1963

Dark and light bottle studies in the lower York River, Virginia, June 1961 - August 1962

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Wool

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IN THE LOWER YORK RIVER, VIRGINIA
JUNE 1961 - AUGUST 1962

VIRGINIA INSTITUTE OF MARINE SCIENCE

SPECIAL SCIENTIFIC REPORT NO. 45

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W. J. Hargis
Director

March 1963

DARK AND LIGHT BOTTLE STUDIES
IN THE LOWER YORK RIVER, VIRGINIA

June 1961 - August 1962

Data obtained by the Planktology Department in 22 productivity experiments performed in situ at a permanent station about 300 yards off the VIMS pier in the York River are reported. This work is a continuation of a long term evaluation of production levels at this site, (VIMS Spec. Sci. Rep. No. 22), as measured by the dark and light bottle differential oxygen method.

Mean low water at the station during the study period was about 28 ft. Hydrographic determinations included vertical profiles of temperature, chlorinity, extinction coefficients and dissolved oxygen. Temperatures (Table 1) were obtained with a thermistor unit or thermometer. Chlorinity (Table 2) was titrated with silver nitrate. Extinction coefficients (Table 3) were calculated from optical densities obtained colorimetrically with a neutral filter at the beginning and end of each experiment, and mean values for the upper 10 ft used to estimate light intensity at different depths and for the whole water column (Table 4). Dissolved oxygen (Table 5) was determined by the unmodified Winkler method in the first seven experiments, and by the azide modification thereafter. Inorganic and ash-free suspended solids (Table 6) were determined beginning with the tenth experiment by filtering water through tared (HA) Millipore filters, desiccating filters plus residues, weighing for total seston, then ashing at 600°C, rehydrating the ash, desiccating, and weighing again to obtain ash weight.

The productivity experiments, all of 24 hours' duration, were designed as described previously (VIMS Spec. Sci. Rep. No. 22), except that in the first nine experiments light bottles were suspended only at the same depths from which the samples were obtained, other combinations of suspension depth for a given collection depth being omitted. Results, in units of oxygen concentration, were converted to gcal cm^{-2} based on $PQ(+O_2/-CO_2) = 1.00$ for experiments 1-9, and $PQ = 1.25$ for experiments 10-22. Reported are gross production at various depths and integral gross production in the upper 20 ft (Table 7), gross production of samples suspended at all combinations of collection depths (Table 8), respiration at various depths and integral respiration (Table 9), net production at the different depths and integral net production (Table 10), and net production of samples suspended at all combinations of collection depths (Table 11). Gross production efficiencies relative to available light at each suspension depth, and integral efficiencies for the upper 20 ft of the water column both with respect to integral and incident radiation are also presented (Table 12).

Distribution of this report does not constitute publication, and the data are subject to correction and/or revision.

Bernard C. Patten
David K. Young
Charles Rutherford

March 15, 1963

EXPERIMENT DATES

Exp. No.	Dates
1	Jun 27-28, 1961
2	Jul 11-12, 1961
3	Jul 18-19, 1961
4	Jul 25-26, 1961
5	Aug 1-2, 1961
6	Aug 10-11, 1961
7	Aug 15-16, 1961
8	Aug 22-23, 1961
9	Aug 29-30, 1961
10	Oct 9-10, 1961
11	Oct 23-24, 1961
12	Nov 6-7, 1961
13	Nov 20-21, 1961
14	Dec 11-12, 1961
15	Jan 8-9, 1962
16	Feb 18-19, 1962
17	Mar 15-16, 1962
18	Apr 16-17, 1962
19	May 8-9, 1962
20	Jun 14-15, 1962
21	Jul 10-11, 1962
22	Aug 16-17, 1962

Table 1. Vertical temperature profiles, °C, at the beginning (B) and end (E) of each experiment.

Exp. No.	Surface		2 ft		6 ft		10 ft		14 ft		18 ft		22 ft		25 ft	
	B	E	B	E	B	E	B	E	B	E	B	E	B	E	B	E
1	22.67	21.64	22.67	21.64	22.63	21.66	22.69	21.66	22.71	21.68	22.56	21.68	21.63	21.64	21.78	21.66
2	24.5	24.6	24.5	24.5	25.0	24.4	24.8	24.4	24.8	24.2	24.6	23.9	24.6	24.0	24.3	24.0
3	26.0	25.2	25.8	25.5	25.5	25.0	25.2	25.0	24.1	24.7	24.0	24.1	23.5	23.8	23.8	23.5
4	29.2	28.8	28.8	29.3	28.2	28.3	27.8	27.8	27.5	27.4	26.4	25.8	26.2	25.3	26.5	24.9
5	28.2	28.0	28.0	28.0	28.2	27.8	27.5	27.5	28.0	27.4	27.2	27.2	27.8	27.2	27.2	27.2
6	27.7	27.4	28.0	27.9	27.8	27.5	27.5	27.2	26.9	26.7	26.6	26.1	26.0	26.0	25.2	25.9
7	26.0	27.8	26.4	27.0	25.9	26.8	26.0	26.4	26.0	26.2	25.0	26.2	26.2	26.2	26.0	26.2
8	25.9	26.2	26.2	26.0	25.9	25.8	25.8	25.8	25.7	25.9	25.7	25.5	25.3	25.3	25.3	25.4
9	28.4	28.1	29.8	28.1	29.0	27.7	28.8	27.1	27.9	27.3	27.7	27.0	28.0	27.0	27.7	27.2
10	22.5	22.0	22.2	22.0	21.6	22.0	21.2	21.7	21.2	21.6	21.2	21.5	21.2	21.4	21.2	21.5
11	12.1	12.0	12.2	12.0	12.2	12.1	12.2	12.1	12.1	12.0	12.1	12.0	12.1	12.0	12.1	12.0
12	18.18	18.0	18.13	17.9	17.62	17.9	17.28	17.8	16.71	17.5	16.73	17.5	16.71	17.7	16.71	17.8
13	12.29	11.97	12.40	11.97	12.90	12.09	12.99	12.11	13.02	12.15	13.04	12.16	13.05	12.20	13.08	12.22
14	8.04	8.00	7.88	7.74	7.81	7.66	7.71	7.63	7.69	7.63	7.68	7.64	7.67	7.64	7.65	7.64
15	6.03	5.36	5.75	5.45	5.72	5.43	5.64	5.46	5.61	5.45	5.35	5.46	5.35	5.46	5.35	5.46
16	3.25	-	3.14	-	3.08	-	3.07	-	3.06	-	2.96	-	2.72	-	2.64	-
17	5.68	6.33	5.65	6.26	4.83	6.15	4.65	5.95	4.35	5.10	4.32	5.05	4.31	4.83	4.32	4.78
18	10.54	11.84	10.47	12.08	10.58	12.22	10.70	12.39	10.82	12.35	10.50	12.21	10.07	11.95	9.96	11.90
19	19.08	19.99	19.02	18.41	18.05	17.52	17.79	17.27	17.77	17.01	17.77	16.92	17.07	16.92	16.92	16.92
20	22.54	22.97	22.54	22.95	22.30	22.56	22.30	22.44	22.30	22.44	22.12	22.55	22.12	21.25	22.12	21.09
21	26.51	29.00	25.99	28.00	25.14	27.5	24.53	26.5	24.33	25.5	24.33	25.0	24.10	25.0	24.10	25.0
22	27.0	27.5	26.8	27.0	26.6	26.8	26.4	26.8	26.2	26.5	26.0	26.3	26.0	26.2	26.0	26.0

Table 2. Vertical profiles of chlorinity, ‰, at the beginning (B) and end (E) of each experiment.

Exp. No.	Surface		2 ft		6 ft		10 ft		14 ft		18 ft		22 ft		25 ft	
	B	E	B	E	B	E	B	E	B	E	B	E	B	E	B	E
1	9.26	9.42	9.42	9.25	9.42	9.12	9.27	9.61	9.80	9.54	9.79	9.73	9.79	9.81	9.82	9.82
2	8.88	8.73	8.80	8.79	8.81	8.76	9.01	9.12	9.32	9.40	9.82	9.80	9.91	10.01	10.10	10.10
3	10.22	10.58	10.19	10.59	10.37	10.60	10.67	10.60	11.22	10.97	11.75	11.30	11.79	11.30	11.84	11.96
4	10.60	10.89	10.70	10.87	10.72	10.90	10.64	10.91	10.90	11.19	11.42	11.75	11.56	11.15	11.70	12.54
5	11.35	11.11	11.28	11.36	11.33	11.35	11.44	11.32	11.26	11.29	11.44	11.27	11.45	11.35	11.26	11.35
6	11.37	11.97	11.33	11.98	11.53	11.99	11.43	12.09	12.03	12.47	12.30	12.90	12.79	13.21	13.34	13.50
7	11.57	10.68	11.32	11.05	11.48	11.20	11.71	11.53	11.87	11.68	12.13	11.59	12.22	11.73	12.39	11.70
8	11.21	11.41	11.34	11.57	11.50	11.70	11.57	11.72	11.60	11.60	11.75	11.90	11.88	12.15	12.00	12.20
9	11.26	11.32	11.26	11.23	11.20	11.23	11.20	11.24	11.21	11.26	11.26	11.30	11.20	11.31	11.20	11.34
10	11.08	11.16	11.16	11.28	11.20	11.31	11.20	11.21	11.20	11.31	11.27	11.31	11.24	11.32	11.26	11.28
11	11.53	11.59	11.53	11.59	11.53	11.60	11.71	11.63	11.71	11.67	11.69	11.62	11.69	11.60	11.69	11.60
12	10.01	10.81	10.01	10.71	10.71	10.91	10.71	11.01	11.21	11.20	11.45	11.42	11.52	11.42	11.53	11.41
13	10.91	11.01	10.98	11.08	11.00	11.02	11.03	11.05	11.10	11.10	11.10	11.10	11.16	11.10	11.16	11.11
14	12.00	11.94	12.00	11.95	12.09	12.09	12.02	12.06	12.19	12.09	12.34	12.11	12.32	12.06	12.34	12.24
15	10.95	9.77	11.08	10.84	11.46	11.28	11.58	11.48	11.48	11.48	11.72	11.56	11.26	11.58	11.78	11.58
16	10.02	10.61	10.00	10.71	10.01	10.71	10.11	10.89	10.16	10.91	10.61	11.09	10.79	11.74	11.81	11.64
17	7.51	8.23	7.85	8.23	8.30	8.13	9.10	8.23	9.41	8.84	10.26	9.45	10.37	9.65	10.47	10.22
18	8.34	7.67	8.26	8.17	8.46	8.39	8.61	8.68	8.80	8.79	9.04	9.09	9.30	9.65	10.01	9.88
19	9.39	9.32	9.30	9.52	9.32	9.82	9.48	9.74	9.81	9.92	10.11	10.01	10.22	10.02	10.28	10.12
20	9.80	9.20	9.80	9.20	9.38	9.30	9.31	9.50	9.38	9.50	9.57	9.60	9.72	10.00	9.96	10.30
21	8.73	8.13	9.42	8.18	9.52	8.83	9.82	9.72	9.99	10.02	10.21	10.30	10.61	10.91	10.84	11.21
22	9.32	9.12	9.43	9.22	10.02	9.52	10.09	10.02	10.32	10.63	10.82	10.63	11.02	10.72	11.02	10.94

Table 3. Extinction coefficients, m^{-1}, at various depths in the water column at the beginning (B) and end (E) of each experiment. Mean coefficients ($\bar{\eta}$) for the upper 10 ft are indicated.

Expt NO.	Surface		2 ft		6 ft		10 ft		14 ft		18 ft		22 ft		25 ft		$\bar{\eta}$
	B	E	B	E	B	E	B	E	B	E	B	E	B	E	B	E	
1	1.96	1.78	1.78	1.61	1.67	1.55	1.50	1.32	1.15	1.32	2.01	1.84	1.05	1.32	1.44	1.40	1.65
2	0.78	1.15	1.01	1.10	0.90	1.12	0.92	1.08	0.94	1.04	0.53	1.17	0.58	1.59	0.58	2.30	1.01
3	0.71	0.78	0.80	1.01	0.78	0.80	0.71	0.92	0.69	0.80	0.79	0.85	1.15	1.15	1.63	2.15	0.82
4	1.36	0.84	1.30	0.68	2.05	1.15	1.84	0.68	1.47	0.69	1.21	0.84	1.58	0.83	3.82	9.68	1.24
5	0.86	1.31	1.02	3.39	1.18	1.80	1.21	1.02	1.24	0.92	2.24	1.29	3.69	1.59	1.52	2.29	1.48
6	1.15	1.21	1.40	1.11	1.21	1.18	1.09	1.17	1.14	0.91	0.78	0.61	1.00	0.48	0.97	0.48	1.19
7	0.94	0.70	1.17	0.95	1.31	0.60	0.84	0.71	0.89	0.24	0.79	0.54	0.55	0.39	1.47	0.61	0.90
8	0.80	0.83	0.79	1.22	0.69	1.38	0.86	1.82	1.24	1.99	1.01	2.18	1.04	2.08	2.67	38.70	1.05
9	1.62	1.10	1.86	1.51	1.88	1.38	2.16	1.59	2.79	1.60	2.64	1.84	4.27	2.15	4.39	2.99	1.64
10	0.72	1.16	1.10	1.00	1.08	0.95	1.15	0.51	1.00	1.39	0.86	1.55	0.86	1.63	5.61	1.61	0.96
11	1.01	1.15	1.40	1.48	1.70	1.48	2.08	1.48	2.48	1.56	2.39	1.51	3.38	1.51	12.66	4.61	1.48
12	0.71	1.16	0.97	1.30	0.79	1.56	1.29	1.70	0.97	1.82	1.12	1.76	1.77	1.87	1.33	2.00	1.19
13	1.67	1.30	1.55	2.30	2.00	2.08	2.12	1.97	1.39	1.97	1.51	1.15	5.51	2.20	8.61	8.06	1.87
14	0.34	0.61	1.28	0.76	0.66	0.48	0.85	0.47	0.94	0.67	1.12	0.74	1.13	0.80	0.74	4.91	0.68
15	0.14	1.28	0.53	1.23	0.72	1.13	0.71	1.13	0.83	1.13	1.01	1.09	1.12	1.31	1.70	1.64	0.85
16	0.77	0.44	1.47	0.55	1.16	0.77	0.84	0.77	0.78	0.44	0.78	0.61	0.70	0.37	0.75	3.44	0.85
17	1.01	0.55	1.85	0.55	0.99	0.63	0.92	0.72	1.09	0.70	1.29	0.82	1.29	0.96	2.71	8.99	0.90
18	2.54	1.09	2.54	1.16	2.54	1.35	2.51	1.35	2.00	1.28	2.00	1.20	1.98	1.53	14.34	4.23	1.88
19	0.80	0.94	0.89	1.09	0.83	1.00	0.67	1.00	0.87	0.99	0.87	1.06	1.17	1.00	5.08	1.45	0.90
20	1.12	1.06	1.17	0.53	1.21	0.46	1.29	0.53	1.28	0.61	1.39	0.53	1.24	0.47	1.56	0.94	0.92
21	0.41	0.72	0.55	0.84	0.78	0.59	0.41	0.67	0.46	0.48	0.92	0.48	0.60	0.67	2.94	2.32	0.62
22	0.76	1.20	0.77	1.35	1.08	1.36	1.24	1.36	1.41	1.36	1.86	1.43	1.86	1.44	24.20	1.44	1.13

Table 4. Daily radiation (I_z) at z = 0, 2, 6, 10, 14, 18 and 22 ft, and integral radiation in the upper 20 ft of the water column ($I\,]_o^b$), in gcal cm^{-2}.

Exp. No.	I_o	I_2	I_6	I_{10}	I_{14}	I_{18}	I_{22}	$I\,]_o^b$
1	142.80	52.55	7.00	0.86	-	-	-	86.76
2	543.40	292.35	86.94	25.00	7.06	2.17	0.54	538.01
3	559.40	339.56	124.75	46.43	17.34	6.15	2.24	679.91
4	607.40	286.93	63.35	14.03	3.10	0.67	1.12	491.09
5	594.4	241.68	39.94	6.60	0.48	0.18	0.03	402.55
6	616.00	296.85	69.61	16.32	3.82	0.86	0.18	516.55
7	647.20	373.43	124.26	40.71	13.66	4.58	1.42	712.83
8	338.80	180.41	50.14	13.92	3.86	1.12	0.30	322.32
9	565.2	207.92	28.14	3.81	0.52	0.07	-	344.85
10	422.60	236.61	72.69	22.57	7.02	2.16	0.72	438.85
11	403.60	164.09	27.12	19.11	0.74	0.12	0.02	273.22
12	152.20	73.60	17.26	4.09	0.96	0.23	0.05	128.56
13	289.80	92.68	9.39	0.97	0.10	0.01	-	154.66
14	93.20	61.23	26.70	11.64	5.08	2.22	0.97	134.17
15	195.20	116.05	41.43	14.79	5.28	1.88	0.65	229.39
16	90.00	53.51	19.10	6.82	2.44	0.86	0.30	105.58
17	405.00	233.66	77.78	25.63	8.62	2.84	0.91	445.99
18	634.00	200.75	20.13	2.12	0.21	0.03	0.00	336.26
19	582.40	335.99	111.82	37.22	12.41	4.14	1.46	642.95
20	324.40	185.29	60.43	19.72	6.42	2.07	0.71	351.00
21	725.00	500.75	236.49	110.56	52.20	24.65	11.60	1147.68
22	506.60	256.64	64.54	17.93	4.05	1.11	0.25	447.34

Table 5. Dissolved oxygen profiles, mg l^{-1}, at the beginning of each experiment.

Exp. No.	Surface	2 ft	6 ft	10 ft	14 ft	18 ft	22 ft	25 ft
1	6.20	6.14	6.10	5.85	5.47	5.08	5.28	5.34
2	8.75	7.97	7.57	6.25	5.63	5.04	4.88	4.55
3	6.13	6.24	6.11	5.49	3.78	3.43	3.38	3.34
4	8.72	8.35	7.60	7.35	7.24	5.99	5.80	5.74
5	-	-	6.29	5.02	6.38	4.35	-	-
6	6.95	6.75	6.53	6.01	3.47	2.95	1.16	1.16
7	10.55	10.49	10.31	8.54	7.43	6.49	6.79	5.61
8	6.32	5.93	5.42	5.27	5.28	5.15	4.34	3.75
9	8.36	8.42	8.17	7.09	7.54	7.03	6.81	6.86
10	7.95	7.51	7.10	6.89	6.96	6.94	6.92	6.83
11	7.71	7.63	7.71	7.71	7.65	7.68	7.66	7.50
12	8.48	8.52	8.05	7.97	7.71	7.44	7.40	7.35
13	8.55	8.72	8.60	8.65	8.55	8.50	8.45	8.35
14	9.97	10.12	9.92	9.95	9.93	9.92	9.96	9.94
15	10.85	10.83	10.65	10.60	10.65	10.62	10.75	10.48
16	12.28	12.23	12.20	12.13	12.17	12.02	11.82	11.71
17	11.42	11.41	11.32	11.12	11.07	10.60	10.62	10.55
18	8.52	8.20	8.27	8.37	8.54	8.50	8.59	7.39
19	8.06	8.03	7.79	7.11	6.71	6.44	6.49	6.16
20	4.93	4.93	4.74	4.67	4.66	4.24	3.95	3.54
21	7.93	7.73	7.96	7.69	7.05	6.49	5.68	4.97
22	5.36	4.78	3.55	4.68	4.05	3.68	3.47	3.05

Table 6. Suspended solids, organic (O) and inorganic (I), at each depth at the start of experiments, mg l^{-1}.

Exp. No.	Surface		2 ft		6 ft		10 ft		14 ft		18 ft		22 ft		Bottom	
	O	I	O	I	O	I	O	I	O	I	O	I	O	I	O	I
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	2.2	4.4	2.6	2.2	2.4	3.6	3.0	4.2	2.2	3.0	1.6	2.6	0.4	6.0	7.6	59.6
11	3.0	7.4	3.2	12.0	4.0	9.6	5.2	18.6	3.6	17.0	1.6	18.8	5.9	22.1	8.9	65.7
12	2.0	5.6	2.0	4.6	2.0	6.8	1.0	5.8	1.0	7.8	1.4	6.0	3.2	7.8	4.4	49.8
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
14	3.8	5.8	4.4	6.8	1.8	4.6	1.2	4.8	3.0	7.8	0.8	11.6	2.4	8.8	1.4	11.6
15	0.2	6.4	2.4	7.2	1.0	7.2	0.6	7.6	0.2	8.4	1.0	13.0	1.0	18.2	2.4	30.2
16	1.8	4.8	4.2	6.6	4.8	7.4	1.0	4.0	2.6	3.8	2.4	3.4	2.6	1.8	0.2	4.4
17	1.2	2.8	1.8	11.8	0.8	5.0	2.8	1.6	3.8	3.2	5.0	3.4	2.8	7.2	28.2	10.6
18	0.2	11.0	3.8	14.0	14.4	16.8	12.4	20.4	11.6	14.8	15.6	13.2	3.6	10.8	19.2	192.4
19	7.0	2.6	6.8	3.2	6.4	1.4	5.0	1.6	7.6	1.2	6.0	2.8	8.4	2.0	9.6	14.0
20	5.0	0.6	4.8	1.2	4.0	2.2	3.2	1.6	3.4	0.8	4.2	0.6	3.2	0.8	1.8	5.6
21	3.1	1.3	6.8	3.2	4.0	1.0	2.8	4.2	4.0	1.0	3.8	2.2	4.4	7.8	7.4	58.8
22	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 7. Gross production, gcal cm^{-2}, at various depths and integral values for the water column down to 20 ft.

Exp. No.	2 ft	6 ft	10 ft	14 ft	18 ft	22 ft	Integral
1	2.63	0.49	0.34	-	-	-	4.90
2	0.00	0.19	0.28	-	-	-	1.00
3	1.26	1.52	1.09	-	-	-	4.64
4	0.98	0.21	0.17	-	-	-	1.82
5	0.58	1.05	0.11	-	-	-	-
6	0.98	0.94	0.86	-	-	-	4.79
7	2.33	0.79	0.39	-	-	-	4.45
8	0.49	0.75	0.15	-	-	-	1.76
9	5.65	5.86	1.78	-	-	-	17.04
10	0.70	0.41	0.27	-0.02	0.10	-0.09	1.76
11	0.14	0.15	0.31	0.03	-0.09	-0.12	0.27
12	0.31	0.14	0.29	0.12	0.09	0.10	1.37
13	0.07	0.00	-0.03	0.10	0.26	0.00	1.28
14	0.08	0.17	0.05	0.02	0.02	0.00	4.47
15	0.20	0.15	0.51	-0.51	0.12	0.00	1.18
16	0.31	0.39	0.05	-0.05	0.21	0.09	1.29
17	0.27	0.32	0.75	0.32	0.10	0.10	2.28
18	0.39	0.70	0.15	0.19	0.03	-0.15	2.40
19	0.71	0.87	0.48	1.60	0.14	0.08	4.44
20	0.17	0.25	0.32	0.12	0.04	-0.01	1.11
21	1.60	1.87	1.41	-2.75	0.51	0.23	3.66
22	0.64	0.23	1.05	0.13	-0.08	-0.15	2.52

Table 8. Gross production, gcal cm^{-2}, in bottles containing water samples obtained from 2, 6 and 10 ft which were suspended at all combinations of these collection depths. The first number of each pair in the column headings is collection depth, and the second number is suspension depth.

Exp. No.	(2,2)	(6,2)	(10,2)	(2,6)	(6,6)	(10,6)	(2,10)	(6,10)	(10,10)
1	2.63	1.39	1.24	1.16	0.49	0.64	0.24	0.86	0.34
2	0.00	-	-	-	0.19	-	-	-	0.28
3	1.26	-	-	-	1.52	-	-	-	1.09
4	0.98	-	-	-	0.21	-	-	-	0.17
5	0.58	-	-	-	1.05	-	-	-	0.11
6	0.98	-	-	-	0.94	-	-	-	0.86
7	2.33	-	-	-	0.79	-	-	-	0.39
8	0.49	-	-	-	0.75	-	-	-	0.15
9	5.65	-	-	-	5.86	-	-	-	1.78
10	0.70	0.63	0.56	-0.56	0.41	0.41	0.36	-0.08	0.27
11	0.14	0.25	0.18	0.49	0.15	0.17	0.04	0.18	0.31
12	0.31	-0.65	0.39	0.22	0.14	0.10	0.17	0.12	0.29
13	0.07	0.19	0.27	0.12	0.00	-0.17	-0.20	-0.05	-0.03
14	0.08	0.27	0.31	0.00	0.17	0.08	-0.75	0.10	0.05
15	0.20	0.27	0.63	2.80	0.15	0.31	-	1.28	0.51
16	0.31	0.29	0.36	0.19	0.39	0.24	0.41	-0.03	0.05
17	0.27	0.41	0.10	0.24	0.32	0.89	0.29	-0.29	0.75
18	0.39	0.73	-	0.26	0.70	0.51	0.53	0.24	0.15
19	0.71	0.83	1.04	0.61	0.87	0.99	0.46	0.53	0.48
20	0.17	0.55	0.42	0.17	0.25	0.40	0.06	0.30	0.32
21	1.60	2.18	2.59	1.86	1.87	2.03	0.75	1.24	1.41
22	0.64	-3.60	1.07	-0.73	0.23	0.42	0.00	0.17	1.05

Table 9. Respiration, gcal cm^{-2}, at various depths and integral values for the water column down to 20 ft.

Exp. No.	2 ft	6 ft	10 ft	14 ft	18 ft	22 ft	Integral
1	2.80	2.20	0.92	0.56	0.43	0.41	7.55
2	3.14	2.27	1.16	0.66	0.64	0.51	9.68
3	1.37	1.52	2.03	0.26	0.75	0.51	7.10
4	6.01	3.72	1.67	1.28	1.22	1.11	17.56
5	-	-	-	-	-	-	-
6	5.20	4.69	4.22	0.73	1.03	0.90	19.55
7	10.74	11.81	4.88	3.53	1.97	0.47	41.55
8	2.57	2.03	1.88	1.90	2.12	1.03	12.81
9	5.82	4.00	2.29	3.02	1.78	1.52	20.39
10	1.16	0.73	0.34	-0.02	0.09	-0.09	2.83
11	0.19	0.14	0.31	0.20	0.09	0.20	1.10
12	0.54	0.19	0.19	0.17	-1.50	-1.35	1.11
13	-0.02	-0.15	-0.10	0.00	0.17	0.12	0.28
14	0.13	-0.09	0.00	-0.02	-0.02	0.04	-0.31
15	0.06	0.09	0.58	0.04	0.24	0.13	1.20
16	0.34	-0.11	0.15	0.26	0.26	0.13	0.15
17	0.13	0.13	0.47	0.41	0.13	0.28	1.83
18	-0.41	0.09	0.00	0.43	0.13	0.56	0.05
19	0.79	0.76	0.62	-1.24	0.61	0.81	1.06
20	0.32	0.28	0.28	0.19	0.01	-0.08	1.31
21	2.80	2.67	2.35	-2.82	1.56	1.13	8.23
22	2.37	-0.38	2.67	1.00	0.51	0.64	7.92

Table 10. Net production, gcal cm^{-2}, at various depths and integral values for the water column down to 20 ft.

Exp. No.	2 ft	6 ft	10 ft	14 ft	18 ft	22 ft	Integral
1	-0.17	-1.71	-0.58	-	-	-	-2.65
2	-3.14	-2.08	-0.88	-	-	-	-8.68
3	-0.11	0.00	-0.94	-	-	-	-2.46
4	-5.03	-3.50	-1.50	-	-	-	-15.74
5	-	-	-	-	-	-	-
6	-4.22	-3.75	-3.36	-	-	-	-14.75
7	-8.41	-11.02	-4.49	-	-	-	-37.09
8	-2.08	-1.28	-1.73	-	-	-	-11.05
9	-0.17	1.86	-0.51	-	-	-	-3.35
10	-0.46	-0.32	-0.07	0.00	0.01	0.00	-1.07
11	-0.05	0.01	-0.15	-0.16	0.00	0.07	-0.82
12	-0.23	-0.06	0.10	-0.05	1.58	1.45	0.25
13	0.08	0.15	0.07	0.10	0.08	-0.12	1.00
14	-0.04	0.26	0.05	0.04	0.04	-0.04	4.16
15	0.14	0.07	-0.06	0.01	-0.12	-0.13	-0.02
16	-0.03	0.50	-0.10	-0.31	-0.05	-0.04	0.15
17	0.14	0.19	0.28	-0.09	-0.03	-0.18	0.46
18	0.80	0.61	0.15	-0.14	-0.10	-0.71	2.35
19	-0.08	0.11	-0.14	2.84	-0.47	-0.73	3.38
20	-0.15	-0.03	-0.04	-0.07	-0.03	0.07	-0.20
21	-1.20	-0.80	-1.05	-0.07	-1.05	-0.90	-4.57
22	-1.73	0.61	-1.62	-0.87	-0.59	-0.79	-5.40

Table 11. Net production, gcal cm^{-2}, in bottles containing water samples obtained from 2, 6 and 10 ft which were suspended at all combinations of these collection depths. The first number of each pair in the column headings is collection depth, and the second number suspension depth.

Exp. No.	(2,2)	(6,2)	(10,2)	(2,6)	(6,6)	(10,6)	(2,10)	(6,10)	(10,10)
1	-0.17	-	-	-	-1.71	-	-	-	-0.58
2	-3.14	-	-	-	-2.08	-	-	-	-0.88
3	-0.11	-	-	-	0.00	-	-	-	-0.94
4	-5.03	-	-	-	-3.50	-	-	-	-1.50
5	-	-	-	-	-	-	-	-	-
6	-4.22	-	-	-	-3.75	-	-	-	-3.36
7	-8.41	-	-	-	-11.02	-	-	-	-4.49
8	-2.08	-	-	-	-1.28	-	-	-	-1.73
9	-0.17	-	-	-	1.86	-	-	-	-0.51
10	-0.46	-0.16	0.22	0.02	-0.32	0.02	-0.82	-0.26	-0.07
11	-0.05	0.14	0.65	-0.82	0.01	0.02	-0.97	-0.14	-0.15
12	-0.23	0.27	0.14	-0.16	-0.06	-0.05	-0.17	-0.03	0.10
13	0.08	0.19	-0.05	0.14	0.15	0.02	0.03	0.07	0.07
14	-0.05	0.36	0.29	-0.11	0.26	0.15	0.06	0.16	0.05
15	0.14	0.17	0.48	-0.66	0.07	0.24	-	-0.32	-0.07
16	-0.03	0.14	0.21	-0.09	0.50	0.13	-0.21	0.53	-0.10
17	0.14	0.50	-0.11	0.11	0.19	0.48	0.05	-0.08	0.28
18	0.80	0.71	-	0.67	0.61	0.55	0.27	0.28	0.15
19	-0.08	0.14	0.46	-0.19	0.11	0.34	-0.33	-0.21	-0.14
20	-0.15	-0.02	0.16	-0.04	-0.03	0.16	-0.16	-0.17	-0.04
21	-1.20	-0.40	0.07	-1.43	-0.80	-0.32	-1.73	-1.26	-1.05
22	-1.73	1.49	-1.51	-2.09	0.61	-1.22	-2.58	0.44	-1.62

Table 12. Gross production efficiency per unit light, gcal kcal^{-1} at 2, 6 and 10 ft, and integral production per unit integral and incident radiation.

Exp. No.	2 ft	6 ft	10 ft	Integral	Incident
1	0.05	0.07	0.40	0.03	0.06
2	-	0.00	0.01	0.00	0.00
3	0.00	0.01	0.02	0.01	0.01
4	0.00	0.00	0.12	0.00	0.00
5	0.00	0.03	0.02	-	-
6	0.00	0.01	0.05	0.00	0.01
7	0.01	0.01	0.01	0.01	0.01
8	0.00	0.01	0.01	0.05	0.05
9	0.03	0.21	0.47	0.03	0.05
10	0.00	0.01	0.01	0.00	0.00
11	0.00	0.00	0.08	0.00	0.00
12	0.00	0.01	0.07	0.01	0.01
13	0.00	0.00	-0.04	0.00	0.01
14	0.00	0.01	0.00	0.05	0.03
15	0.00	0.00	0.03	0.01	1.01
16	0.01	0.02	0.01	0.01	0.01
17	0.00	0.00	0.03	0.01	0.01
18	0.00	0.03	0.07	0.00	0.01
19	0.00	0.01	0.01	0.01	0.01
20	0.00	0.00	0.02	0.00	0.00
21	0.00	0.01	0.02	0.01	0.00
22	0.00	0.00	0.06	0.00	0.01