Phytoplankton Succession in Lake Valencia, Venezuela

William M. Lewis, Jr.
University of Colorado, Department of Environmental, Population and Organismic Biology, Boulder, CO 80309, U.S.A.

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Abstract

Phytoplankton counts and supporting physical and chemical data were taken on Lake Valencia, Venezuela, over a five-year interval. The data are used to test the validity of a successional paradigm for class-level taxa. According to the paradigm, formulated from previous studies of Lake Lanao, Philippines, and from data on temperate lakes, the order of taxa from early to late succession is: diatoms, chlorophytes, blue-green algae, dinoflagellates. A successional episode is considered to begin when stability of a water column is restored after deep mixing. As the episode progresses, there is a steady decrease in concentration of the limiting macronutrient (in this case, N). In a test of the validity of the paradigm for Lake Valencia, dates of exceptional population increase or decrease were obtained for each taxon. Since nitrate concentration declines steadily as succession progresses, the entry of a given taxon into the successional sequence is indicated quantitatively by the mean nitrate concentration on dates of exceptional increase in population density, and exit from the successional sequence is indicated by mean nitrate concentration on dates of exceptional population declines. The successional position of each major taxon, bounded by its entry and exit in the sequence, can be mapped on the complete spectrum of nitrate concentrations observed in the lake. For Lake Valencia, the nitrate mapping procedure agrees exactly with the predictions based on the successional paradigm. Conformance of Lake Valencia phytoplankton with predictions made a priori suggests that there is a generalized pattern in the phytoplankton succession of the mixed layers of temperate and tropical lakes.

Introduction

The sequential appearance of algal taxa in plankton environments has been termed phytoplankton succession, which is considered to have certain features in common with biological succession in other kinds of environments (Margalef, 1958, 1967). Despite general agreement on the importance of succession in phytoplankton communities, numerous aspects of phytoplankton succession are as yet not well understood (Hutchinson, 1967; Reynolds, 1980). Treatments of phytoplankton succession are too often largely descriptive and too often rely on a posteriori reasoning to explain associations and trends. While description is essential, analysis of succession should incorporate more statistical and experimental approaches. For statistical approaches, it is especially desirable that a priori hypothesis testing be used to establish the validity of specific concepts related to succession. The present paper describes phytoplankton abundance patterns in Lake Valencia, Venezuela, and uses the information to test hypotheses formulated a priori concerning phytoplankton succession.

The Lake Valencia data span a five-year interval over which phytoplankton counts are available for all autotrophic taxa found in the growth zone of the lake. The phytoplankton data are supported by concurrent physical and chemical data. The present analysis focuses on the existence of patterns in the
abundance of class-level taxa. This type of analysis will yield a null result unless classes contributing to the phytoplankton have a certain amount of ecological coherence, i.e., unless species of a given class are more likely to respond in a similar manner than species of different classes. Ecological coherence is expected in view of the shared morphology and physiology of the members of a class, and has been demonstrated statistically for at least one lake (Lewis 1977).

Methods

The phytoplankton samples were taken at a mid-lake station between January 1977 and October 1981 (Fig. 1). Samples were taken weekly in 1977 and 1978 and biweekly thereafter. On each sampling date, an integrating sampler of the type described by Lewis & Saunders (1979) was used to collect successive 5-m increments of water from the top to the bottom of the water column (35 m). This sampling strategy assures that concentrated layers of phytoplankton will not be missed. Although the vertical distributions of the phytoplankton are known from counts of successive samples over the vertical profile, the present analysis deals only with the average abundance of phytoplankton between 0–15 m depth.

Phytoplankton samples were preserved in the field with Lugol’s solution. Counts of each sample were made with an inverted microscope following sedimentation in a 5-ml chamber. Counting methodology was as described by Lewis (1978a). Care was taken to count all autotrophic cells regardless of size. Cells as small as 0.7 μm in diameter were routinely counted. Fluorescence microscopy showed that all autotrophic cells were being counted by the inverted microscope method.

Individual cells were counted except for filamentous species, which were quantified by length, and a few colonial species with exceedingly high numbers of cells per colony, which were counted as colonies. Numerous measurements were made of

Fig. 1. Outline map of Lake Valencia showing the location of the main sampling station from which the phytoplankton samples were taken.