

PRELIMINARY CRUISE REPORT

CRUISE No: SK 352

ORV SAGAR KANYA

12th September 2018 – 15th October 2018

(Goa to Goa)



Submitted by

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1. Cruise Summary

Cruise SK352 of ORV *Sagar Kanya* was undertaken under Marine Ecosystem Dynamics of eastern Arabian Sea (MEDAS) project with the aim of understanding the influence of various oceanographic processes on the biogeochemistry and biology of the ecosystem at various trophic levels through time series observations. This is the 7th cruise of the MEDAS observational series and 2nd on the ORV *Sagar Kanya*. The vessel sailed from Goa on 13th September 2018 and reached Goa on 14th October 2018. The sampling of major physical, biogeochemical and biological parameters were carried out along 10 transects covering the entire eastern Arabian Sea from different depths (10-2000m). A total of 94 stations were covered.

Surface waters were collected for taxonomic analysis of phytoplankton. Zooplankton samples were collected using MPN and Bongo nets with concurrent collection of CTD data. The samples were also collected for the measurement of Chlorophyll and accessory Pigments, Phytoplankton absorption (a_{ph}), autotrophic and heterotrophic bacterioplankton, total bacterial and viral abundance, Dissolved Oxygen (DO), Nutrients, Particulate Organic Carbon (POC), Total Organic Carbon (TOC), Dissolved nutrients, Dissolved Inorganic Carbon (DIC). Sediment samples were also collected for sediment organic carbon (SOC), and isotopic ratios textural analysis and benthic studies. Samplings were also done along 50m depth contour at each degree from off Goa to off Kanyakumari and off Okha to off Manglore during initial and final phase of the cruise respectively.

2. Cruise Objectives

- I. Biogeochemistry of the eastern Arabian Sea
- II. Biological responses including resources to varying ecosystem processes over eastern Arabian Sea.

3. List of scientific participants

Scientific Compliment

1. Dr. G.V.M.Gupta	Chief Scientist (CMLRE)
2. Dr. Shaju Sudheeshan Sushama	Project Scientist (CMLRE)
3. Dr. Venkataramu Cherukuri	Project Scientist (CMLRE)
4. Mr. Sherin	Project Scientist (CMLRE)
5. Dr. Jhimli Mandal	Project Scientist (CMLRE)
6. Ms.Naseera Kottangadan	Project Scientist (CMLRE)
7. Ms. Sangeeta Mahableshwar Naik	Project Scientist (CMLRE)
8. Dr. Pandiarajan	Project Scientist (NCCR)
9. Mr. Akhilesh Vijay	Project Scientist (NCCR)
10. Mr. Aduru Yudhistir Reddy	Project Assistant (CMLRE)
11. Ms. Gouri Satheesh	Project Assistant (NIO, Kochi)
12. Mr. Alok Kanancheri Thampan	Project Assistant (NIO, Kochi)
13. Mr. Rashid C P	Project Assistant (NIO, Kochi)
14. Ms. Josna Mary	Project Assistant (NIO, Kochi)
15. Mr. Chinmayanandhan Nair Ravikumar	Project Assistant (NIO, Kochi)
16. Mr. Basil Wilson	Student, KUFOS
17. Ms. Ginchu Mariam Sunny	Student, KUFOS
18. Ms. Mariya Anna John K	Student, KUFOS
19. Mr. Sam J Pious	Student, KUFOS
20. Mr. Sunil Kumar Padhi	Student, Berhampur University
21. Mr. Abhinash Behera	Student, Berhampur University
22. Ms. Shubhashree Jena	Student, Berhampur University
23. Mr. Smrutirekha Acharya	Student, Berhampur University
24. Mr. Rahul Mavi	NCPOR, Goa
25. Mr. Anantha Krishnan	NCPOR, Goa

Engineering Compliment

26. Mr. V. C. Sarathchandran	AMC Service Eng (NORINCO)
27. Mr. Avertano Callistus Luis	AMC Service Eng (NORINCO)
28. Mr. Rajendra Prakash	AMC Service Eng (NORINCO)
29. Mr. Muthuramalingam Manivannan	AMC Service Eng (NORINCO)

4. Details of stations & sampling

Sampling locations

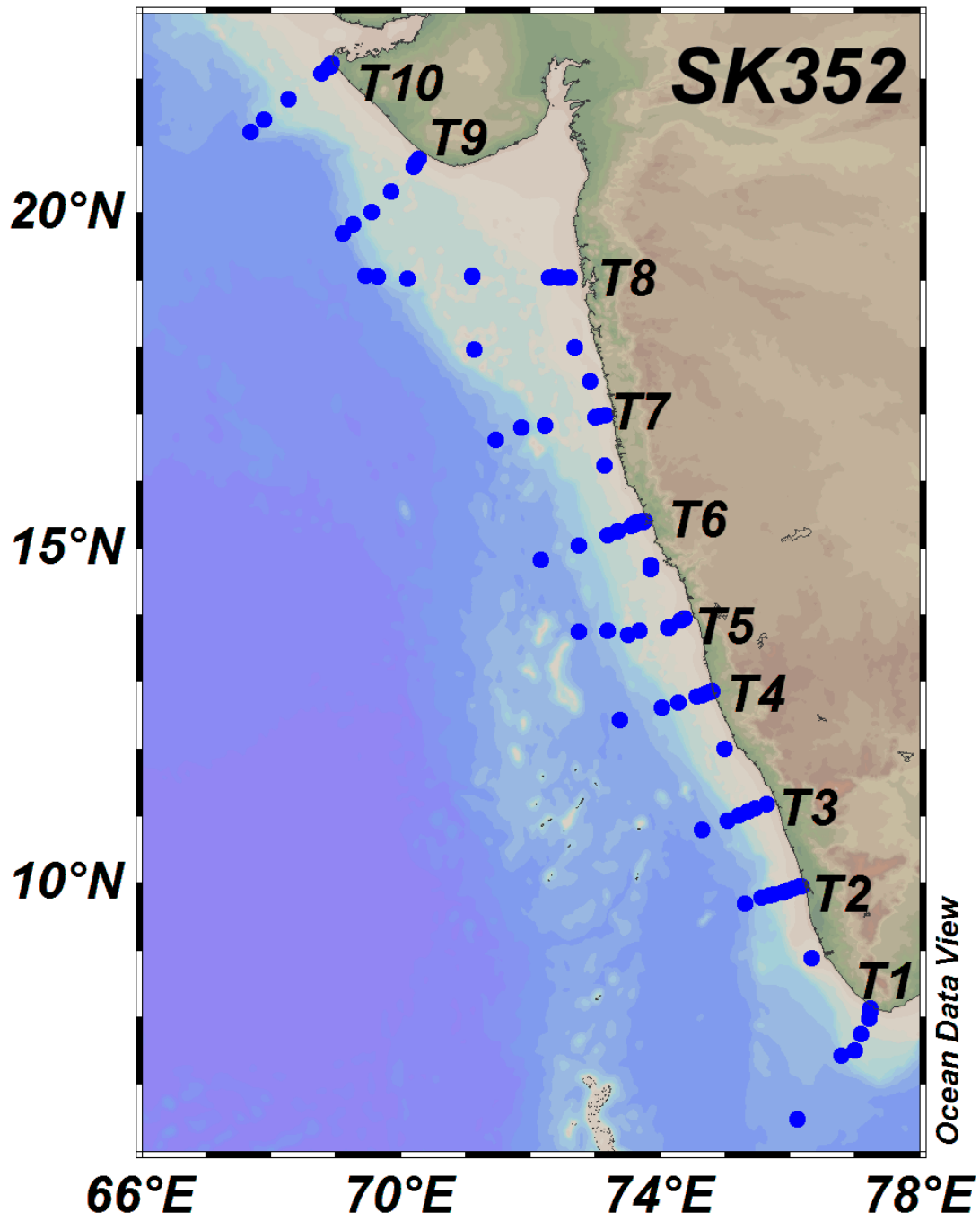


Table 1: Stations inventory with details of various operations made

Sl. No.	Station ID	Date	Time	Latitude	Longitude	Station Depth(m)	CTD	MPN	Grab	Bongo	Remarks
1	SK 352-50C-S1	13-09-2018	03:10	1523.70N	7344.74E	19	✓				
2	SK 352-50C-S2	13-09-2018	05:05:00	1524.58N	7343.18E	22.3	✓				
3	SK 352-50C-S3	13-09-2018	06:22:00	1523.68N	7339.14E	32.8	✓				
4	SK 352-50C-S4	13-09-2018	07:55:00	1522.46N	7336.51E	40.6	✓				
5	SK 352-50C-S5	13-09-2018	09:37:00	1521.04N	7333.56E	50.7	✓				
6	SK 352-50C-S6	13-09-2018	15:39:00	1445.32N	7350.61E	52.3	✓				
7	SK 352-50C-S7	14-09-2018	01:10:00	1349.53N	7407.68E	52.2	✓				
8	SK 352-50C-S8	14-09-2018	10:32:00	1247.19N	7433.32E	51.2	✓				
9	SK 352-50C-S9	14-09-2018	18:58:00	1200.32N	7459.48E	50.2	✓				
10	SK 352-50C-S10	15-09-2018	03:13:00	114.79N	7521.36E	59.5	✓				
11	SK 352-50C-S11	15-09-2018	13:44:00	0951.84N	7553.66E	52.9	✓				
12	SK 352-50C-S12	15-09-2018	23:18:00	0852.77N	7619.81E	52.4	✓				
13	T1-3	16-09-2018	15:55:00	0808.16N	7714.39E	31	✓	✓	✓	✓	
14	T1-4	16-09-2018	17:25:00	805.70N	7713.73E	45	✓	✓		✓	
15	T1-5	16-09-2018	10:10:00	759.37N	7713.19E	49.4	✓	✓	✓	✓	
16	T1-6	16-09-2018	22:46:00	745.31N	7705.49E	67.9	✓			✓	
17	T1-7	17-09-2018	02:12:00	730.66N	7659.45E	101.2	✓	✓	✓	✓	
18	T1-9	17-09-2018	06:40:00	725.51N	7647.61E	1201	✓	✓		✓	
19	T1-10	17-09-2018	20:30:00	629.00N	767.06E	1992.5	✓	✓		✓	
20	T2-1	19-09-2018	11:20:00	957.76N	7610.86E	13.1	✓		✓	✓	
21	T2-2	19-09-2018	13:06:00	957.23N	768.26E	17.3	✓		✓	✓	
22	T2-3	19-09-2018	16:12:00	955.49N	762.68E	32.9	✓	✓	✓	✓	
23	T2-4	19-09-2018	18:42:00	953.50N	7558.08E	40.2	✓	✓	✓	✓	
24	T2-5	19-09-2018	05:14:00	952.10N	7553.34E	52.1	✓	✓	✓	✓	
25	T2-6	19-09-2018	22:50:00	950.13N	7544.69E	75	✓			✓	

Sl. No.	Station ID	Date	Time	Latitude	Longitude	Station Depth(m)	CTD	MPN	Grab	Bongo	Remarks
26	T2-7	20-09-2018	00:30:00	948.95N	7540.98E	94.6	✓	✓	✓	✓	
27	T2-9	20-09-2018	07:03:00	947.16N	7533.62E	921	✓	✓			Bongo not operated due to winch problem
28	T2-10	20-09-2018	12:22:00	941.98N	7518.18E	2012.3	✓	✓		✓	
29	T3-3	22-09-2018	05:54:00	1111.420N	7538.010E	33.4	✓	✓	✓	✓	
30	T3-4	22-09-2018	02:29:00	1107.260N	7528.150E	46.3	✓	✓	✓	✓	
31	T3-5	21-09-2018	22:44:00	114.630N	7521.490E	58.9	✓	✓	✓	✓	
32	T3-7	21-09-2018	18:06:00	1101.180N	7512.470E	99.1	✓	✓	✓	✓	
33	T3-9	21-09-2018	12:37:00	1056.510N	7501.720E	989.3	✓	✓		✓	
34	T3-10	21-09-2018	03:54:00	1047.69N	7438.41E	2004.3	✓	✓		✓	
35	T4-05	23-09-2018	03:41:00	1247.32N	7433.440E	49.9	✓	✓	✓	✓	
36	T4-04	23-09-2018	07:11:00	1248.67N	7438.82E	40.3	✓	✓	✓	✓	
37	T4-03	23-09-2018	10:00:00	1249.840N	7441.960E	32	✓	✓	✓	✓	
38	T4-02	23-09-2018	12:33:00	1251.120N	7444.580E	22.3	✓		✓	✓	
39	T4-01	23-09-2018	14:22:00	1251.820N	7447.510E	13.4	✓		✓	✓	
40	T4-07	23-09-2018	22:19:00	1242.190N	7416.260E	101.7	✓	✓	✓	✓	
41	T4-09	24-09-2018	03:42:00	1237.690N	7401.660E	998.6	✓	✓		✓	
42	T4-10	24-09-2018	14:06:00	1226.300N	7322.930E	1983.6	✓	✓		✓	
43	T5-03	26-09-2018	15:55:00	1357.29N	7422.19E	31.9	✓	✓	✓	✓	
44	T5-04	26-09-2018	13:32:00	1355.501N	7418.323E	40.9	✓	✓	✓	✓	
45	T5-05	26-09-2018	09:50:00	1348.956N	7406.773E	50.3	✓	✓	✓	✓	
46	T5-06	26-09-2018	05:00:00	1346.70N	7341.023E	77.2	✓		✓	✓	
47	T5-07	26-09-2018	00:33:00	1342.745N	7329.867E	111.6	✓	✓	✓	✓	
48	T5-09	25-09-2018	15:42:00	1346.110N	7311.372E	1077.5	✓	✓		✓	
49	T5-10	25-09-2018	08:35:00	1345.55N	7244.30E	1945.3	✓	✓		✓	
50	T6-10	28-09-2018	17:20	1449.52N	7204.41E	2051	✓	✓		✓	

Sl. No.	Station ID	Date	Time	Latitude	Longitude	Station Depth(m)	CTD	MPN	Grab	Bongo	Remarks
51	T6-09	28-09-2018	08:53	1502.98N	7244.41E	1005.2	✓	✓		✓	
52	T6-07	28-09-2018	02:12	1511.89N	7310.95E	101.8	✓	✓	✓	✓	
53	T6-06	27-09-2018	23:53	1515.416N	7320.753E	76.3	✓				Only surface water collected
54	T6-05	27-09-2018	09:47:00	1520.129N	7332.678E	52.7	✓	✓	✓		Bongo skipped due to the presence of tar balls on the surface waters
55	T6-04	27-09-2018	12:35:00	1521.379N	7335.810E	42.3	✓	✓	✓	✓	
56	T6-03	27-09-2018	14:54	1523.03N	7338.69E	32.8	✓	✓	✓	✓	
57	T6-02	27-09-2018	19:05	1524.098N	7342.708E	20.4	✓		✓	✓	
58	T6-01	27-09-2018	17:40	1524.40N	7344.97E	15.9	✓		✓	✓	
59	T7-10	29-09-2018	12:40	1636.85N	7127.156E	2005.4	✓	✓		✓	
60	T7-09	29-09-2018	21:18	1647.98N	7151.79E	1036.1	✓	✓		✓	
61	T7-07	30-09-2018	03:56	1650.117N	7213.41E	102.3	✓	✓	✓	✓	
62	T7-05	30-09-2018	13:32	1657.32N	7259.51E	54.6	✓	✓	✓	✓	
63	T7-04	30-09-2018	16:30	1658.52N	7303.94E	43.8	✓	✓	✓	✓	
64	T7-03	30-09-2018	19:23	1658.50N	7304.001E	32.8	✓	✓	✓	✓	
65	SK352-30C-01	01-10-2018	01:56	1729.95N	7254.82E	35.1	✓				
66	SK352-30C-02	01-10-2018	07:55	1759.962N	7240.448E	41.1	✓				
67	T8-02	01-10-2018	18:55	1902.117N	7236.205E	23.3	✓		✓	✓	
68	T8-03	01-10-2018	21:32	1902.88N	7226.29E	33.4	✓	✓	✓	✓	
69	T8-04	01-10-2018	23:50	1902.92N	7221.98E	41.6	✓	✓	✓	✓	
70	T8-05	02-10-2018	02:15	1902.89N	7217.22E	52.9	✓	✓	✓	✓	
71	T8-06	02-10-2018	17:24	1903.98N	7105.92E	83.2	✓	✓	✓	✓	
72	T8-07	03-10-2018	05:10	1901.77N	7006.09E	98.9	✓	✓	✓	✓	
73	T8-09	03-10-2018	11:57	1903.63N	6938.68E	1103.6	✓	✓		✓	
74	T8-10	03-10-2018	16:57	1904.07N	6927.38E	2150.3	✓			✓	MPN operation failed
75	T9-03	07-10-2018	16:18	2049.296N	7016.638E	33.5	✓	✓	✓	✓	

Sl. No.	Station ID	Date	Time	Latitude	Longitude	Station Depth(m)	CTD	MPN	Grab	Bongo	Remarks
76	T9-04	07-10-2018	18:42	2045.90N	7014.17E	44.4	✓	✓	✓	✓	
77	T9-05	07-10-2018	20:54	2041.93N	7011.48E	52.8	✓	✓	✓	✓	
78	T9-06	08-10-2018	03:40	2019.27N	6951.37E	73.7	✓			✓	
79	T9-07	08-10-2018	08:35	201.43N	6932.85E	111.8	✓	✓	✓	✓	
80	T9-09	08-10-2018	14:16	1950.30N	6916.18E	981.2	✓	✓		✓	
81	T9-10	04-10-2018	05:06	1941.82N	6906.84E	2000	✓	✓		✓	
82	T10-02	06-10-2018	18:35	2214.22N	6856.22E	21.2	✓		✓	✓	
83	T10-03	06-10-2018	16:57	2212.12N	6855.11E	35.1	✓	✓	✓	✓	
84	T10-04	06-10-2018	15:02	2210.41N	6853.01E	41.2	✓	✓	✓	✓	
85	T10-05	06-10-2018	10:45	2205.51N	6846.37E		✓	✓	✓	✓	
86	T10-07	05-10-2018	01:10	2141.96N	6815.96E	100	✓	✓	✓	✓	
87	T10-09	05-10-2018	17:17	2124.1N	6753.4E	1000	✓	✓		✓	
88	T10-10	05-10-2018	08:40	2113.24N	6740.83E	1937.6	✓	✓		✓	
89	SK352-50C-13	09-10-2018	13:00	1903.808N	7106.27E	84.1	✓				
90	SK352-50C-14	10-10-2018	01:24	1757.85N	7107.70E	88.6	✓				
91	SK352-50C-15	10-10-2018	23:50	1557.28N	7259.72E	54.7	✓				
92	SK352-50C-17	11-10-2018	19:40	1520.24N	7332.89E	51.2	✓				
93	SK352-50C-18	12-10-2018	03:17	1444.88N	7350.61E	51.8	✓				
94	SK352-50C-19	12-10-2018	14:17	1348.61N	7407.02E	48.8	✓				
95	SK352-50C-20	13-10-2018	03:40	1247.32N	7433.440E	49.9	✓				
96	SK352-50C-21	14-10-2018		1520.129N	7332.678E	52.7	✓				
97	SK352-50C-22	14-10-2018		1521.379N	7335.810E	42.3	✓				
98	SK352-50C-23	14-10-2018		1523.03N	7338.69E	32.8	✓				
99	SK352-50C-24	14-10-2018		1524.098N	7342.708E	20.4	✓				
100	SK352-50C-25	14-10-2018		1524.40N	7344.97E	15.9	✓				

5. Brief report of the work done onboard

5.1. Physical Oceanography:

The CTD was operated at all stations for the collection of hydrographic parameters like temperature, salinity, PAR, density, fluorescence etc. The SST was measured using bucket thermometer. Mixed layer depth, Isothermal layer depth, D_{15} (depth showing 15 degree celsius temp) and D_{26} (depth showing 26 degree celsius temp) isotherms were calculated from the CTD profiles.

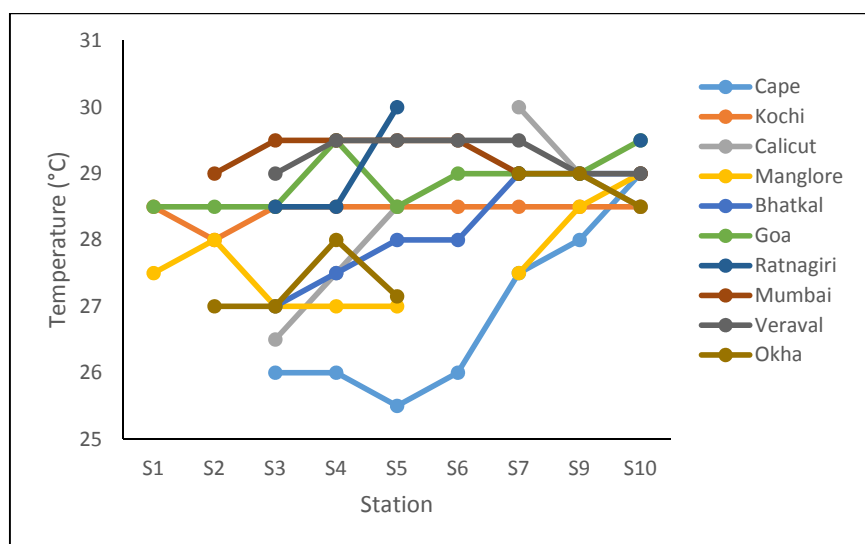


Figure 2. Variation in SST measured using bucket thermometer along ten transects.

XBT and XCTD Deployment:-

Used XBT probes (T-7 type) for vertical profiling of temperature from surface up to 760m. XCTD-1 type probes were also deployed for profiling temperature, salinity and sound velocity up to 1000m. A total of 30 XBT's (at 800m, 1250m and 1500m) and 10 XCTD's (2000m) were deployed along with CTD. The details of stations for these deployments are given in Tables 2 & 3.

Table 2. Details of XBT deployment at different locations

St. No.	Lat. (°N)	Long. (°E)	Date	Time (LST)	Transect Number	Ship Speed (knots)	Depth (m)	SST (°C)	Sea State
1	07 26 N	76 49 E	17-09-2018	06:33	T1	7	800	28	Calm
2	07 20 N	76 43 E	17-09-2018	11:57	T1	7.3	1590	28.5	Calm
3	07 12.05N	76 37.82E	17-09-2018	13:21	T1	7.5	1780	27.5	Calm
4	07 46N	76 34E	20-09-2018	06:46:46	T2	7.4	810	27.5	Calm
5	9 45N	75.30E	20-09-2018	10:41	T2	7	1300	28	Calm
6	09 43.35N	75 22.70E	20-09-2018	11:44	T2	7	1650	28	Calm
7	10 53.00N	74.50.75E	21-09-2018	11:00	T3	7.5	1555	26.5	Calm
8	10 55.72N	74 58.68E	21-09-2018	12:03	T3	7	1250	26	Calm
9	10 57.52N	75 03.61E	21-09-2018	16:41	T3	7.8	800	30	Calm
10	12 38.70N	74 04.25E	24-09-2018	03:01	T4	7.8	800	27.5	Calm
11	12 36.11N	73 56.57E	24-09-2018	09:04:40	T4	8.1	1250	28.5	Calm
12	12 33.08N	73 45.04E	24-09-2018	10:37	T4	7.6	1500	29	Calm
13	13 46.07N	73 01.35E	25-09-2018	16:23:32	T5	7.5	1650	29	Calm
14	13 46.37N	73 05.16E	25-09-2018	16:54:13	T5	7.6	1300	29	Calm
15	13 45.49N	73 17.18E	25-09-2018	22:25:22	T5	7.4	800	29.5	Calm
16	15 04.49N	72 47.94E	28-09-2018	08:20	T6	7.6	800	29.5	Calm
17	15 00.51N	72 36.83E	28-09-2018	13:17	T6	7.4	1250	29.5	Calm
18	14 56.63N	72 25.74E	28-09-2018	14:46	T6	6.9	1500	29.5	Calm
19	16 38.85N	71 30.73E	29-09-2018	17:41	T7	7.2	1500		Calm
20	16 47.20N	71 48.70E	29-09-2018	20:32	T7	6.7	1250		Calm
21	16 48.46N	71 56.21E	30-09-2018	01:18	T7	6.1	800		Calm
22	19 03.65N	069 45.14E	03-10-2018	11:08	T8	6.9	800	29.5	Calm
23	19 02.22N	69 37.57E	03-10-2018	15:24	T8	5.7	1250	29.5	Calm
24	19 03.90N	69 33.24E	03-10-2018	16:09	T8	5.8	1500	29.5	Calm
25	19 53.55N	69 20.82E	08-10-2018	13:33	T9	6.8	800	29.5	Calm
26	19 46.59N	89 12.85E	04-10-2018	11:22	T9	7.1	1250	29	Calm
27	19 43.66N	69 10.23E	04-10-2018	10:46:40	T9	7	1500	29	Calm
28	21 21.05N	67 50.22E	05-10-2018	16:17	T10	6.9	1500	29	Calm
29	21 24.30N	67 53.41E	05-10-2018	16:58	T10	6.7	1250	29.5	Calm
30	21 25.34N	67 55.26E	05-10-2018	20:53	T10	6.9	800	29	Calm

Table 3. Details of XCT operations at different locations

1	6 28.108N	76 6.048E	17-09-2018	20:56	T1	1	1992.5	28.5	calm
2	09 41.96N	75 18.20E	20-09-2018	13:46:46	T2	0.4	2012.3	28.5	calm
3	10 48.42N	74 38.29E	21-09-2018	05:43:06	T3	0.1	2004.3	28.5	Moderate
4	12 26.25N	73 23.13E	24-09-2018	14:58:15	T4	0.6	1983.6	29	Calm
5	13 45.39N	72 44.08E	25-09-2018	09:47:53	T5	0.2	1945.3	29	Calm
7	14 50.27N	72 10.01E	28-09-2018	18:22:44	T6	0.4	2051	29.5	Calm
6	16 37.57N	71 27.95E	29-09-2018	14:37:33	T7	0.2	2005.4	29.5	Calm
8	19 03.85N	69 27.89E	03-10-2018	18:46:56	T8	0.4	2150.3	29	calm
9	19 42.65N	69 07.48E	04-10-2018	06:37:37	T9	0.4	2000	29	moderate
10	21 12.93N	67 14.53E	05-10-2018	10:45:10	T10	0.5	1937.6	28.5	moderate

5.2. Chemical oceanography: The parameters studied include DO, pH, Nutrients, inorganic and organic carbon (POC, DOC, and DIC).

For the determination of dissolved oxygen water samples were collected from the rosette immediately upon its arrival on deck. The samples were collected in 125 ml borosilicate glass bottles with a ground glass stopper. Extreme care was taken to avoid bubbles formation during the sampling. After collection of samples the DO was fixed with 1ml of Winkler A and B and the samples were analyzed by potentiometric end point determination method (Carpenter, 1965). Intense anoxia was observed at the bottom layers off Manglore to off Ratnagiri.

For the determination of pH the sea water samples were collected directly from the Niskin bottle using the drawing tube into the 10 cm cylindrical cuvettes and immediately measured spectrophotometrically using m-cresol purple method. About 1-2 L of water samples were filtered through pre-combusted (450°C for 4 h) Whatmann GF/F filter at low vacuum and the filters were stored at -20°C for POC analysis. The filtrate was collected in 22 ml screw cap glass vials and preserved with H₃PO₄ for DOC analysis. Also filtered sea water samples were used for measuring Coloured Dissolved organic Matter (CDOM) spectrophotometrically onboard and samples for CDOM fluorescence preserved at 4°C respectively.

The samples filtered through GF/F filter were analysed for nutrients using Skalar Autoanalyser available onboard. Ammonium analysis done spectrophotometrically onboard. Filtrates were preserved with saturated HgCl₂ for the analysis of total nitrogen and phosphorus.

Sediment sampling

The sediment samples were collected from Vanveen grab and kept at -20°C for analysis of phytoplankton pigments, metals and sedimentary organic carbon. Samples were also collected for analysing grain size and texture. Meiofauna and microfauna samples were preserved in 5% ethanol and 5% rose bengal formalin solutions, respectively. Macrofauna samples were sieved through 500 micron mesh, preserved with 5% rose bengal formalin solution and taken to laboratory for the further analysis. The black colour sediment was observed at off Bhatkal with hydrogen sulphide smell indicating the intense anoxia.

5.3. Biological oceanography: The parameters studied include phytoplankton, zooplankton biomass, chlorophyll and accessory pigments, sediment pigments, autotrophic and heterotrophic bacterioplankton, total bacterial and viral abundance, macro & meio benthos.

Water samples for estimation of taxonomy, fluorescence and absorption:

Surface water samples were collected from all the stations for the microscopic analysis of phytoplankton. The water samples from standard depths (10, 20, 30, 40, 50, 75, 100, 200, 500, 1000, 2000 m) were collected from Niskin bottles operated at various depths in each station and filtered by gentle vacuum filtration under low light conditions. For filtration, a minimum of 2 L were taken for absorption analysis of phytoplankton (a_{ph}) and detritus (a_{dg}), and 2L for chlorophyll and accessory pigment analysis using HPLC base method. Size fractionation filtration were done by using three different filters of pore size 20 μ m, 2 μ m and 0.2 μ m for micro, nano and pico-plankton respectively. Samples were grouped by station, completely labeled and wrapped in aluminum foil during storage and kept in frozen condition.

Bacterioplankton

To estimate the autotrophic and heterotrophic Bacterioplankton (nanoplankton and picoplankton) 10ml of water samples were collected from all the proposed depths in the photic zone. The samples were fixed with glutaraldehyde and kept in -20°C for further analysis.

Phytoplankton

For phytoplankton taxonomy, 1L water samples were collected from standard depths (Euphotic depths-0, 10, 20, 30, 50, 75, 100 and 200m) and immediately preserved in 5% Lugol's solution. The samples are concentrated to 20ml using 10 μ m mesh and stored for further analysis.

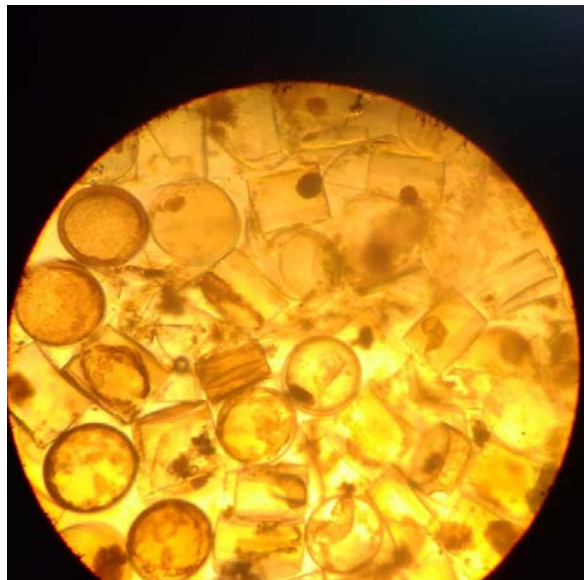


Figure 3. Microscopic image of diatom *Coscinodiscus* sp. bloom observed off Okha

Microzooplankton

For microzooplankton, 5L of samples were passed in series through 200 μm and 20 μm bolting mesh, and the material retained on the latter mesh is preserved with 3% acid Lugol's iodine solution in black polythene bottles. The samples were concentrated to 200 ml using the gravity settling method for further analysis.

Mesozooplankton

Mesozooplankton (MSP) samples were collected from 50 stations using either bongo or Multiple Plankton Net (MPN) or both (mesh size 200 μm). Surface MSP was collected from all the locations by towing the bongo net for ten minutes with speed of the vessel adjusted to ~ 2 knots. The depth strata for MPN operation was predefined as surface to Mixed Layer Depth (MLD), MLD-bottom of Thermocline and Oxygen Minimum Zone (OMZ). The actual depths were decided after corresponding CTD casts. After the removal of large particles, the biomass of the zooplankton were analysed using the standard displacement volume (DV) method and the samples were preserved in 4% formaldehyde for later enumeration and identification.

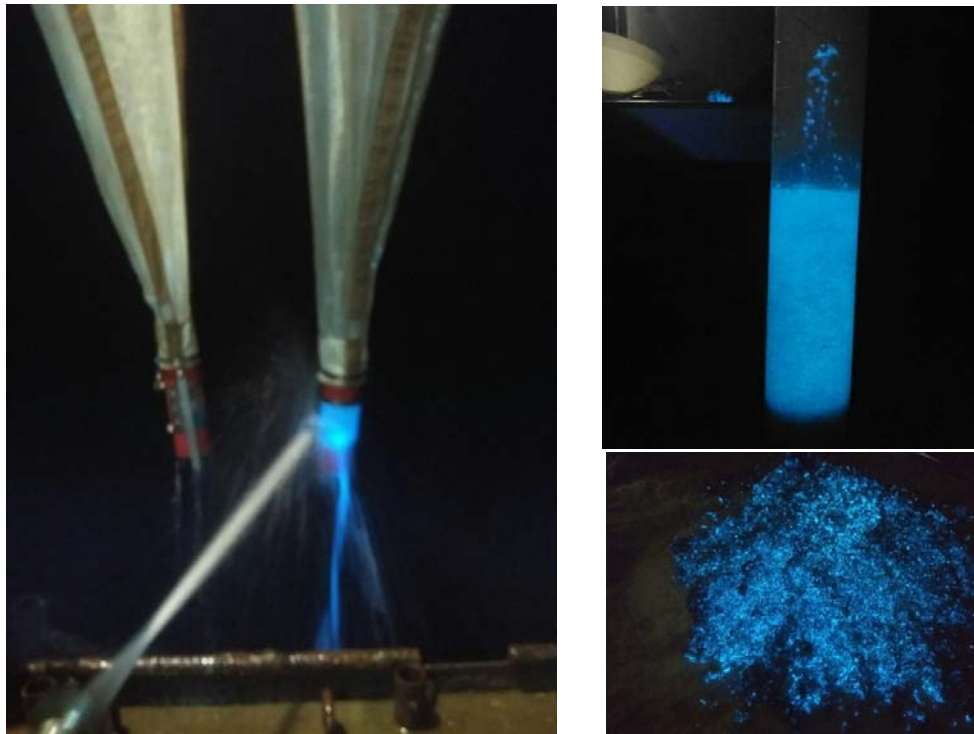


Figure 4. Bioluminescence of mesozooplankton *Ostracoda* sp. observed off Goa and Okha

Microbiology Analysis

Water samples collected from various depths in five transects (Table 1) were subjected to plant count on Zobell marine agar plates. For total bacterial and

viral abundance (TC) analysis, samples were fixed with formalin and filtered through anodisc membranes. Similarly, for total viable count (TVC), samples were stained with acridine orange and filtered through black nucleopore filter. The abundance will be counted using epifluorescence microscope at laboratory. Water samples were filtered for DNA isolation for metagenomic analysis in the laboratory.

Tarballs menace

The map of floating tarballs spotted in this cruise is given in Figure 5. At these locations the tarballs were collected either from the bongo net or surface bucket sampling. The presence of these tarballs indicates severity of oil spills from various marine activities viz. exploration, transportation, navigation, etc. Barnacles were attached to these tarballs, and the barnacles size is large off Bhatkal and small off Mumbai.

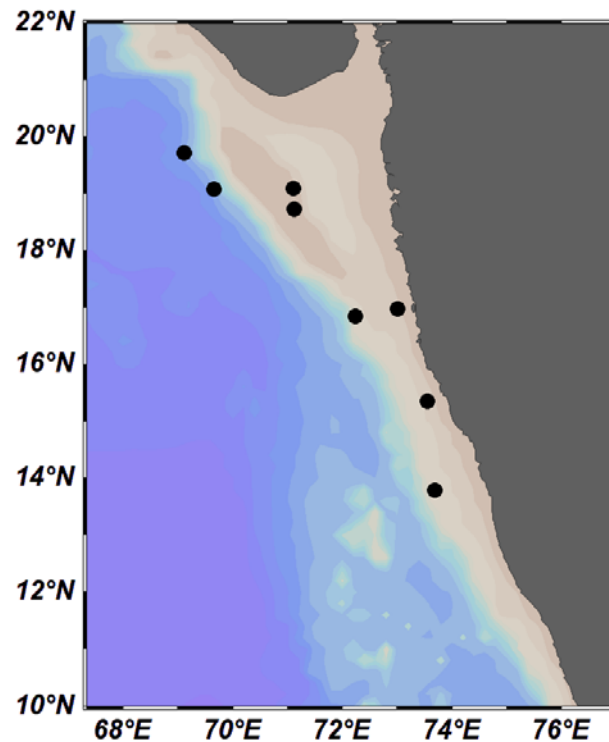


Figure 5. Location map of tarballs observed in this cruise.



Figure 6. The photo of tarballs floating in the surface waters off Goa and the comparative size of tarballs collected from off Goa and off Bhatkal with barnacles attached to it

6. Suggestions and recommendations

- a) Awareness on ocean cleanliness, plastic usage and disposal need to be strengthened to arrest their dumping into the sea from the vessel.
- b) Frequently ADCP data showing black boxes (data gaps), which needs to be rectified.
- c) AWS data output screen should be provided in the CTD lab.
- d) For undertaking multi-disciplinary studies like this require huge volume of water samples from each depth, so a rosette with 12 numbers of 12 liters niskin bottles should be made available onboard to minimize the number of CTD casts and operation time.

7. Acknowledgements

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