GROWTH OF DIATOMS IN RELATION TO DISSOLVED GASES.

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Periods of diatom abundance have been long known to occur during the colder months of the autumn and spring. Kofoid (1904) found this to be true of the diatoms of the plankton of the Illinois river with the exception of *Melosira granulata*. The latter reaches its greatest abundance during the summer months. Temperature was advanced by the earlier writers as an explanation for the greater growth during the colder months. Allen (1925) considered temperature to be an important factor in relation to the abundance of marine diatoms. Kofoid indicated that the spring and autumn floods were important factors as the heaviest abundance appeared after the overflows and did not occur when the floods did not appear at their usual season.

An increase in nitrates was noted by Whipple (1894) as an important factor in the increase of diatoms in reservoir waters. Whipple and Parker (1901) pointed out that while diatom abundance had been previously explained by an increase in the soluble nitrates, their occurrence in waters containing a large carbon dioxide content indicated a response to this gas. Diatoms have been shown by Palmer (1897) to produce oxygen and by Whipple and Parker to be carbon dioxide consumers. The latter also indicated that the autumn and spring growths of diatoms may be due to the increased circulation of the carbon dioxide as well as of the nitrates brought to the surface by the overturning of the larger bodies of waters. Pearsall (1923) advanced the theory that this semi-annual abundance was largely due to an increase in the dissolved oxygen content caused by the excessive rainfall. Pearsall further states that a deficiency of oxygen, nitrates, silica, or calcium is usually the limiting factor of diatom distribution.

Circulation caused by autumnal and vernal overturns and floods no doubt increases the mineral content of the water and adds to the dissolved gaseous content. The writer, however, has often observed periods of maximum abundance of diatoms which could not be attributed to either of these causes. The majority of the periods of abundance of diatoms have been observed in the colder months, but periods of equal abundance have been noted in the warmer months when conditions were at the opposite extreme. Whipple and Parker have shown that the waters of ponds and streams dissolve a much greater amount of carbon dioxide during the winter months than during the summer months. During the colder season the bottoms of the shallow streams of Illinois are covered with a thick brown scum of Gomphonema which disappears during the spring floods. In the latter part of the summer during the period of low water and drouth, when the earlier aquatic vegetation begins to die and decompose, the carbon dioxide content of the waters is often high. During this season the great growths of Melosira and some Synedra often appear. This would indicate that carbon dioxide is a probable factor influencing the growth of diatoms.

With this factor in mind the writer conducted a series of experiments to determine the response of diatoms to carbon dioxide. Rich cultures of diatoms (mostly Synedra) were secured from scrapings of the bottoms of some laboratory tanks at the University of Illinois. In the following series, each of two cultures of diatoms were subjected to various amounts of carbon dioxide and oxygen for a period of several weeks.

Series 1—Cultures of diatoms through which CO_2 was allowed to bubble for twenty minutes every twenty-four hours.

Series 2—Cultures of diatoms through which a slow stream of air bubbled continually.

Series 3—Cultures of diatoms undisturbed.

Series 4—Cultures of diatoms into which water dripped, creating considerable aeration.

All cultures were placed side by side under the same conditions of light and temperature. Observations were made at the beginning and at the following intervals as described in the following table. The collections were made by stirring the contents of the culture and removing one cubic centimeter with a pipette. This collection was placed in a Sedwick-Rafter slide and the diatoms of a known area were counted, giving sufficient data for an estimate per cubic centimeter. The results per cubic centimeter for the cultures of each series at the different periods of observation are as follows:

Days		1	2	8	12
Series 1	A	131,250	167,600	373,000	1,560,000
	B	120,750	147,000	2,100,000	24,000,000
Series 2	A	168,000	78,750	525,000	575,000
	B	210,000	184,800	630,000	627,000
Series 3	A	187,350	210,000	2,572,500	15,000,000
	B	210,000	210,000	3,202,500	25,000,000
Series 4	A	199,500	157,500	105,000	75,000
	B	131,250	52,500	26,250	30,500

A repetition of the experiments gave practically the same results. The diatoms of the cultures subjected to carbon dioxide (Series 1) showed an increase over those of all the other cultures except those of Series 3. The diatoms of the air cultures, (Series 2) showed only a slight increase during the first eight days, while those of the running water cultures (Series 4) decreased. This decrease may have been due to the removal of some of the diatoms by the water currents, but as the current was maintained at a very low rate, this probability was rather slight. The diatoms of the cultures (Series 3) which were undisturbed showed considerable increase in eight days. In these cultures there was evidence of decomposition of the organic matter, resulting in a high acidity and hydrogen-ion concentration. This indicating an abundance of carbon dioxide. The cultures showing the greatest increase in diatom growth were those of the series containing the greater abundance of carbon dioxide. The diatoms showed a greater growth response under the influence of the carbon dioxide than under the influence of oxygen. In the series containing the most diatoms the water was opaque. The diatoms were immotile and clustered together in large masses, especially on the twelfth day. Apparently their only reaction was that of growth. In the cultures of the air series the water remained clear, and the diatoms were quite active. In these cultures the diatoms exhibited general activity, but less growth response. In the cultures of the carbon dioxide series the accompanying Protozoa disappeared probably because of the toxic effect of the carbon dioxide, but were quite abundant in the cultures of the other series.

They probably destroyed some of the diatoms, but not enough to cause the resulting differences.

In the natural waters of Illinois the mineral content is probably sufficient for abundant diatom growth at all times. Turbidity, light, temperature, and dissolved gases are the more important factors involved in diatom distribution. In the spring following the melting of the ice, more light penetrates the water. The rising temperature increases the bacterial action upon the accumulated bottom debris, resulting in a greater carbon dioxide content. An abundance of carbon dioxide is an important factor for the growth of most diatoms. Not all diatoms react to the same factors or with the same degree of response. As with most organisms not one, but a combination of factors in the right ratio are responsible for the maximum development.

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