

Seaweed resources and distribution in deep waters from Dhanushkodi to Kanyakumari, Tamilnadu

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ABSTRACT

The deepwater seaweed resources survey was carried out during 1986-1991 at the depths ranging from 5 to 22 m in Tamilnadu coast from Dhanushkodi to Kanyakumari. The vegetation of seaweeds and seagrasses occurred in all areas except Dhanushkodi - Mandapam and Manapad - Kanyakumari. A total number of 100 algae and 5 seagrasses were recorded. Among the 100 algal species recorded, 20 species belonged to Chlorophyta, 18 species to Phaeophyta, 61 species to Rhodophyta and 1 species to Cyanophyta. The total estimated standing crop (wet wt.) from 1863 sq. km. sampled area was 75374.5 tonnes consisting of 2750 tonnes of *Sargassum* spp., 962.5 tonnes of *Gracilaria* spp., 5262.5 tonnes of *Hypnea* spp. and 66399.5 tonnes of other seaweeds. The quantitative analysis of economically important seaweeds revealed the feasibility of commercial exploitation of *Sargassum* from Mandapam to Kilakkarai and Tuticorin areas, *Hypnea* from Mandapam to Vembar area and *Gracilaria* from Vembar to Nallatanni Tivu region. Hydrological data were also collected from the area surveyed.

Introduction

Seaweeds are the only source for the production of phytochemicals such as agar, alginate and carrageenan. In India, agar and alginate are manufactured from the seaweeds exploited from the natural seaweed beds, particularly from Tamilnadu coast. Algin yielding seaweeds are available in large quantity to meet the raw material requirement of algin industries. The quantity of agar

yielding seaweeds available in shallow waters of Indian coast are inadequate to meet the demand of agar industries. The investigations made earlier were mostly on the distribution of seaweeds from the nearshore areas of the east and west coast of India and Lakshadweep and Andaman-Nicobar Islands to locate the seaweed growing areas and to assess the standing crop of seaweeds (Kaliaperumal et al., 1987).

Very few attempts were made to assess

the availability of seaweeds growing in deep waters at Tuticorin area (Varma, 1960; Mahadevan and Nagappan Nayar, 1967). In order to know the distribution and standing crop of seaweeds in deep waters from Dhanushkodi to Kanyakumari in the Gulf of Mannar region of Tamilnadu, Central Marine Fisheries Research Institute and Central Salt & Marine Chemicals Research Institute have jointly carried out the seaweed resources survey in this region during the period 1986-1991. Hydrological data were collected from the area surveyed. The information collected on these aspects are presented in this paper.

Materials and Methods

The area from Dhanushkodi to Kanyakumari (Latitude 8° 04' - 9° 11' N and Longitude 77° 34' - 79° 24' E) was surveyed during December 1986 to January 1991. The total area of 1863 sq. km. was covered in four sectors - I Sector - Kattapadu to Tiruchendur (650 sq. km), II Sector - Alantalai to Manapad and Vembar to Nallatanni Tivu (443 sq. km), III Sector - Valinokkam to Kilakkarai and Manapad to Kanyakumari (352.5 sq. km) and IV Sector - Kilakkarai to Dhanushkodi (417.5 sq. km). The seaweed and seagrass samples were collected from one square meter area along the transects employing "SCUBA" divers. The sampling stations were fixed at every 500 m distance along the transect using patent log. The distance between one transect to another was 5 km. The seaweed and seagrass samples were sorted out, identified specieswise and fresh weight of each algal species was taken.

The biomass taken in one square metre area is computed for 2.5 sq. km area, taking into consideration the area covered on all sides from each sampling station. The estimates and the area of all sampling stations were added to get the total standing crop of the area. The specieswise resource

estimates and the area covered are also computed by the same method. Estimation of the resource for a species is given only when the sampling density exceeded 5 grams (wet wt.) per metre square while all the others are described only qualitatively.

The water samples were collected from the bottom between 07.00 and 13.00 hrs. at the first, middle and last station of each transect and they were analysed for pH, salinity, dissolved oxygen and nutrients such as phosphate, silicate nitrite and nitrate following the methods given by Strickland and Parsons (1972). The atmosphere and bottom seawater temperatures were also recorded at the collection spot.

Results

The map showing the area surveyed is given in Fig. 1. The number of stations sampled along the transects in the four sectors varied from 2 to 30. The depths of sampling stations varied from 5 to 22 m and the vegetation occurred between 5.5 and 19.5m. The substratum at the sampling stations consisted of sand, mud, rock, pebbles and sand-mud mixture. The vegetation generally occurred on rocks and pebbles.

There was no vegetation in Dhanushkodi to Mandapam and Manapad to Kanyakumari regions. In all the four sectors surveyed, a total number of 100 algal species were recorded. Of these, 20 species belonged to Chlorophyta, 18 species to Phaeophyta, 61 species to Rhodophyta and 1 species to Cyanophyta. Totally five species of seagrasses viz. *Cymodocea rotundata*, *C. serrulata*, *Halophila ovalis*, *H. ovata* and *H. stipulacea* were recorded (Table 1).

The total estimated standing crop (wet wt.) from 1863 sq. km area was 75374.5 tonnes with 9100 tonnes in the I Sector, 42150 tonnes in II Sector, 5962.5 tonnes in III Sector and 18162 tonnes in IV Sector. Of the 75374.5 tonnes of total standing crop, *Sargassum* spp.

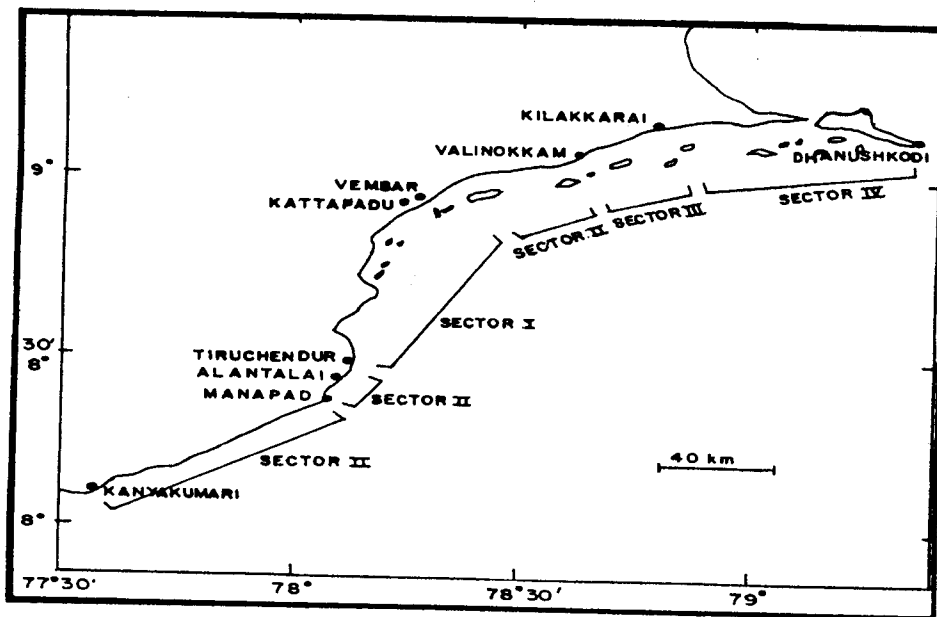


Fig. 1. Map showing the areas surveyed from Dhanushkodi to Kanyakumari, Tamilnadu.

constituted 2750 tonnes, *Gracilaria* spp. 962.5 tonnes, *Hypnea* spp. 5262.5 tonnes and other seaweeds 66399.5 tonnes (Table 1). Data collected on distribution and biomass of algae in each sector is given below.

Sector - I: Kattapadu- Tiruchendur

Survey was conducted in this sector during December 1986- March 1987. Totally 58 species of algae were recorded of which 7 belonged to Chlorophyta, 12 to Phaeophyta and 39 to Rhodophyta. The total standing crop of seaweeds estimated was 9100 tonnes (wet wt.). The estimates for dominant species were *Dictyota maxima* 525 t, *Sargassum tenerrimum* 637.5 t, *Dictyota bartayresiana* 862.5 t, *Solieria robusta* 2087.5 t and *Hypnea valentiae* 2425 t. Species of *Sargassum* (787.5 t wet wt.) occurring near Tuticorin and species of *Hypnea* (2700 t wet wt.) occurring near Tiruchendur could be exploited commercially for the manufacture of phycocolloids. (Anon, 1989; Chennubhotla *et al.*, 1990 and Kaliaperumal *et al.*, 1995).

II Sector : Alantali - Manapad and Vembar - Nallatanni Tivu

Survey was carried out in this sector during March 1988. In the Alantalai-Manapad region the vegetation consisted of 28 species of algae of which 4 species belonged to Chlorophyta, 5 to Phaeophyta and 19 to Rhodophyta. The total standing crop of all seaweeds in 175 sq. km area was 12812.5 tonnes (wet wt.). The estimates for dominant species were *Spatoglossum asperum* 5137.5 t, *Halymenia venusta* 1687.5 t, *Solieria robusta* 1575 t, *Scinaia bengalica* 1250 t, *Codium tomentosum* 1025 t, and *Dictyota maxima* 750t. In Vembar to Nallatanni Tivu region 27 species of algae occurred consisting 3 species of Chlorophyta, 5 species of Phaeophyta and 19 species of Rhodophyta. The total standing crop of all seaweeds in 268 sq. km area was 29337.5 tonnes (wet wt.). The estimates for the following 12 species were found above 500 tonnes (wet wt.): *Codium tomentosum* 7062.5 t, *Spatoglossum asperum* 4150 t, *Halimeda macroloba* 3800 t, *Halymenia dilatata* 3550 t,

Table 1. List of marine algae and their standing crop (wet wt. in tonnes) in deep waters from Dhanushkodi to Kanyakumari.

Sl. No.	Name of the alga	Biomass (wet wt. in tonnes)				Total biomass
		Sector-I	Sector-II	Sector-III	Sector-IV	
GREEN ALGAE						
1.	<i>Enteromorpha compressa</i>	-	+	-	-	-
2.	<i>E.intestinalis</i>	-	+	+	-	-
3.	<i>Ulva lactuca</i>	-	-	+	-	-
4.	<i>Chaetomorpha aerea</i>	-	+	+	-	-
5.	<i>C.linoides</i>	-	-	-	25.0	25.0
6.	<i>C.littorea</i>	25.0	-	-	-	25.0
7.	<i>Cladophora fascicularis</i>	37.5	-	-	-	37.5
8.	<i>C.tranguebarensis</i>	12.5	-	-	-	12.5
9.	<i>C.utriculosa</i>	-	-	+	-	-
10.	<i>Caulerpa fergusonii</i>	-	-	-	237.5	237.5
11.	<i>C.microphysa</i>	-	-	+	+	-
12.	<i>C.sertularioides</i>	-	+	+	+	-
13.	<i>C.taxifolia</i>	-	-	-	12.5	12.5
14.	<i>Acetabularia caliculus</i>	+	-	-	-	-
15.	<i>Neomeris annulata</i>	-	-	-	+	-
16.	<i>Codium dwarkense</i>	12.5	-	-	-	12.5
17.	<i>C.tomentosum</i>	350.0	8087.5	-	-	8437.5
18.	<i>Halimeda macroloba</i>	275.0	3800.0	350.0	1325.0	5750.0
19.	<i>Anadyomene stellata</i>	-	-	125.0	-	125.0
20.	<i>Struvea anastamosans</i>	-	-	-	+	-
BROWN ALGAE						
21.	<i>Ectocarpus irregularis</i>	+	50.0	-	-	50.0
22.	<i>Dictyota delicatula</i>	-	-	-	+	-
23.	<i>D. bartayresiana</i>	862.5	-	+	-	862.5
24.	<i>D.dichotoma</i>	25.0	+	187.5	50.0	262.5
25.	<i>D.dichotoma var. intricata</i>	+	-	-	-	-
26.	<i>D.maxima</i>	525.0	750.0	50.0	-	1325.0
27.	<i>Padina pavonica</i>	75.0	75.0	37.5	-	187.5
28.	<i>P.tetrastromatica</i>	175.0	-	-	-	175.0
29.	<i>Spatoglossum asperum</i>	+	9287.5	1200.0	9775.0	20262.5
30.	<i>Zonaria crenata</i>	-	-	-	650.0	650.0
31.	<i>Z. variegata</i>	-	12.5	-	-	12.5
32.	<i>Colpomenia sinuosa</i>	-	-	+	-	-
33.	<i>Hormophysa triquetra</i>	-	-	+	75.0	75.0
34.	<i>Sargassum ilicifolium</i>	37.5	-	25.0	1550.0	1612.5
35.	<i>S. plagiophyllum</i>	-	+	-	12.5	12.5
36.	<i>S. tenerrimum</i>	637.5	250.0	-	-	887.5
37.	<i>S. wightii</i>	100.0	-	-	125.0	225.0
38.	<i>Sargassum sp.</i>	12.5	+	-	-	12.5

Table 1. List of marine algae and their standing crop (wet wt. in tonnes) in deep waters from Dhanushkodi to Kanyakumari.

Sl. No.	Name of the alga	Biomass (wet wt. in tonnes)				Total biomass
		Sector-I	Sector-II	Sector-III	Sector-IV	
RED ALGAE						
39.	<i>Helminthocladia australis</i>	-	-	237.5	-	237.5
40.	<i>Scinaia bengalica</i>	50.0	1250.0	12.5	-	1312.5
41.	<i>Chondrococcus hornemanii</i>	+	12.5	-	12.5	25.0
42.	<i>Amphiroa anastromosans</i>	-	1125.0	-	-	1125.0
43.	<i>A. anceps</i>	-	-	-	25.0	25.0
44.	<i>A. fragilissima</i>	-	-	12.5	1925.0	1937.5
45.	<i>Jania adhaerens</i>	-	+	-	100.0	100.0
46.	<i>J. iyengarii</i>	+	-	-	-	-
47.	<i>Lithothamnion fruticulosum</i>	+	+	-	-	-
48.	<i>Cryptonemia toriacea</i>	25.0	125.0	-	-	150.0
49.	<i>Grateloupia comorinii</i>	+	-	-	-	-
50.	<i>G. filicina</i>	25.0	-	-	-	25.0
51.	<i>Halymenia dilatata</i>	-	3550.0	-	-	3550.0
52.	<i>H. floresia</i>	375.0	3912.5	2550.0	-	6837.5
53.	<i>H. porphyroides</i>	-	550.0	-	-	550.0
54.	<i>H. venusta</i>	+	2525.0	12.5	75.0	2612.5
55.	<i>Halymenia sp.</i>	-	187.5	-	-	187.5
56.	<i>Gracilaria corticata</i>	+	-	-	-	-
57.	<i>G. dura</i>	-	175.0	-	-	175.0
58.	<i>G. edulis</i>	75.0	-	-	-	75.0
59.	<i>G. millartedtii</i>	-	75.0	-	-	75.0
60.	<i>G. pigmaea</i>	+	-	-	-	-
61.	<i>G. textorii</i>	+	625.0	12.5	-	637.5
62.	<i>G. verrucosa</i>	+	-	+	-	-
63.	<i>Gracilaria sp.</i>	+	-	-	-	-
64.	<i>Gracilariopsis sjoestedtii</i>	+	-	-	-	-
65.	<i>Sarcodia indica</i>	+	175.0	+	+	175.0
66.	<i>Agardhiella robusta</i>	-	1100.0	-	-	1100.0
67.	<i>Sarconema filiforme</i>	37.5	-	150.0	-	187.5
68.	<i>S. furcellatum</i>	25.0	+	12.5	-	37.5
69.	<i>Solieria robusta</i>	2087.5	2425.0	150.0	-	4662.5
70.	<i>Hypnea esperi</i>	87.5	575.0	-	-	662.5
71.	<i>H. flagelliformis</i>	-	-	412.5	-	412.5
72.	<i>H. musciformis</i>	187.5	975.0	75.0	300.0	1537.5
73.	<i>H. pannosa</i>	+	-	-	-	-
74.	<i>H. valentiae</i>	2425.0	+	225.0	-	2650.0
75.	<i>Gymnogongrus pygmaeus</i>	+	-	-	-	-
76.	<i>Botryocladia leptopoda</i>	-	-	-	862.5	862.5
77.	<i>Coelarthrum opuntia</i>	-	-	-	+	-
78.	<i>Champia compressa</i>	-	+	-	-	-
79.	<i>C. parvula</i>	-	+	-	-	-

Table 1. List of marine algae and their standing crop (wet wt. in tonnes) in deep waters from Dhanushkodi to Kanyakumari.

Sl. No.	Name of the alga	Biomass (wet wt. in tonnes)				Total biomass
		Sector-I	Sector-II	Sector-III	Sector-IV	
RED ALGAE						
80.	<i>Gastroclonium iyengarii</i>	+	-	-	-	-
81.	<i>Ceramium miniatum</i>	+	-	-	-	-
82.	<i>Haloplegma duperreyi</i>	+	375.0	+	+	375.0
83.	<i>Spyridia filamentosa</i>	-	+	-	-	-
84.	<i>S. insignis</i>	25.0	-	-	-	25.0
85.	<i>Wrangelia argus</i>	125.0	+	-	-	125.0
86.	<i>Martensia fragilis</i>	-	-	-	+	-
87.	<i>Acanthophora muscoides</i>	12.5	-	-	-	12.5
88.	<i>A. spicifera</i>	+	+	-	-	-
89.	<i>Chondria armata</i>	12.5	-	-	-	12.5
90.	<i>C. dasyphylla</i>	+	-	-	-	-
91.	<i>C. hypnoides</i>	-	25.0	-	-	25.0
92.	<i>Herposiphonia stuposa</i>	350.0	-	-	-	350.0
93.	<i>Laurencia ceylanica</i>	-	-	125.0	-	125.0
94.	<i>L. papillosa</i>	+	-	-	-	-
95.	<i>L. pinnatifida</i>	12.5	+	-	-	12.5
96.	<i>Polysiphonia coacta</i>	+	-	-	-	-
97.	<i>P. tuticorinensis</i>	+	75.0	-	-	75.0
98.	<i>Neurymenia fraxinifolia</i>	-	-	-	12.5	12.5
99.	<i>Dictyurus purpurescens</i>	-	-	+	-	-
BLUE-GREEN ALGAE						
100.	<i>Lyngbya majuscula</i>	-	-	-	1012.0	1012.0
	Total	9100.0	42150.0	5962.5	18162.0	75374.5
SEAGRASSES						
1.	<i>Cymodocea rotundata</i>	-	+	-	-	-
2.	<i>C. serrulata</i>	+	-	-	+	-
3.	<i>Halophila ovalis</i>	+	+	+	-	-
4.	<i>H. ovata</i>	+	-	-	-	-
5.	<i>H. stipulacea</i>	-	+	-	-	-

+ Present

-Absent

H. floresia 3437.5 t, *H. venusta* 8375 t, *Amphiroa anastromosans* 1125 t, *Agardhiella robusta* 975 t, *Hypnea musciformis* 975 t, *Solieria robusta* 850 t, *Gracilaria textorii* 625 t and *Hypnea esperi* 575 t. The quantitative analysis of economic seaweeds encountered in the II Sector revealed the feasibility of commercial exploitation of *Spatoglossum asperum*, *Halymenia* spp., *Hypnea* spp. and *Gracilaria textorii* for phycocolloid industry (Anon, 1988; Subba Rao *et al.*, 1992 and Rama Rao *et al.*, 1996).

Sector III : Valinokkam - Kilakkarai and Manapad - Kanyakumari

Survey was conducted in this area between Valinokkam and Kilakkarai during January 1989 and from Manapad to Kanyakumari during March 1990. There was no vegetation in the whole area surveyed from Manapad to Kanyakumari. In the survey from Valinokkam to Kilakkarai 33 species of algae were recorded of which 8 species belonged to Chlorophyta, 8 species to Phaeophyta and 17 species to Rhodophyta. The estimated standing crop from 200 sq. km area was 5962.5 tonnes (wet wt). The estimates for the dominant species were *Spatoglossum asperum* 1200 t, *Halymenia floresia* 2550 t, and *Hypnea* spp. 712.5 t. Species of *Hypnea* could be exploited for the production of carrageenan by the seaweed industries (Anon, 1993 a; Kaliaperumal *et al.*, 1992 and 1996).

Sector IV : Kilakkarai - Dhanushkodi

This sector was covered during December 1990 and January 1991. A total biomass of 18162.5 tonnes (wet wt) of seaweeds was estimated from 417.5 sq. km area surveyed. Of the 29 species of algae recorded 8 belonged to Chlorophyta, 8 to Phaeophyta, 12 to Rhodophyta and 1 to Cyanophyta. Twenty species were found in estimable quantities of which the following 8 species were abundant - *Halimeda macroloba*, *Spatoglossum asperum*, *Zonaria crenata*,

Sargassum ilicifolium, *Amphiroa fragilissima*, *Hypnea musciformis*, *Botryocladia leptopoda* and *Lyngbya majuscula* with a biomass of 1325, 9775, 650, 1550, 1925, 300, 862.5 and 1012.5 tonnes (wet wt.) respectively. The species of *Hypnea* and *Sargassum* could be exploited for the manufacture of phytochemicals (Anon, 1993 b and Rama Rao *et al.*, 1993).

The minimum and maximum values of hydrological parameters in each sector are given in Table 2 a and b. The atmospheric temperature varied from 25.0 to 36.8°C and bottom seawater temperature from 25.3 to 31.8°C. The pH of seawater ranged from 8.0 to 8.5. The salinity varied from 26.39 to 34.40‰ and dissolved oxygen from 2.85 to 8.31 ml/l. The phosphate content ranged from 0.03 to 0.50, silicate from 1.00 to 14.50, nitrite from 0.01 to 3.99 and nitrate from 0.25 to 4.50 µg at/l.

Discussion

The present investigation shows that the seaweed biomass of 0.564 tonnes wet wt/ha in the deep waters from 5 to 19.5 m was found to be less when compared with the data collected on the seaweed biomass (1.275 tonnes wet wt/ha) from the intertidal and shallow waters upto 4 m depth during the seaweed resources survey conducted by CMFRI and CSMCRI from Mandapam to Kanyakumari during 1971-1976 (Anon, 1978). It is also evident that the deep water algal flora is almost similar to that of intertidal and shallow water flora of this region except very few species *Halymenia*, *Gracilaria*, *Sarcodia*, *Chondria*, *Laurencia* and *Neurymenia*. The quantitative analysis of economically important seaweeds revealed the feasibility of commercial exploitation of *Sargassum* from Mandapam to Kilakkarai and Tuticorin area, *Hypnea* from Mandapam to Vembar area and *Gracilaria* from Vembar to Nallatanni Tivu region for production of phytochemicals such as agar, algin and carrageenan by the Indian seaweed industries.

Table 2 a. Hydrological data collected in deep waters from Dhanushkodi to Kanyakumari

Area	Period of collection	Time of collection (hrs)	Depth (m)	Temperature (°C)				pH		Salinity (‰)		Dissolved oxygen (ml/l)	
				Atmosphere Min.	Atmosphere Max.	Bottom water Min.	Bottom water Max.	Min.	Max.	Min.	Max.	Min.	Max.
Sector-I Kattapadu-Tiruchendur	December 86 to March 87	08.00-12.20	5.5-20.0	25.0	36.8	26.0	31.8	8.3	8.5	26.39	33.43	3.42	8.05
Sector-II Alantalai-Manapad	March 88	08.30-11.30	10.0-19.5	28.0	30.8	28.0	30.1	8.0	8.1	31.75	33.81	4.63	5.64
Vembar-Nallatanni Tivu	-do-	08.15-13.00	6.0-19.0	29.0	34.0	29.0	31.6	7.9	8.1	31.11	34.16	4.69	8.31
Sector-III Valinokkam-Kilakkarai	January 89 & March 90	07.00-10.45	8.0-22.0	25.2	30.4	25.3	30.2	8.2	8.4	27.90	33.72	2.85	5.58
Manapad-Kanyakumari	March 90	07.00-10.00	10.0-20.0	28.0	29.2	27.0	28.8	8.2	8.4	32.60	33.66	3.53	5.13
Sector-IV Kilakkarai-Dhanushkodi	December 90 & January 91	08.10-10.55	5.0-21.0	26.3	31.0	27.3	29.5	8.2	8.4	30.26	34.40	3.68	7.72

Table 2 b. Hydrological data collected in deep waters from Dhanushkodi to Kanyakumari

Area	Period of collection	Time of collection (hrs)	Depth (m)	Nutrients ($\mu\text{g. at/l}$)							
				Phosphate		Silicate		Nitrite		Nitrate	
				Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Sector-I Kattapadu- Tiruchendur	December 86 to March 87	08.00- 12.20	5.5- 20.0	0.05	0.15	4.00	12.00	1.05	3.99	0.50	1.00
Sector-II Alantalai- Manapad	March 88	08.30- 11.30	10.0- 19.5	0.05	0.08	3.00	8.50	0.02	0.63	0.25	0.50
Vembar- Nallatanni Tivu	-do-	08.15- 13.00	6.0- 19.0	0.03	0.20	5.50	12.00	0.02	0.42	0.50	4.50
Sector-III Valinokkam- Kilakkarai	January 89 & March 90	07.00- 10.45	8.0- 22.0	0.05	0.50	1.00	14.50	0.01	0.23	0.25	3.25
Manapad- Kanyakumari	March 90	07.00 10.00	10.0- 20.0	0.03	0.10	2.50	4.00	0.01	0.15	0.25	1.50
Sector-IV Kilakkarai- Dhanushkodi	December 90 & January 91	08.10 10.55	5.0- 21.0	0.03	0.35	3.00	9.00	0.01	0.23	0.25	1.25

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