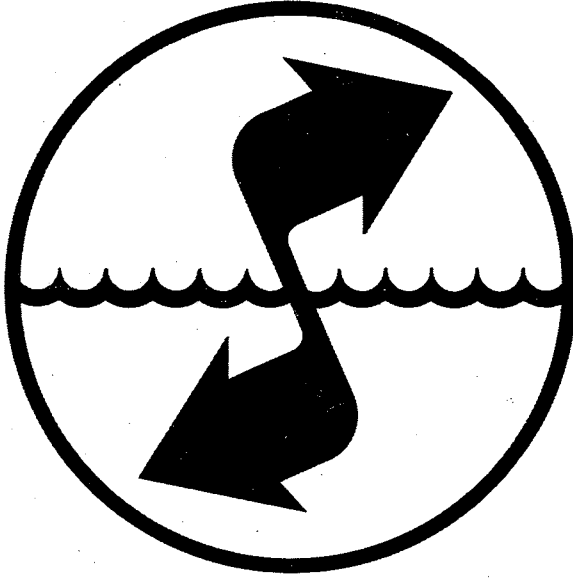


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U.S. PROGRAM IN BIOLOGY
INTERNATIONAL INDIAN OCEAN EXPEDITION

FINAL CRUISE REPORT
ANTON BRUUN CRUISE I

VOLUME 1 (of 2)
OCEANOGRAPHIC DATA

INDIAN
INTERNATIONAL
OCEAN

EXPEDITION

Woods Hole Oceanographic Institution
ATLAS - GAZETTEER COLLECTION

WOODS HOLE OCEANOGRAPHIC INSTITUTION

JULY, 1964

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U. S. PROGRAM IN BIOLOGY
INTERNATIONAL INDIAN OCEAN EXPEDITION

Final Report: ANTON BRUUN Cruise 1.

The following report, in two volumes, presents the reduced oceanographic, chemical, and biological data, bathythermograph positions, and station lists for biological collections taken during Cruise 1 of the ANTON BRUUN in the Bay of Bengal during March-May, 1963, as a part of the International Indian Ocean Expedition. The cruise track is shown in Figure 1. Tables 1-3 respectively give the cruise itinerary with port calls, a summary of the types of scientific activities carried out during the cruise, and a list of the techniques employed with references.

A narrative report of Cruise 1 including the list of participants, related shore activities, and preliminary scientific results was issued as News Bulletin No. 2 of the U. S. Program in Biology, IIOE, dated July, 1963.



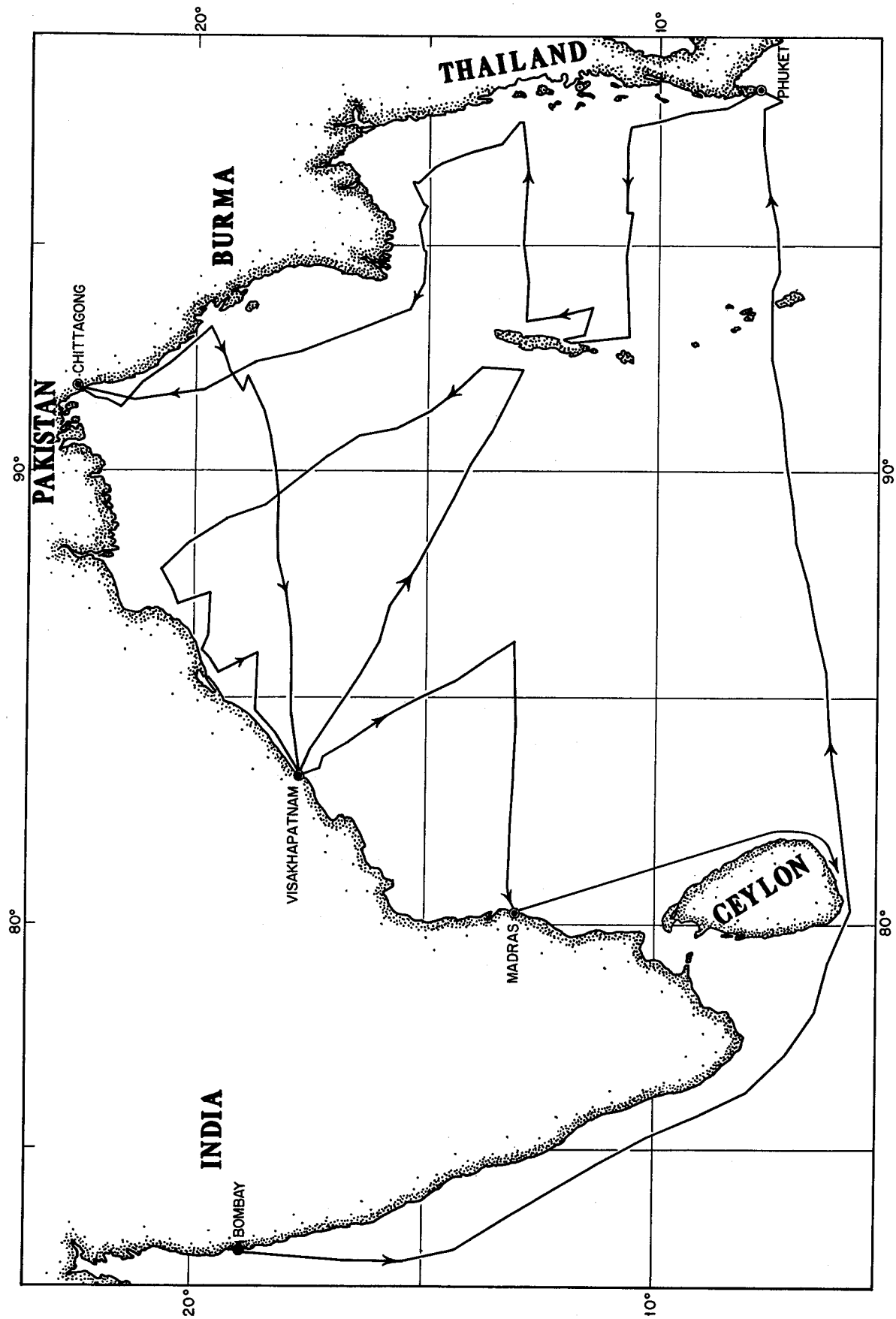


Fig. 1. Cruise track - R/V ANTON BRUUN Cruise 1.

Table 1.

Cruise 1 Itinerary

Departure	Date	Arrival	Date
Bombay, India	3/12/63	Phuket, Thailand	3/22/63
Phuket	3/23/63	Chittagong, E.Pakistan	4/3/63
Chittagong	4/4/63	Vizagapatnam, India	4/11/63
Vizagapatnam	4/14/63	Vizagapatnam	4/25/63
Vizagapatnam	4/28/63	Madras, India	5/3/63
Madras	5/4/63	Bombay	5/10/63

Table 2.

Summary of Scientific Activities, Cruise 1, showing number of stations occupied each leg for the different types of work.

Cruise Leg	Stations				
	Oceanographic ¹		Bottom Trawl	Dredge	Sediment
	Complete	Surface Obs. only			
Bombay-Phuket	5	26	5	0	0
Phuket-Chittagong	25	5	18	15	2
Chittagong-Vizagapatnam	21	0	10	4	12
Vizagapatnam-Vizagapatnam	23	3	0	7	14
Vizagapatnam-Madras	18	0	0	0	2
Total	92	34	33	26	30

1. Hydrography, chemistry, primary productivity, plankton tows

Table 3.

Methods and Techniques employed on Cruise 1
with references.

1. Navigation: Celestial navigation and dead reckoning. Corrected positions taken from smooth navigation plots.
2. Bottom depth: Precision Echo Sounder Recorder (Alpine Geophysical Assoc.). Note - Continuous records taken throughout Cruise 1 have been turned over to Dr. Bruce Heezen, Lamont Geological Observatory.
3. Bathythermograph observations: Taken on arrival at each station and at intervals of 1 hour or less between stations. Records deposited with National Oceanographic Data Center, Washington, D.C.
4. Temperature and depth: Paired protected and unprotected deep-sea reversing thermometers. Reliability of depth calculations shown on relative scale of 1 (high) - 3 (low).
5. Water samples
 - a) Chemistry: Teflon-coated Nansen bottles (Balauf Mfg. Co., Washington, D.C.).
 - b) Productivity and pigments: Large volume, all-plastic (lucite) water sampler designed by D.W. Menzel, Woods Hole Oceanographic Institution, Woods Hole, Mass.
6. Salinity: Inductance-type salinometer (Autolab Industries, Sydney, Australia).
7. Dissolved oxygen: Winkler method, biniodate standard.
8. Phosphate: Murphy, J. and J.P. Riley. 1962. A modified single solution method for the determination of phosphate in natural waters. *Anal. Chim. Acta* 27: 31-36.
9. Nitrite: Rider, B.F. and M.G. Mellon. 1946. Colorimetric determination of nitrites. *Ind. Engin. Chem. Anal. Ed.* 18: 96-99.
10. Nitrate: Mullen, J.B. and J.P. Riley. 1955. The spectrophotometric determination of nitrate in natural waters, with special reference to sea water. *Anal. Chim. Acta.* 12: 464-480.
11. Mullen, J.B. and J.P. Riley. 1955. The colorimetric determination of silicate with special reference to sea and natural waters. *Ibid.* 12: 162-175.

12. Plankton pigments:
 - a) Richards, F.A. with T.G. Thompson. 1952. The estimation and characterization of plankton populations by pigment analysis. II. A spectrophotometric method for the estimation of plankton pigments. J. Mar. Res. 11: 156-172
 - b) Creitz, G.I. and F.A. Richards. 1955. _____ III. A note on the use of "millipore" membrane filters in the estimation of plankton pigments. Ibid. 14: 211-216.
 - c) Whatman GF/C glass fiber filters used in place of millipore filters.
 - d) Data for chlorophyll^a only reported here. Optical densities of acetone extracts A/C Richards with Thompson may be obtained on request from J. H. Ryther, Woods Hole Oceanographic Institution, Woods Hole, Mass.
13. Primary production:
 - a) C-14-technique, basically as in: Steemann Nielsen, E. 1952. The use of radioactive carbon (C¹⁴) for measuring organic production in the sea. J. Cons. Internat. Explor. Mer. 18: 117-140.
 - b) Millipore HA type membrane filters used throughout. Filters rinsed with 10 ml 0.01 N HCl in 3% NaCl.
 - c) Simulated in situ measurements: Water samples collected from depths of penetration of 100, 50, 25, 10, and 1% incident light. Samples with C¹⁴ added incubated for 24 hours on deck in water cooled lucite cylinders covered with neutral density (wire mesh) filters to simulate in situ light intensities.
 - d) Artificially-illuminated measurements: Samples from same depths as in (c) incubated for 4 hours at approximately 1000 foot candles from fluorescent lamps.
 - e) Dark bottle C¹⁴ uptake subtracted from light bottle values for each depth and for both sets of measurements (c and d).
14. Incident Radiation: Eppley 50-junction pyrhelimeter recorded on Leeds and Northrup Speedomax recorder. Records mechanically integrated with planimeter to give daily radiation. Radiation data refer to 24 hour period of simulated in situ productivity value (i.e. for 24 hours following arrival on station).
15. Biological sampling gear: See key immediately preceding station lists for biological collections.

16. Plankton displacement volume: Taken only for Indian Ocean Standard Net 200 m. vertical hauls. Volume measured on "squeeze-dried" plankton by displacement in volumetric cylinder.
17. Meteorological observations: Taken by member of International Indian Ocean Meteorology Programme. (Dr. Colin Ramage, Scientific Director).

ERRATUM

Silicate values should be reduced by 8%.

SURFACE OBSERVATIONS

R/V ANTON BRUUN CRUISE 1

Station No.	Date	Time	Latitude	Longitude	Sal.‰	PO ₄ -P	NO ₃ -N	NO ₂ -N	SiO ₃ -Si	Chl.a	C ¹⁴ uptake	BT No.
						μgA/L	μgA/L	μgA/L	μgA/L	μg/L	at 1000 f.c. μgC/L/d	
13A	13 Mar 63	1200	16°40'N	72°36'E	33.956	0.39	0.46	0.015	7.20	0.72	206.86	-
13B	"	1800	15°30'N	72°33'E	33.641	0.09	0.66	0.012	6.01	0.42	59.33	141
13C	14 Mar 63	0005	14°24'N	72°51'E	34.187	0.31	0.33	0.017	4.22	0.23	76.22	147
13D	"	0600	13°19'N	73°30'E	33.926	0.36	0.33	0.032	3.46	0.24	32.18	153
13E	"	1155	12°17'N	74°06'E	33.680	0.22	0.33	0.012	6.53	0.38	64.74	159
13F	"	1805	11°16'N	74°45'E	33.682	μ	3.34	0.029	2.82	0.43	108.25	165
13G	15 Mar 63	0002	10°11'N	75°17'E	33.689	0.25	0.26	0.004	3.71	0.27	111.01	171
13H	"	0600	9°04'N	75°48'E	33.704	0.31	0.33	0.010	5.63	0.02	13.09	177
13I	"	1200	8°00'N	76°20'E	33.943	0.94	0.20	0.029	1.66	0.11	18.24	183
13J	"	1800	7°10'N	77°06'E	33.810	0.18	0.20	0.017	1.94	--	7.76	189
13K	16 Mar 63	0000	6°34'N	78°04'E	33.957	0.96	0.20	0.020	1.78	0.01	1.84	195
13L	"	0600	6°13'N	79°09'E	34.103	0.25	0.72	0.042	3.46	0.02	12.21	201
13M	"	1200	5°47'N	80°14'E	34.096	0.27	0.33	0.017	2.69	0.01	11.06	207
13N	"	1800	5°53'N	81°25'E	33.910	0.28	0.06	0.020	2.69	0.02	2.38	212
13O	17 Mar 63	0030	6°01'N	82°30'E	33.908	0.13	0.06	0.010	3.84	0.02	13.67	218
13P	"	0600	6°09'N	83°29'E	33.870	0.33	--	0.015	--	0.02	14.67	224
13Q	"	1200	6°15'N	84°30'E	33.877	0.32	--	0.022	--	0.01	3.07	230
13R	"	1800	6°19'N	85°30'E	33.815	0.30	--	0.034	3.71	0.02	5.22	236
13S	18 Mar 63	0001	6°32'N	86°32'E	34.362	0.29	--	0.024	--	0.01	7.95	242
13T	"	0600	6°43'N	87°26'E	34.118	0.28	--	0.024	--	μ	3.53	247
13U	"	1200	6°57'N	88°29'E	33.502	0.13	--	0.039	2.05	0.01	3.46	253
13V	"	1800	7°03'N	89°09'E	33.425	0.13	--	0.054	2.69	0.04	7.03	259
13W	19 Mar 63	0002	7°11'N	90°10'E	33.702	0.15	--	0.039	4.09	0.05	18.47	265
13X	"	0600	7°20'N	91°16'E	33.061	0.16	--	0.039	3.71	0.04	10.91	271
13Y	"	1200	7°30'N	92°27'E	33.054	0.14	--	0.054	2.69	0.03	12.36	277
13Z	"	1800	7°16'N	93°41'E	33.153	0.27	--	0.024	--	0.12	4.42	
41A	31 Mar 63	0008	15°13'N	95°23'E	32.864	--	--	--	--	--	--	
43A	1 Apr 63	1800	15°24'N	93°32'E	32.344	0.11	0.06	0.044	2.18	0.04	0.76	417
43B	2 Apr 63	0000	16°28'N	93°06'E	32.086	0.06	0.18	0.047	0.90	0.12	1.93	423
43C	"	0600	17°37'N	92°41'E	31.368	0.07	0.31	0.061	2.43	0.44	2.68	429
43D	"	1206	18°43'N	92°14'E	28.778	0.19	0.37	0.039	5.76	0.72	4.82	435
43E	"	1810	19°45'N	91°49'E	31.071	0.05	0.46	0.007	3.07	0.99	17.72	441

REDUCED DATA

U. S. PROGRAM IN BIOLOGY - INTERNATIONAL INDIAN OCEAN PROGRAM

STATION NO. 71
 CRUISE NO. 1
 VESSEL R/V ANTON BRUUN
 DATE 17-IV-63
 RELIABILITY OF DEPTH 1

LAT. 14° 53' N
 LONG. 88° 40' E
 DEPTH 2789 M
 TIME 0411 hrs.
 WIND 18 kn., 160° dir.

PRIMARY PROD. .10 g C / m² / day
 EXT. COEFF. (k) _____
 RADIATION 134 gcal. / cm² / day
 ZOOPLANKTON VOL. _____
 IOSN STD. TOW 8.0 ml. / m²

DEPTH	TEMP.	SAL. ‰	O ₂	PO ₄ -P	NO ₃ -N	NO ₂ -N	SiO ₃ Si			DEPTH	Chl. a	INSITU C ¹⁴	C ¹⁴ -1000 fc	
			ml./l.	μgA/l.	μgA/l.	μgA/l.	μgA/l.				μg/l.	μgC/l./d.	μgC/l./d.	
1	28.86	32.978	4.65	0.07	0.3	0.01	5.0			1	0.01	2.5	10.1	
24	28.92	33.392	4.78	0.09	0.4	0.02	6.1			9	u	5.8	10.9	
47	26.94	33.381	4.86	0.11	0.2	0.02	9.9			17	u	3.0	1.6	
71	26.82	33.869	4.83	0.16	0.4	0.02	3.8			29	u	0.6	2.7	
94	26.34	33.954	4.56	0.21	0.6	0.06	5.0			58	u	u	1.6	
118	22.81	34.727	0.96	1.51	28.0	0.12	16.5							
141	20.33	34.826	0.40	1.87	34.4	0.06	22.0							
188	16.34	34.874	0.25	2.21	39.8	0.07	33.2							
283	12.11	35.014	0.19	2.54	42.2	0.06	40.3							
377	10.87	35.023	0.22	2.63	45.3	0.07	47.8							
473	10.06	35.030	0.29	2.72	49.3	0.08	53.1							
568	9.36	35.015	0.30	2.80	49.0	0.10	60.8							
667	8.60	35.002	0.45	2.91	50.0	0.07	68.9							
766	7.92	34.989	0.56	2.93	--	0.07	77.1							
865	7.26	34.964	0.83	2.94	--	0.06	83.9							
965	6.70	34.938	0.88	2.94	--	0.07	94.5							
952	6.77	34.967	0.92	2.94	--	0.05	92.8							
1142	5.78	34.915	1.26	2.94	--	0.01	104.0							
1431	4.54	34.866	1.75	2.81	--	0.05	117.0							
1719	3.32	34.820	2.35	2.75	--	0.05	132.0							
2110	2.53	34.788	2.87	2.63	--	0.02	141.0							
2603	1.97	34.763	3.20	2.58	--	0.02	146.0							
2679	1.92	34.756	3.26	2.53	--	0.02	150.0							

REDUCED DATA

U. S. PROGRAM IN BIOLOGY - INTERNATIONAL INDIAN OCEAN PROGRAM

STATION NO. 75
 CRUISE NO. 1
 VESSEL R/V ANTON BRUUN
 DATE 18-IV-63
 RELIABILITY OF DEPTH 1

LAT. 13° 16' N
 LONG. 91° 34' E
 DEPTH 2977 M
 TIME 1212 hrs.
 WIND 4 kn., 047° dir.

PRIMARY PROD. .13 g C / m² / day
 EXT. COEFF. (k) 0.07
 RADIATION 443 gcal. / cm² / day
 ZOOPLANKTON VOL. _____
 IOSN STD. TOW 12.0 ml. / m²

DEPTH	TEMP.	SAL. ‰	O ₂	PO ₄ -P	NO ₃ -N	NO ₂ -N	SiO ₂ Si				DEPTH	Chl. a	INSITU C ¹⁴	C ¹⁴ -1000 fc
			ml./l.	μgA/l.	μgA/l.	μgA/l.	μgA/l.					μg/l.	μgC/l/d.	μgC/l/d.
1	29.49	32.339	4.64	0.03	0.2	0.01	4.0				1	0.04	2.3	11.1
25	27.87	32.788	4.98	0.03	0.3	0.02	3.3				10	0.03	1.5	21.5
50	25.78	33.238	4.69	0.17	0.4	0.01	3.8				20	0.05	3.3	25.8
75	24.02	34.534	0.86	1.42	18.4	0.13	18.4				33	0.08	0.6	36.7
100	19.74	32.835	0.23	1.41	22.3	0.05	27.2				66	0.26	1.5	9.0
125	17.63	34.849	0.13	2.13	27.2	0.07	29.5							
150	15.68	34.905	0.24	2.32	29.3	0.02	34.8							
200	12.94	34.998	0.26	2.45	31.7	0.03	39.9							
300	11.11	35.030	0.32	2.57	35.7	0.02	--							
400	10.18	35.029	0.33	2.68	39.8	0.03	53.4							
500	9.55	35.022	0.40	2.73	36.9	0.03	61.4							
600	8.82	34.996	0.49	2.73	32.2	0.04	67.1							
700	8.16	34.984	0.71	2.77	37.2	0.03	79.8							
800	7.63	34.969	0.82	2.76	--	0.03	80.6							
900	6.95	34.943	0.94	2.80	--	0.03	93.8							
1000	6.40	34.931	1.16	2.86	--	0.02	94.7							
998	6.47	34.939	1.07	2.90	--	0.02	92.9							
1198	5.55	34.901	1.35	--	--	0.01	105.0							
1498	4.39	34.855	1.84	2.61	--	0.06	116.0							
1798	3.19	34.804	2.42	2.62	--	0.04	131.0							
2197	2.45	34.775	2.87	2.51	--	0.02	137.00							
2597	1.99	34.750	3.16	2.44	--	0.03	142.0							
2997	1.62	34.739	3.55	2.40	--	0.02	147.0							

REDUCED DATA

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STATION NO. 97
 CRUISE NO. 1
 VESSEL R/V ANTON BRUUN
 DATE 1-V-63
 RELIABILITY OF DEPTH 1

LAT. 13°08' N
 LONG. 86°12' E
 DEPTH 3173 M
 TIME 0320 hrs
 WIND _____

PRIMARY PROD. .32 g C / m²/day
 EXT. COEFF. (k) _____
 RADIATION 437 gcal./cm²/day
 ZOOPLANKTON VOL. _____
 IOSN STD. TOW 14 ml./m²

DEPTH	TEMP.	SAL. ‰	O ₂	PO ₄ -P	NO ₃ -N	NO ₂ -N	SiO ₃ Si			DEPTH	Chl. a	INSITU C ¹⁴	C ¹⁴ -1000 fc
			ml./l.	μgA/l.	μgA/l.	μgA/l.	μgA/l.				μg/l.	μgC/l/d.	μgC/l/d.
1	29.98	33.048	4.56	u	0.9	0.02	3.1			1	0.11	7.2	2.4
25	28.88	33.985	5.49	0.01	0.1	0.01	3.2			9	0.04	8.5	5.2
50	--	33.299	4.76	0.08	1.8	u	3.2			19	0.12	8.7	3.4
74	26.02	33.934	3.94	0.28	1.5	0.37	6.3			31	0.03	5.3	u
99	23.51	34.619	0.52	1.58	23.1	0.06	15.4			62	0.08	0.4	u
124	20.27	34.819	0.32	1.91	28.3	0.01	22.4						
149	17.47	34.868	0.29	2.10	34.4	0.03	28.9						
198	14.32	34.956	0.28	2.36	33.0	0.02	36.1						
297	11.67	35.055	0.40	2.46	44.2	0.01	40.7						
400	10.41	35.038	0.26	2.62	43.9	0.02	50.6						
500	9.74	35.030	0.34	2.71	34.4	tr	58.1						
600	8.95	35.018	0.35	2.80	44.1	0.02	67.7						
700	8.23	34.998	0.58	2.80	42.2	0.02	75.6						
800	7.63	34.976	0.74	2.83	43.2	0.02	80.6						
900	7.00	34.959	0.81	2.89	38.3	u	88.2						
1000	6.43	34.934	1.00	2.86	36.3	0.01	95.5						
1199	5.43	34.905	1.91	2.81	38.8	tr	104						
1499	4.21	34.857	1.90	2.76	40.6	u	122						
1798	3.04	34.814	2.45	2.57	45.1	0.02	133						
2097	2.50	34.782	2.83	2.53	40.7	0.02	142						
2397	2.14	34.764	2.92	2.49	39.7	0.01	147						
2796	1.83	34.750	3.18	2.48	41.2	0.02	152						
3096	1.55	34.740	3.46	2.45	41.2	0.02	154						

