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Biochemical oxygen consumption in the waters of the Northwest Atlantic

by

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SUMMARY

Biochemical oxygen consumption (BOC) in the waters of Georges Bank and American Shelf is determined at different depths between the surface and 200 m. The mean biochemical oxygen consumption rate (c) is 0.14. The obtained values (c) reflect the rate of decomposition of organic matter in the plankton. On the average, according to all the data, the concentration of easily assimilated organic matter in terms of oxygen is 1.61 mg O_2/l on the Georges Bank and 1.43 mg O_2/l on the American Shelf which corresponds to 0.54 and 0.48 mg C/l.

INTRODUCTION

Decomposition of organic matter in the water is accompanied by oxygen consumption which allows to determine a decomposition rate and the quantity of mineralized organic matter in terms of biochemical oxygen consumption (BOC).

MATERIAL AND METHODS

A total of 57 stations for BOC determinations were made in the area of Georges Bank and American Shelf in June, August

and October 1972. The samples were collected at the depths of 0, 10, 20, 30, 50, 75, 100, 150 and 200 m and in pre-bottom layer as well, when the depth was 200 m or less. The samples were exposed in the dark in 0.5 l bottles under 20 ± 1°C temperature. BOC was determined twice in 5 and 10 days after the beginning of the experiment. Determinations were made repeatedly. Oxygen concentration was determined by Winkler method in the water samples of 0.1 l in volume. The samples were titrated by 0.01 hyposulphite, the burette scale point being 0.02 mg.

RESULTS AND DISCUSSION

The decrease of absolute oxygen consumption rate in time could be observed at the majority of stations. This allowed us to use the following equation in the treatment of the data:

$$BOC_t = BOC_{compl.} (1 - 10^{-K}t),$$

where BOC_t is oxygen consumption at time t,

$BOC_{compl.}$ is complete oxygen consumption at the beginning of destruction

K is a constant of the oxygen consumption rate

t is the time of sample exposure.

A constant of consumption rate (K) can be easily calculated according to the formula:

$$K = \frac{1}{t} \lg \frac{BOC_{t1}}{BOC_{t2} - BOC_{t1}}, \quad \text{where}$$

BOC_{t1} and BOC_{t2} are the indices of consumption during the exposure times t_1 and t_2 accordingly (Alekin, 1970).

Basing on the data obtained, the values of K were determined. The existing knowledge suggests that the stable, difficult to oxidize organic matter is accumulated with depth. Therefore K must decrease with depth. However, our calculations

show that K has a wide range of values both at the same station, and in different areas (table 1). The values of K are so widely scattered that no regularity can be observed. Nevertheless, the values of K reflect the rate of decomposition of the plankton (Riley, 1941) : larger values of K are recorded within the intermediate layers during the intensive plankton development and later in pre-bottom layers.

For analysis the results were grouped by the layers 0-30 (surface layer with maximum photosynthesis), 30-100 (intermediate) and 100-200 (prebottom) for the Georges Bank and the American Shelf (table 2).

On the average, oxygen consumption rate (K) is the same for Georges Bank and the American Shelf and is 0.14 when the observed values fluctuate between 0.032 and 0.436.

In literature the values of K fluctuating within a considerable range which depends on the nature of oxidizing organic matter are given. Thus, Ostapenya (1971) gives the K value of 0.07 for the tropical Atlantic; Keys et al. (1935) gives 0.20 for the Atlantic.

To compare the data obtained in different areas and layers, the values of biochemical oxygen consumption were calculated for the first twenty four hours (tables 1, 2). The values of oxygen consumption fluctuated within the range of 0.03 and 0.74 mg O.g/l. In October it was impossible to determine the oxygen consumption for the surface layer at the stations made on the Nuntucket Shoals, because the results cannot be described by the equation of the first order reaction. In control samples the beginning of nitrification process was recorded in 5-7 days. In general, oxygen consumption somewhat decreased with the depth.

Scopintzev (1948) recommends to be very careful when using the data on biochemical oxygen consumption with the aim of characterizing the dynamics of organic matter decomposition in the sea water. The results giving the quantity of easily assimilated organic matter would be more representative if

expressed in terms of $BOC_{compl.}$

The organic matter dissolved in water is represented by two fractions. One is easily assimilated by water organisms which surve to transfer the energy accumulated in organic matter to food chain. The second one represents stable difficult to oxidize organic matter practically not assimilated by water organisms, therefore, its participation rate in the production process is negligible. A task of calculating the contribution of easily assimilated organic matter therefore seems of interest.

To assess the quantity of organic matter accessible to the water microflora the values of $BOC_{compl.}$ were calculated (tables 1, 2). The distribution of the quantity of easily oxidized organic matter approximately corresponds to that of the oxygen consumption values.

On the average, according to all the data, the concentration of easily assimilated organic matter in terms of oxygen is 1.43 mg O_2/l over the American Shelf and 1.61 mg O_2/l on the Georges Bank. The oxygen equivalent of organic matter equal to 1.50 mg O_2/mg (Skopintzev, 1950) and carbon content in organic matter of 50% give a concentration of easily oxidized substance in terms of carbon of 0.48 mg/C/l over the American Shelf and of 0.54 mg C/l on the Georges Bank. It is of interest to compare this value with total organic matter. The concentration of organic matter in the ocean is approximately the same in different areas and at different depths (0.5-3.0 mg C/l) (Menzel 1969; Menzel, Ryther, 1964; Plunkett, Rakestraw, 1955; Skopintzev et al., 1966). The value of 1.75 mg C/l gives the contribution of organic matter accessible to water heterotrophs equal to 27% over the American Shelf and to 31% on the Georges Bank.

CONCLUSIONS

1. The rate of biochemical oxygen consumption (c) fluctuated within a wide range of 0.032 and 0.436, the mean value of 0.14 being the same both for the American Shelf and Georges Bank.

The values of c reflect a seasonal character of development and decomposition in the plankton.

2. Biochemical oxygen consumption during the first twenty four hours fluctuated between 0.03 and 0.74 mg O_2/l, the mean value being 0.47 mg O_2/l on the Georges Bank and 0.36 mg O_2/l on the American Shelf.

3. The contribution of organic matter accessible to water heterotrophs is 0.54 mg C/l on the Georges Bank and 0.48 mg C/l on the American Shelf.

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Table 1

BOC (mg O_2/l) and the constant of oxygen consumption by the depths at separate stations

Depth	American sh. (st.88) June					Depth	Georges Bank (st.34) June				
	BOC_5	BOK_{10}	O	$BOC_{compl.}$	BOC_1		BOC_5	BOC_{10}	O	$BOC_{compl.}$	BOC_1
0	1.59	2.07	0.103	2.30	0.46	0	1.22	2.06	0.032	3.92	0.27
10	1.39	1.67	0.139	1.74	0.49	10	1.52	2.24	0.064	2.92	0.40
20	1.59	1.60	0.409	1.61	0.97	20	5.42	5.82	0.226	5.89	2.36
						30	1.73	1.83	0.248	1.88	0.83
30	1.60	1.66	0.289	1.72	0.82	50	1.90	1.92	0.396	2.02	0.40
40	1.49	1.89	0.114	2.04	0.47	75	1.94	2.34	0.137	2.46	0.66
						100	1.62	2.04	0.134	2.06	0.61
						150	3.32	3.53	0.240	3.57	1.43
						175	0.97	1.44	0.063	1.87	0.26

Table 2

Mean weighted value of BOC (mg O_2/l) and (O) by the layers on the American Shelf and Georges Bank

Layers	June				August				October			
	BOC_1	BOC_5	BOC_{compl}	O	BOC_1	BOC_5	BOC_{compl}	O	BOC_1	BOC_5	BOC_{compl}	OO
					American Shelf							
0-30	0.46	1.34	1.66	0.144	0.38	1.46	1.66	0.156		021		-
30-100	0.36	1.19	1.64	0.112	0.44	1.16	1.34	0.172	0.03	0.16	0.40	0.044
100-200	0.31	0.86	1.02	0.160	0.18	0.70	1.27	0.069		-		-
Mean	0.38	1.13	1.44	0.134	0.33	1.11	1.42	0.151				
					Georges Bank							
0-30	0.74	2.09	2.56	0.148	0.54	1.52	1.79	0.156	0.43	1.24	1.57	0.136
30-100	0.70	1.97	2.24	0.156	0.46	1.20	1.43	0.167	0.21	0.74	1.12	0.080
100-200	0.67	1.76	2.04	0.173	0.34	0.89	1.00	0.186	0.10	0.37	0.74	0.062
Mean	0.70	1.94	2.28	0.154	0.45	1.20	1.41	0.165	0.25	0.78	1.14	0.100