	—	—	—	—	—	—	22.4	0.5	57.5	0.7	3.2	—
13.	*Sargassum cinereum* var.	1200.0	1250.0	20.0	20.0	840.0	—	2540.0	30.1	0.1	13.8	2.6	0.7	198.0
	berberifolia	1670.0	7350.0	20.0	80.0	7200.0	—	1500.0	224.1	1.5	4.2	0.2	1.1	3.0
14.	*S. jonhstonii*	1470.0	1670.0	20.0	10.0	1390.0	—	1820.0	107.4	0.6	9.1	1.6	2.1	203.6
	RED ALGAE													
15.	*Porphyra vietnamensis*	5660.0	1110.0	300.0	450.0	3580.0	—	110.0	—	—	—	—	—	—
16.	*Gelidiella acerosa*	80.0	20.0	280.0	70.0	90.0	1340.0	730.0	—	—	—	—	—	—
17.	*Gracilaria edulis*	1230.0	2010.0	570.0	160.0	3840.0	2140.0	4500.0	28.0	1.0	55.0	1.4	8.3	—
18.	*Sarconema filiforme*	—	—	—	—	—	—	—	19.6	0.7	18.7	0.7	6.4	—
19.	*S. furcellatum*	560.0	400.0	510.0	410.0	2400.0	930.0	2900.0	14.0	3.0	39.0	0.9	5.8	—
20.	*Hypnea musciformis*	—	—	—	—	—	—	—	28.0	0.9	19.5	0.8	8.0	—
21.	*Acanthophora spicifera*	320.0	320.0	420.0	380.0	3060.0	740.0	2000.0	28.0	1.2	8.5	0.4	7.0	—
22.	*Chondria dasyphylla*	—	—	—	—	—	—	—	30.8	0.9	17.5	0.9	6.8	—
23.	*Laurencia papillosa*	1160.0	820.0	610.0	310.0	2400.0	1000.0	380.0	37.8	0.5	24.0	0.5	5.5	—

TABLE 2. *Chemical constituents in seaweeds*

Sl. No.	Seaweed	Protein (%)	Carbo-hydrate(%)	Lipid (%)	Iodine (mg/100 g dry weed)	Bromine (%)	Ascrobic acid (mg/ 100 g fresh weed)
	GREEN ALGAE						
1.	*Enteromorpha compressa*	23.8	24.8	11.4	-	-	-
2.	*E. intestinalis*	-	-	-	58.00	-	-
3.	*E. prolifera*	-	-	-	-	-	0.22
4.	*Enteromorpha* sp.	-	-	-	4.16	0.032	-
5.	*Ulva fasciate*	25.5	-	-	7.40	-	-
6.	*U. lactuca*	25.8	16.0	7.4	6.27	-	6.10
7.	*U. reticulata*	24.4	16.9	8.6	-	-	5.69
8.	*U. rigida*	22.4	-	-	4.83	-	-
9.	*Chaetomorpha aerea*	10.1	31.5	8.6	-	-	-
10.	*C. antennina*	19.7	27.0	11.5	-	0.105	-
11.	*C. brachygonia*	-	-	-	-	-	5.92
12.	*C. linoides*	16.7	27.0	12.1	72.00	-	-
13.	*Cladophora expansa*	-	-	-	18.06	-	-
14.	*C. fascicularis*	16.3	49.5	15.7	64.64	-	-
15.	*C. fritschii*	-	-	-	-	-	6.04
16.	*Clasophora* sp.	9.2	6.6	6.5	18.83	0.024	-
17.	*Bryopsis plumosa*	19.2	27.0	9.0	-	-	-
18.	*Caulerpa chemnitzia*	11.8	32.6	11.4	-	-	-
19.	*C. cupressoides*	7.4	51.8	11.0	-	-	-
20.	*C. fergusonii*	7.8	23.6	7.2	-	-	-
21.	*C. laetevirens*	8.8	56.3	8.8	-	-	-
22.	*C. peltata*	24.4	45.0	11.4	-	-	-
23.	*C. racemosa* var. *macrophysa*	24.8	33.8	10.6	-	0.130	-
24.	*C. scalpelliformis*	25.2	10.7	7.6	-	-	-
25.	*C. sertularioides*	22.7	49.5	7.0	-	0.027	-
26.	*C. taxifolia*	23.6	9.7	4.1	-	-	-
27.	*Codium adhaerens*	7.3	40.5	7.4	-	-	-
28.	*C. decorticatum*	6.9	50.6	9.0	-	-	-
29.	*C. dwarkense*	7.2	-	-	5.31	-	-
30.	*C. tomentosum*	5.1	29.3	7.2	-	-	-
31.	*Halimeda macroloba*	5.4	32.6	9.1	-	-	-
32.	*H. tuna*	-	-	-	31.30	-	-
33.	*Udotea indica*	13.0	-	-	215.30	-	-
34.	*Boodlea composita*	10.3	-	-	29.77	-	-
35.	*Chaemodoris auriculata*	13.7	-	-	10.43	-	-
36.	*Cladophoropsis zollingerii*	10.3	0.3	0.5	-	-	-
37.	*Dictyosphaeria cavernosa*	6.1	42.8	10.5	-	-	-
38.	*Microdictyon agardhianum*	20.9	27.0	9.4	-	-	-
39.	*Boergesenia forbesii*	7.4	21.4	11.4	-	-	-
40.	*Valonipsis pachymema*	18.8	31.5	9.1	-	-	-
	BROWN ALGAE						
41.	*Dictyopteris australis*	8.1	-	-	23.48	0.039	-
42.	*Dictyopteris* sp.	-	-	-	25.81	-	-
43.	*Dictyota bartayresiana*	-	-	-	-	0.015	-
44.	*D. dumosa*	-	-	-	-	0.022	-
45.	*Padina australis*	-	-	-	500.00	-	7.86

Table 2. continued

46.	*P. gymnospora*	13.0	13.2	1.3	7.95	-	-
47.	*P. tetrastromatica*	-	-	-	-	0.022	-
48.	*Spatoglossum asperum*	-	-	-	-	0.055	-
49.	*S. variabile*	15.7	-	-	16.44	-	-
50.	*stoechospermum marginatum*	14.9	15.4	3.7	5.44	-	-
51.	*Levringia borgensenii*	-	-	-	104.50	-	-
52.	*Colpomenia sinuosa*	6.6	-	-	8.99	-	-
53.	*Cystoseira* sp.	11.2	-	-	34.19	-	-
54.	*Hormophysa triquetra*	16.6	3.3	0.6	-	-	-
55.	*Sargassum cinereum* var. *berberifolia*	9.6	-	-	33.20	-	-
56.	*S. ilicifolium*	15.1	24.0	1.1	-	-	-
57.	*S. johnstonii*	10.9	-	-	39.80	-	-
58.	*S. myriocystum*	15.6	23.8	0.5	-	-	66.60
59.	*S. swartzii*	-	-	-	28.18	-	-
60.	*S. tenerrimum*	12.1	-	-	37.21	0.040	-
61.	*S. vulgare*	-	-	-	29.29	-	-
62.	*S. wightii*	16.3	24.9	1.2	-	-	-
63.	*Turbinaria conoides*	15.2	14.0	3.6	-	-	-
	RED ALGAE						
64.	*Porphyra* sp.	16.0	-	-	-	-	-
65.	*Scinaia indica*	12.5	-	-	5.62	-	-
66.	*Asparagopsis taxiformis*	16.2	-	-	499.30	-	-
67.	*Asparagopsis* sp.	-	-	-	556.70	-	-
68.	*Gelidiella acerosa*	8.8	57.0	3.6	54.00	-	-
69.	*Chondrococcus* sp.	-	-	-	-	0.054	-
70.	*Amphiroa anceps*	-	-	-	5.15	-	-
71.	*Jania rubens*	1.5	1.8	0.4	-	-	-
72.	*Grateloupia lithophila*	5.8	36.9	0.7	-	-	-
73.	*Halymenia venusta*	-	-	-	25.00	-	-
74.	*Gracilaria corticata*	6.1	45.5	6.0	18.41	0.078	-
75.	*G. crassa*	4.3	30.4	0.9	-	-	-
76.	*G. edulis*	7.6	45.8	2.4	208.00	-	7.25
77.	*G. foliifera*	-	-	-	8.07	-	-
78.	*Agardhiella tenera*	-	-	-	12.65	-	-
79.	*Sarconema filiforme*	-	-	-	107.00	-	-
80.	*S. furcellatum*	-	-	-	357,00	-	-
81.	*Soleria robusta*	-	-	-	15.54	-	-
82.	*Hypnea musciformis*	-	-	-	100.00	0.027	8.58
83.	*H. valentiae*	6.1	37.8	6.1	-	-	-
84.	*Hypnea* sp.	7.5	-	-	-	-	-
85.	*Centroceras clavulatum*	20.1	4.8	3.4	20.79	0.063	-
86.	*Acanthophora delile*	-	-	-	5.78	-	-
87.	*A. muscoides*	21.8	-	-	-	-	-
88.	*A. spicifera*	4.8	29.7	0.5	90.00	0.095	4.00
89.	*Chondria armata*	-	-	-	-	0.400	-
90.	*Laurencia papillosa*	4.3	11.6	0.6	137.00	-	5.92
91.	*Polysiphonia ferulacea*	-	-	-	39.06	-	-
92.	*Polysiphonia* sp.	-	-	-	4.78	-	-
93.	*Heterosiphonia muelleri*	-	-	-	10.01	-	-
94.	*Corallina* sp.	-	-	-	-	0.020	-

TABLE 3. *Agar and agaroid yielding seaweeds of India*

Sl. No.	Seaweed	Yield (%)	Gel strength (g/cm^2) 1.5% conc.	Gelling temp. (°C) 1.5% conc.	Melting temp. (°C) 1.5% conc.	Places of occurrence
	AGAROPHYTES					
1.	*Gelidiella acerosa**	50.8	325	52	99	Okha, Dwarka, Porbandar, Diu, Veraval, Manapad, Tuticorin, Mandapam, Lakshadweep and Andaman-Nicobar
2.	*G. indica*	44.0	30	52	76	Muttam, Kovalam, Idinthakarai, Manapad and Tiruchendur
3.	*Gracilaria edulis**	45.0	139	57	99	Tuticorin, Mandapam, Lakshadweep and Andaman-Nicobar
4.	*G. crassa**	23.0	140	48	84	Tuticorin, Mandapam and Andaman-Nicobar
5.	*G. arcuata* var. *arcuata*	48.0	67	52	98	Kanyakumari, Tiruchendur, Tuticorin, Mandapam and Lakshadweep
6.	*G. corticata* var. *corticata**	45.0	134	49	68	Dwarka, Bombay, Karwar, Goa, Quilon, Vizhinjam, Muttam, Idinthakarai, Manapad, Tiruchendur, Tuticorin, Mandapam, Mahabalipuram, Madras, Visakhapatnam and Andaman-Nicobar
7.	*G. corticata* var. *cylindrica*	43.0	15	45	98	Idinthakarai, Manapad, Tuticorin, Mandapam and Andaman-Nicobar
8.	*G. folifera*	50.0	55	41	68	Gopnath, Okha, Bombay, Muttam, Kovalam, Idinthakarai, Tuticorin and Mandapam
9.	*G. obtusa*	35.0	19	22	38	Muttam, Kovalam, Idinthakarai, Tiruchendur, Manapad, Tuticorin and Mandapam
10.	*G. verrucosa**	23.0	41	40	55	Okha, Bombay, Goa, Tuticorin, Mandapam, Madras, Pulicat, Chilka and Andaman-Nicobar
11.	*Gelidium pusillum*	50.0	276	38	86	Dwarka, Porbandar, Veraval, Bombay, Karwar, Cannanore, Quilon, Muttam, Kovalam, Idinthakarai, Tiruchendur, Mandapam, Madras, Visakhapatnam, Lakshadweep and Andaman-Nicobar
12.	*Pterocladia heteroplatos*	35.0	288	38	83	Bombay, Mandapam, Visakhapatnam, Lakshadweep and Andaman-Nicobar
	AGAROIDOPHYTES					
1.	*Hypnea musciformis**	51.6	75	-	-	Gopnath, Okha, Dwarka, Bombay, Goa, Karwar,Tuticorin, Mandapam, Visakhapatnam, Lakshadweep and Andaman-Nicobar
2.	*H. valentiae**	39.0	151	-	-	Bombay, Muttam, Kovalam, Idinthakarai, Manapad, Tuticorin, Mandapam and Lakshadweep
3.	*Acanthophora spicifera**	12.0	-	-	-	Okha, Bombay, Goa, Karwar, Kovalam, Idinthakarai, Manapad, Tiruchendur, Tuticorin, Mandapam, Porto Novo, Visakhapatnam and Lakshadweep
4.	*Laurencia papillosa*	19.0	-	-	-	Okha, Bombay, Manapad, Tiruchendur, Tuticorin, Mandapam, Lakshadweep and Andaman-Nicobar

* Available in exploitable quantity.

TABLE 4. *Algin yielding seaweeds of India*

Sl. No.	Seaweed	Yield (%)	Places of occurrence
1.	*Sargassum wightii**	31.7	Bombay, Goa, Alleppey, Muttam, Kovalam, Idinthakarai, Tiruchendur, Tuticorin, Mandapam, Madras and Andaman-Nicobar
2.	*S. tenerrimum**	15.2	Gulf of Kutch, Okha, Dwarka, Bombay, Goa, Karwar, Mandapam, Visakhapatnam and Andaman-Nicobar
3.	*S. myriocystum**	34.5	Kovalam, Idinthakarai, Manapad, Tuticorin, Mandapam and Andaman-Nicobar
4.	*S. ilicifolium**	34.9	Bombay, Goa, Karwar, Tuticorin, Mandapam, Madras, Visakhapatnam and Andaman-Nicobar
5.	*S. cinereum var. berberifolia**	29.2	Gulf of Kutch, Bombay, Goa, Karwar and Vizhinjam
6.	*S. johnstonii**	22.3	Okha
7.	*S. vulgare**	25.3	Dwarka, Goa and Visakhapatnam
8.	*S. duplicatum**	19.1	Muttam, Lakshadweep and Andaman-Nicobar
9.	*Turbinaria conoides**	35.6	Manapad, Tuticorin, Mandapam, Lakshadweep and Andaman-Nicobar
10.	*T. ornata**	32.2	Dwarka, Mandapam, Lakshadweep and Andaman-Nicobar
11.	*T. decurrens*	26.3	Tuticorin, Mandapam and Andaman-Nicobar
12.	*Cystoseira trinodis*	30.5	Okha, Dwarka, Bombay, Tuticorin and Mandapam
13.	*Hormophysa triquetra*	25.5	Okha, Manapad, Tuticorin, Mandapam and Andaman-Nicobar
14.	*Spatoglossum asperum**	17.1	Gulf of Kutch, Okha, Dwarka, Bombay, Malwan, Goa, Karwar, Kovalam, Idinthakarai, Tiruchendur, Tuticorin and Mandapam
15.	*Colpomenia sinuosa*	16.7	Gulf of Kutch, Okha, Dwarka, Porbandar, Veraval, Bombay, Goa, Karwar, Idinthakarai, Manapad, Tuticorin, Mandapam and Visakhapatnam
16.	*Hydroclathrus clathratus*	14.7	Dwarka, Tuticorin, Mandapam, Lakshadweep and Andaman-Nicobar
17.	*Rosenvingea intricata*	20.5	Okha, Dwarka, Tuticorin, Mandapam, Madras, Pulicat and Lakshadweep
18.	*Chnoospora implexa*	10.6	Muttam, Kovalam, Tuticroin, Mandapam, Pullicat and Lakshadweep
19.	*Padina boergesenii*	24.8	Dwarka, Bombay, Manapad, Tuticorin, Mandapam, Lakshadweep and Andaman-Nicobar
20.	*P. tetrastromatica*	23.3	Gulf of Kutch, Okha, Dwarka, Bombay, Goa, Karwar, Vizhinjam, Muttam, Kovalam, Tuticorin, Mandapam, Mahabalipuram, Madras, Pulicat, Visakhapatnam and Andaman-Nicobar
21.	*Stoechospermum marginatum*	23.8	Okha, Dwarka, Bombay, Malwan, Goa, Karwar, Cannanore, Idinthakarai, Manapad, Tiruchendur, Tuticorin and Mandapam
22.	*Dictyota dishotoma*	21.8	Okha, Dwarka, Bombay, Goa, Karwar, Idinthakarai, Tiruchendur, Tuticorin, Mandapam, Visakhapatnam, Lakshadweep and Andaman-Nicobar
23.	*D. bartayresiana*	22.9	Okha, Dwarka, Bombay, Goa, Karwar, Kovalam, Tuticorin, Mandapam, Mahabalipuram, Madras, Lakshadweep and Andaman-Nicobar
24.	*D. dumosa*	13.3	Bombay, Goa and Karwar

* Available in exploitable quantity.