so diverse that no one sampler has been devised to serve all purposes. Of the three samplers tested, the Ponar dredge is the most versatile and is only limited in deposits of silt over 12.7 cm. The orange-peel dredge, with its variable sampling characteristics and production of a shock wave, is of questionable value.

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## Plastic Enclosure Versus Open Lake Productivity Measurements

INTRODUCTION

Studies to determine the effects of nutrient enrichment on primary productivity in lakes have been conducted using: (1) whole lake fertilization (Ball and Tanner, 1951); (2) addition of nutrients to glass bottles or polyethylene tubes suspended in the lake (Wetzel, 1966 and Goldman, 1962); and (3) batch and continuous laboratory bioassays of the lake water of interest (Oswald, 1960 and Pearson *et al.*, 1969). Recently in the *Transactions*, Kemmerer (1968) indicated that the polyethylene enclosures give more valid approximations of the fertilization effects than do the laboratory methods. Other authors, including McAllister *et al.* (1961) have implied that these enclosures are superior to bottle tests for phytoplankton studies. Following Kemmerer's report, Verduin (1969) commented on these results, questioning the usefulness of the column technique. Our experiments were conducted to establish the comparability of productivity measurements made in these columns to those made in the open lake, in anticipation of incorporating the column method into our own enrichment studies.

The productivity comparisons were made in Third Sister Lake, a protected 10-acre lake located in the Saginaw Forest preserve near Ann Arbor, Michigan. The columns used in the study were constructed of polyethylene film 0.006 inches in thickness. The tubes were held open with polyethylene hoops placed at one meter intervals, and when completed formed cylinders of the following dimensions: 0.5 × 10 meters. These columns were suspended in the lake from a wooden frame, and samples were collected three times during each experiment, at one meter intervals from the surface to nine meters. In the first experiment, a Van Dorn sampler was used, but in the second experiment a specially constructed sampler, designed to minimize the turbulence produced in the column, was substituted.

Lake samples were collected at the same depths at 2 stations within 3 meters of the position of the columns. The samples from the columns and from the lake stations were placed in 300-ml BOD bottles, 2 light and 2 dark, for each depth. Following the removal of 1 ml of lake water from each sample, 1 ml to a solution containing 0.5 $\mu$C/ml of C-14 as sodium bicarbonate was added. The samples were then incubated at their respective depths for 24 hours, sunrise to sunrise, a period necessitated by our research and teaching schedules. After incubation the samples were filtered through 0.45$\mu$ membrane filters, air dried, glued to planchets, and their Beta activity counted for 10 minutes in a gas flow proportional counter (Beckman-Sharpe Laboratories Low Beta II).

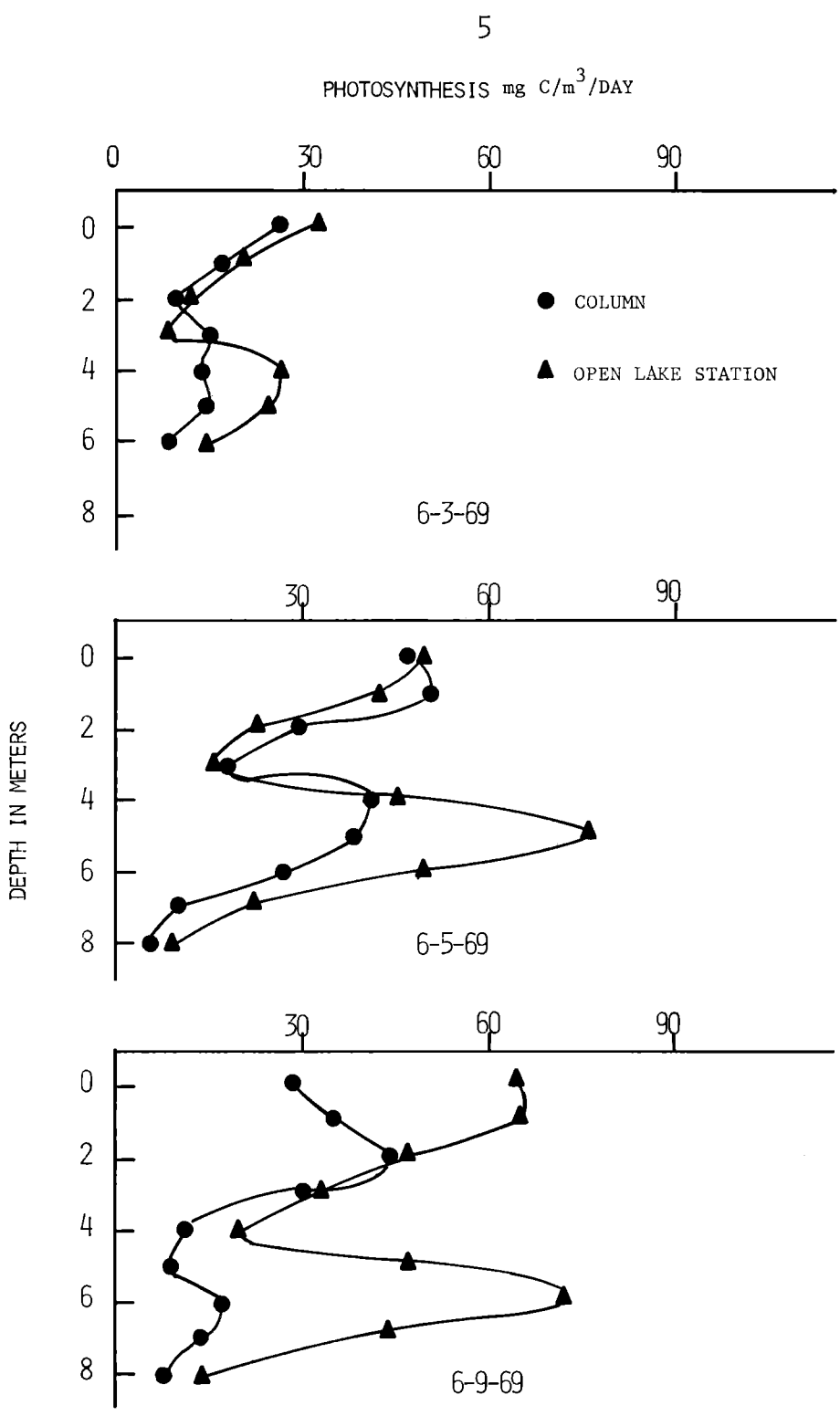


FIGURE 1.—Column versus lake productivity, Third Sister Lake, Michigan (Experiment 1).

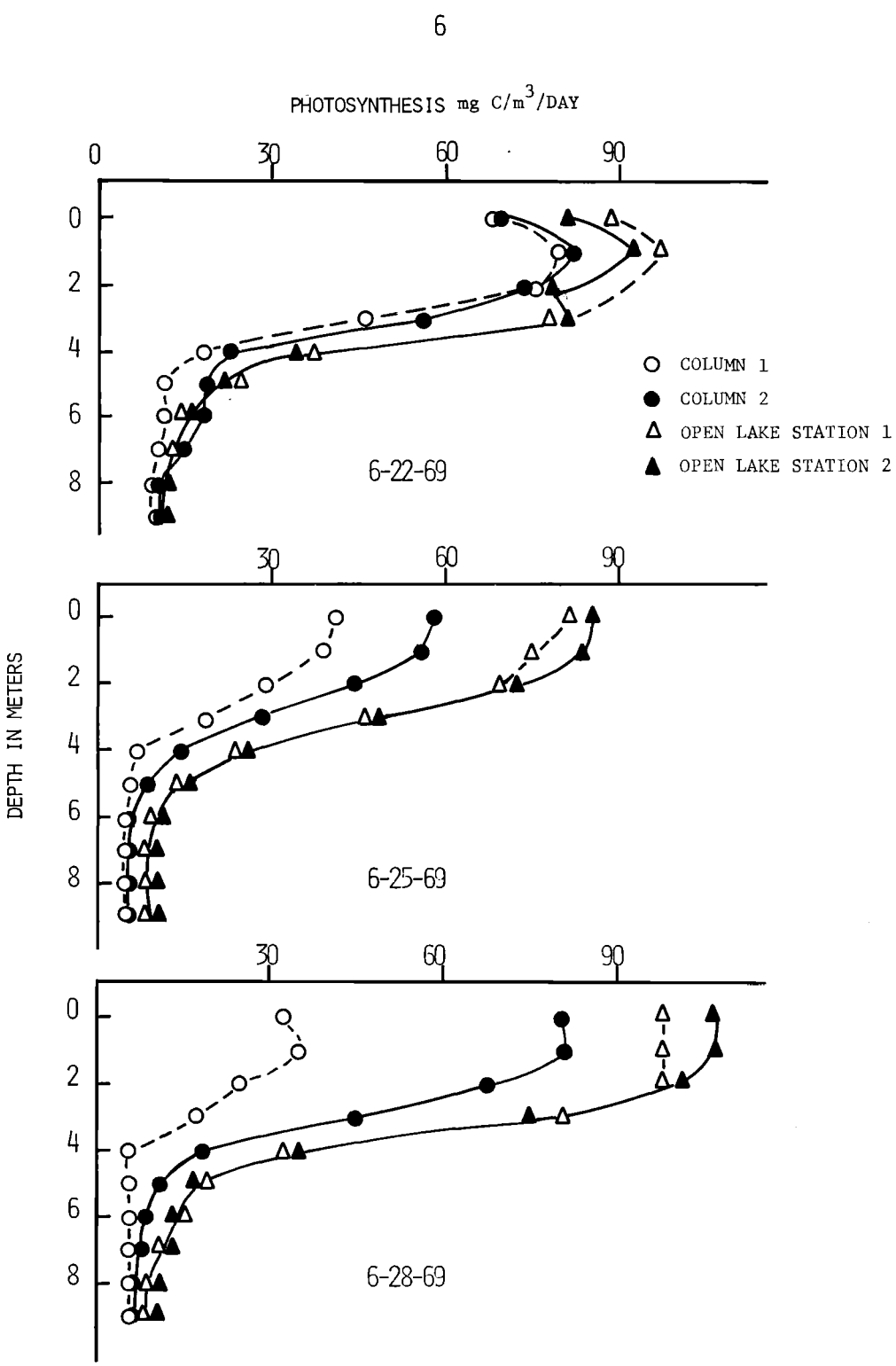


FIGURE 2.—Column versus lake productivity, Third Sister Lake, Michigan (Experiment 2).

TABLE 1.—*Productivity profiles—column versus open lake—Third Sister Lake, Michigan*

| Date | Location | mg C/m²/day |
|---|---|---|
| 6- 3-69 | Column | 101.4 |
| 6- 3-69 | Lake | 107.8 |
| 6- 5-69 | Column | 235.4 |
| 6- 5-69 | Lake | 302.2 |
| 6- 9-69 | Column | 181.4 |
| 6- 9-69 | Lake | 380.3 |
| 6-22-69 | Column 1 | 302.3 |
| 6-22-69 | Column 2 | 337.7 |
| 6-22-69 | Lake sample 1 | 418.5 |
| 6-22-69 | Lake sample 2 | 395.2 |
| 6-25-69 | Column 1 | 127.4 |
| 6-25-69 | Column 2 | 195.3 |
| 6-25-69 | Lake sample 1 | 292.9 |
| 6-25-69 | Lake sample 2 | 306.9 |
| 6-28-69 | Column 1 | 126.4 |
| 6-28-69 | Column 2 | 297.6 |
| 6-28-69 | Lake sample 1 | 413.8 |
| 6-28-69 | Lake sample 2 | 429.6 |

The fixation of carbon by algae within one square meter of the photosynthetic columns, as estimated by the various methods, is shown in Table 1, while Figure 1 shows the results of the first experiment in which only one column was used. Initially, the column and lake profiles were quite similar. However, as the experimental period progressed, the column and lake profiles began to diverge. On the final sampling date the productivity in the column was 181.4 mg/m² as compared to 381.3 mg/m² for the lake. The photosynethetic maxima appear at the same depths in both the lake and column indicating that the populations sampled were distributed similarly although producing at different rates. Figure 2 shows the second trial, in which 2 columns and 2 lake stations were used. Again on the initial sampling date the productivity curves for columns and the lake stations were quite similar, but continued isolation of the water in the columns reduced the quantity of carbon fixed considerably. Also the paired columns diverged from one another while the duplicate profiles from the lake remained very close.

## DISCUSSION

The most plausible explanation for these differences in production, in the authors' opinion, is the reduction of eddy diffusion in the columns. Verduin (1969) mentioned this in his discussion of Kemmerer's data. Another possible explanation could be the attachment of phytoplankton to the sides of the tube. However, such attachment was not visually detectable during the short time period of the experiment. Whatever the explanation, it is obvious from the data presented that the columns cannot be expected to function as miniature lakes for nutrient addition experimentation.

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