
Succession in Net Plankton Populations in a Series of Waste Treatment Ponds[1]

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INTRODUCTION

The purpose of this report is to show some aspects of succession in a planktonic population in a series of ponds which receive a charge of organically-enriched effluents. In such a series of ponds or in a stream, a succession of species may be correlated to time and to estimates of biomass, such as chlorophyll "a" concentration, ash-free dry weight, and population densities. In this report, since much of the data has not been processed, chlorophyll "a" concentration and generic composition will be used to illustrate some aspects of succession.

METHODS

Descriptions of Ponds

Ten ponds were constructed end to end in a series so that water traveled the entire length of the series before being discharged to the receiving stream. The average depth of each pond was approximately 5 feet. Each pond held about 1 day's flow, therefore about 10 days were required for the water to travel through the system.

Methods of Collection and Analysis

Chlorophyll and plankton samples were taken from two stations at approximately 3, 4, 6, 7, 9, and 10 days holding time, and from one station at 1 day's holding time. One hundred milliliter aliquots of a water

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sample were filtered through Millipore filters of 0.45 millimicron pore size for the chlorophyll analysis. The filtrate was extracted in 90% acetone for 24 hours in the dark at about 5 C and centrifuged. Optical density was determined at a wavelength of 663 millimicrons in a Bausch and Lomb Spectronic 20 photoelectric colorimeter. Odum et al. (1958) compared results based on the methods of Richards and Thompson (1952) for cholorphyll "a". They found a straight line relationship to exist, indicating a close correlation between the two methods.

Plankton samples were taken at the same stations with a Kemmerer water bottle and concentrated by pouring through a Wisconsin plankton net of #20 bolting silk. The concentrate samples were preserved in formalin and later examined for generic composition.

RESULTS AND DISCUSSION

Ecological succession is the orderly process of community change (Odum, 1959). A community of simple structure develops toward more complex and mature or stable composition. In terms of diversity, a community develops from low diversity or few species through a series of changes toward the greater diversity of a stable community.

When a plankton community is subjected to a sudden increase of nutrients, different species will be able to take advantage of their respective rates of increase (Margalef, 1961). Since these rates differ widely, a few species will show dominance and a decrease in diversity will result. As succession continues, according to Margalef, diversity increases until a stable value is attained or drops slightly at the end.

The decrease in diversity resulting from an influx of nutrients may be caused by one or more of several factors. When a phytoplankton species increases greatly, it may produce a shading effect, thereby reducing or eliminating other species. Another possibility may be an antibiotic effect of one species of alga upon another. Current effect and other environmental factors may also play important roles in the succession of a community.

As the charge of nutrients becomes tied up in new protoplasm of the dominant species, other species with different rates of increase will occupy the community until the highest level of diversity or stability is attained.

Margalef (ibid) shows parallelism or analogy between changes in diversity at the specific level and also at the biochemical level. As photosynthetic pigments respond to influx of nutrients, chlorophyll "a" concentration will increase at a much higher rate than the other pigments in a planktonic population. In terms of pigment concentrations, as differences increase there is a low diversity, and as differences are reduced, diversity increases toward its normal or stable units. If these two factors are closely correlated or exhibit parallelism as indicated by Margalef, there should be a rapid increase in biomass and a decrease in species composition as organically enriched effluents are discharged into a series of ponds. If the effluent is toxic enough to prevent utilization of available nutrients in the early part of the system, decreases in species composition may be less evident.

Data from 1 August 1961 (Figure 1) are used to illustrate some aspects of succession. At one day's holding time, chlorophyll "a" concentration was 0.293 mg./l. and by 3 days holding time it had increased to 0.787 mg./l. This suggests that nutrients became available between 1 and 3 days holding time and that there was an increase in biomass or total numbers of individuals. *Euglena* sp. increased from 412 to 650/ml. Seven genera were identified at 1 day's holding time with an increase to 10 genera at 3 days.

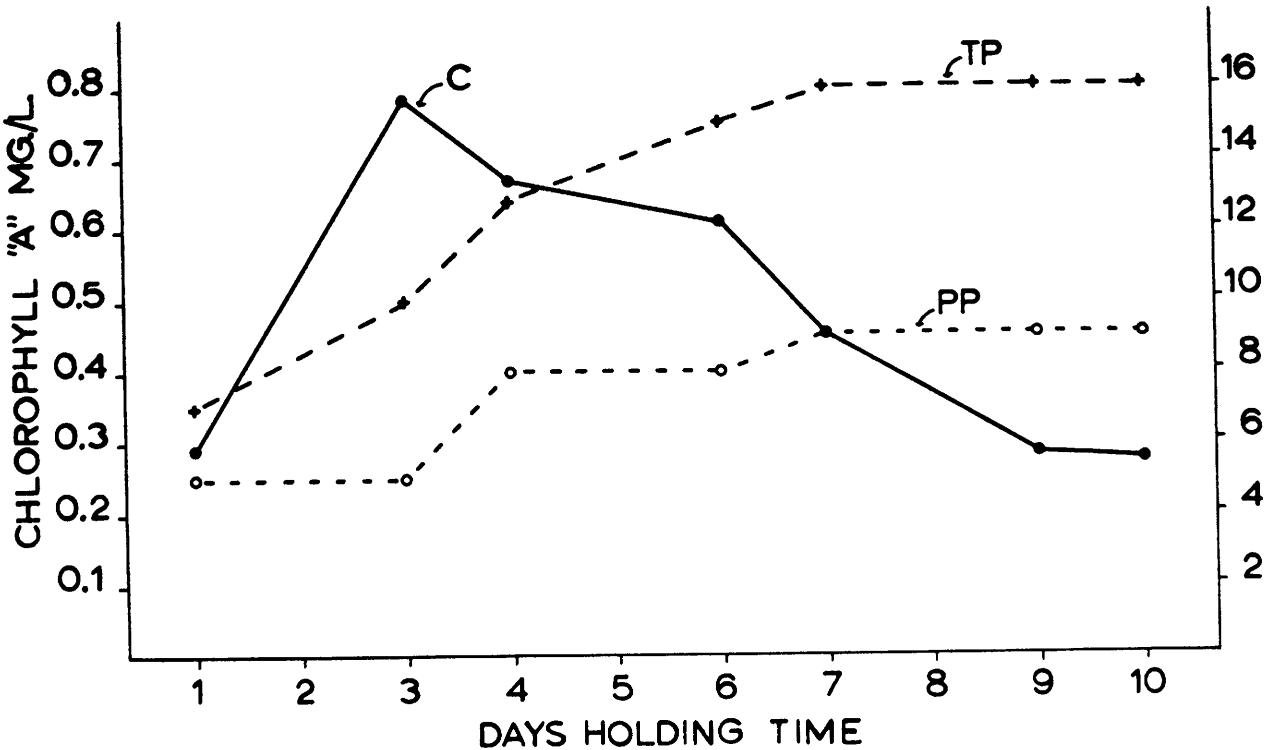

Figure 1. Chlorophyll "a" concentration and numbers of genera plotted against days holding time in a series of waste treatment ponds. TP=Total plankton, PP=Phytoplankton C=Chlorophyll "a".

Although there is an indicated increase in generic diversity, toxic nature of the effluent may have been responsible for an initial, atypical, low generic diversity. Very likely, toxicity decreased during the first 3 days. Phytoplankton genera did not increase but zooplankters increased from 2 to 5 genera during the first 3 days.

At 4 days holding time, chlorophyll "a" concentration decreased to 0.662 mg./l. (Figure 1). *Euglena* decreased to 350/ml., with an increase of 3 phytoplankters. This suggests that there is an increase in the diversity of the pigments, as more genera are able to reappear and compete with the rest of the community; however, these new genera appeared in relatively small numbers.

By 6 days holding time, chlorophyll "a" concentration had decreased only to 0.613 mg./l., but *Euglena* decreased to 200/ml. with no change in numbers of phytoplankton genera. *Eudorina* increased approximately 40 times over the population present at 4 days. This might account for the high pigment concentration. Zooplankters increased by 2 genera. Increase in zooplankters may account for some decrease in the *Euglena* numbers, because of the grazing effect.

At 7 days holding time, chlorophyll "a" concentration decreased to 0.450 mg./l. while the total number of genera increased 1, adding another phytoplankter to the population. The *Euglena* population was reduced to 100/ml.

At the end of the system, 9 and 10 days, chlorophyll "a" concentration decreased to 0.288 mg./l. and 0.275 mg./l., respectively. Total number of genera was 16, with *Euglena* almost disappearing from the population while other genera increased in numbers and biomass. Zooplankton populations were considerably larger at the end of the system.

For the last 6 days holding time there is an increase of 6 genera, which indicates diversity or succession from 3 to 10 days holding time. It is presumed that the decrease in chlorophyll "a" concentration indicates pigment diversity. Since there is a continuous flow of water through the ponds, this may be defined as longitudinal succession as in a stream (Odum, 1959).

Literature Cited

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