FACTORS AFFECTING CHANGES IN INVERTEBRATE COMMUNITY STRUCTURE IN BEAR LAKE

Don C. Erman
Utah State University
Logan, Utah

Abstract: Recent studies on Bear Lake, Utah, indicated changes in plankton and nutrient levels in some shallow areas. A study of the littoral bottom invertebrates was initiated to determine possible differences in some communities. The study showed that some areas were affected by apparently eutrophic changes near shore and breakwaters. The most important environmental influences were increased amounts of silt and clay, organic matter, and consequent decreased concentrations of oxygen near the bottom.

INTRODUCTION

The purpose of this study was to investigate the factors affecting littoral invertebrate community structure in Bear Lake, Utah-Idaho. Bear Lake is a typical oligotrophic lake--clear, cold, and usually saturated with dissolved oxygen. It lies at an altitude of 5,923 feet. By most standards Bear Lake would appear as an undeveloped lake. Since early settlement by Mormon pioneers the gentle sloping hills on the western side were cultivated and used for livestock grazing. Residential development is also located along the western shoreline and a number of resorts and motels are scattered on each side of the main town of Garden City.

Recent studies on the lake have found changes in nutrient levels and phytoplankton in some littoral areas on the west side (Nyquist 1967). I sampled invertebrate communities to detect any differences along the western shore. Invertebrate communities are useful indicators of trophic status as well as eutrophication (Jonasson 1969). Invertebrates in Lake Erie gave some of the first evidence of organic pollution especially in benthic communities near enriched incoming streams and near population centers (Beeton 1965, 1969).

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METHODS

Three areas along the western shoreline were selected for sampling of littoral benthic invertebrates. Area A was located at a breakwater near Garden City. Area B was approximately 4 miles south of A and also at a breakwater. Area C was 4 miles south of B where there was neither breakwater nor human development. Six stations were sampled at each area on two transects perpendicular to the shoreline. Stations were apportioned evenly at depths of approximately 5, 10 and 15 feet. Two Ekman dredge samples (total area 452 cm^2) were taken at each station in June and August 1967. Measurement of selected environmental factors were made at the same time (oxygen near the bottom, temperature, organic matter, silt and clay percentage, median particle size of the sediments).

To facilitate an objective analysis and comparison of the 18 stations for the two sampling periods (June and August), I used a technique of community ordination (Erman and Helm in press). Ordination is a graphical arrangement of communities along axes corresponding to dominant ecological factors (Goodall 1954). These methods are used more often in vegetation analysis (Greig-Smith 1964) than in analyzing animal communities.

Relative importance of the invertebrate species was determined by dividing the estimated amount of exygen consumed by one species at a station by the amount of oxygen consumed by all species at a station. The basis for this relationship was developed elsewhere (Erman and Helm 1970; Erman and Helm in press).

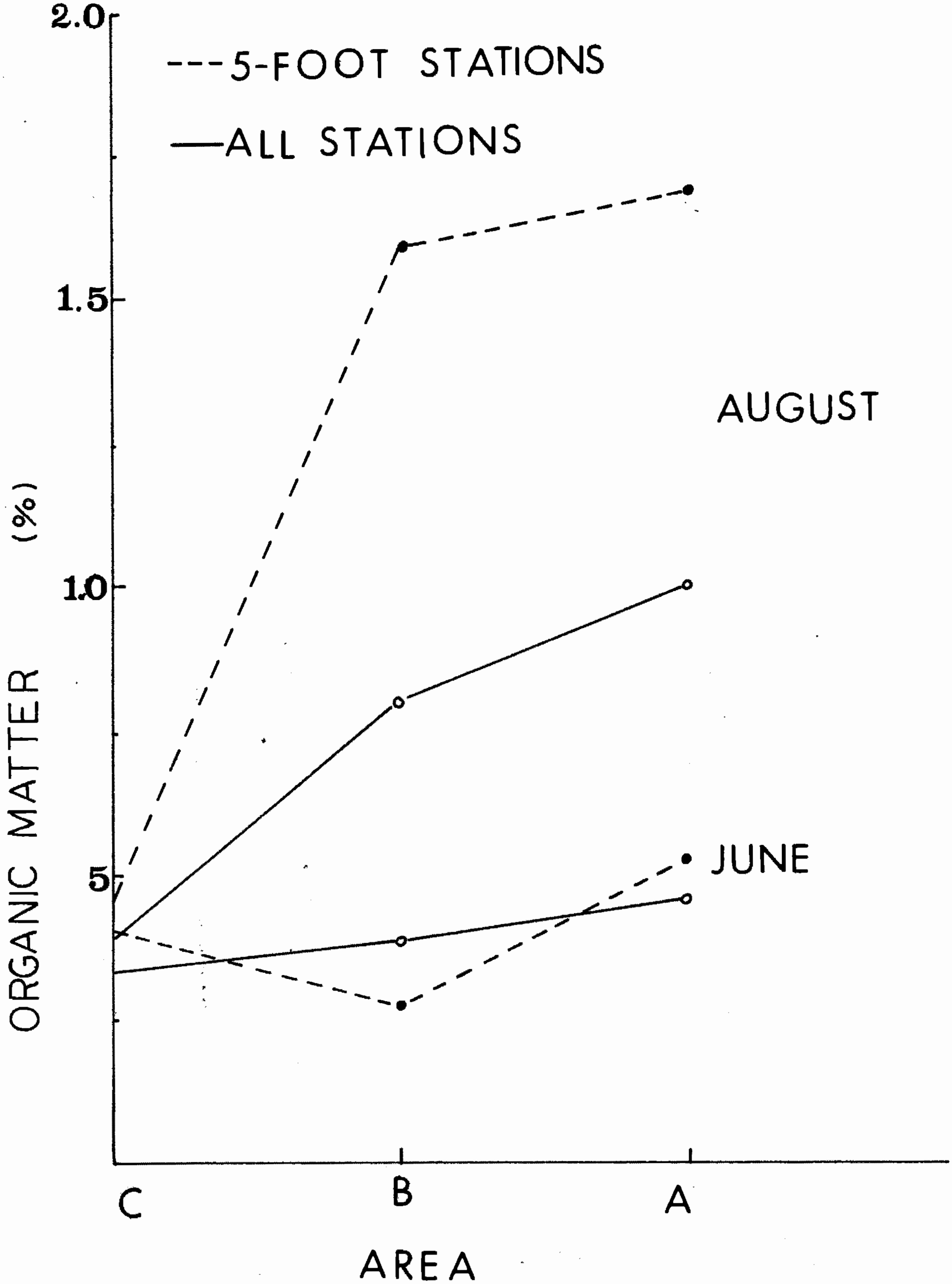

Figure 1. Trend of increasing organic matter from area C to A.

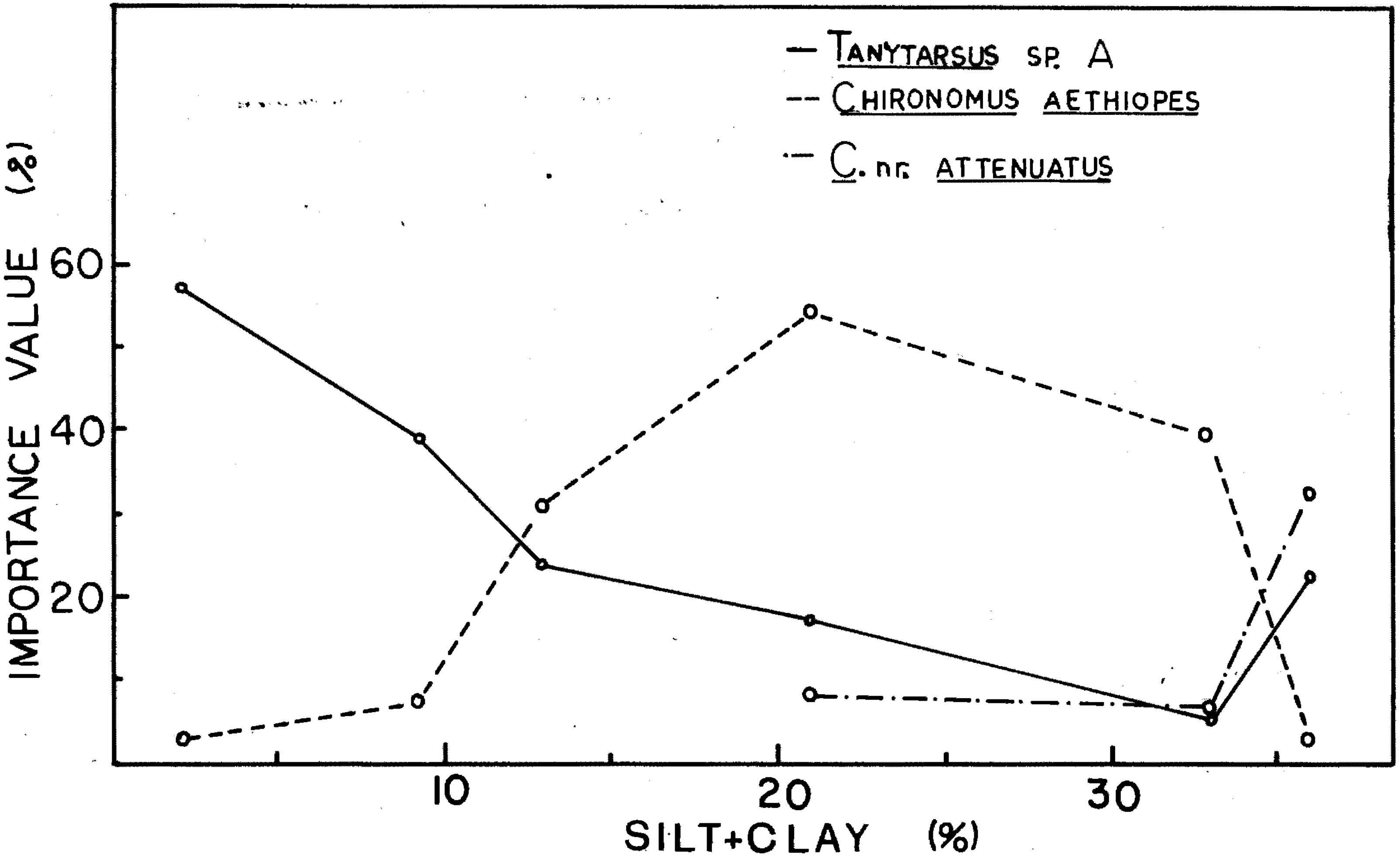

Figure 2. Relationship of three chironomid larvae to the percentage of silt and clay.

MAJOR FINDINGS AND CONCLUSIONS

Results obtained from the analysis in June showed definite relationships among the environmental factors. The amount of silt and clay, organic matter, dissolved oxygen near the bottom, and the median grain size of the sediments were all correlated. The areas were different in relation to these environmental factors. There was a slight trend of increasing organic matter from C to A (Figure 1). Stations associated with higher amounts of organic matter showed the greatest dissimilarity to other stations. The stations showing differences were primarily at areas A and B where breakwaters affected current and sediment composition.

A small (3.0 mm), larval chironomid Tanytarsus sp. A was the dominant invertebrate in the littoral zone samples (mean relative importance 51.2%). Tanytarsus is considered an indicator of oligotrophic conditions (Brundin 1958). Differences in the relative importance of this species were largely responsible for differences in the communities in the ordination graph. It appeared that changes in Tanytarsus sp. A were a function of eutrophying influences--accumulating fine sediments, organic matter and decreasing oxygen concentration near the bottom.

Conclusions about community differences and environmental relationships were strengthened by the ordinations in August. Correlations among environmental factors and between ordination axes and environmental factors were higher in August than in June. The trend of increasing amounts of organic matter from area C to A was accentuated in August (Figure 1). The 5-foot stations in particular, showed increases over the amounts in June.

The relative importance of Tanytarsus sp. A was reduced in August (mean 33.0%) although it was still the dominant species at most stations. Other changes in community structure were typified by the relative importance of two other larval chironomids--Chironomus (Dicrotendipes) aethiopes and C. (Chironomus) near attenuates. These three species formed a series of overlapping response to increasing amounts of silt and clay and probably organic matter and oxygen concentration near the bottom (Figure 2).

The first three ordination axes were related, in order, to Tanytarsus sp. A, C. aethiopes, and C. nr. attenuatus and described oligo-, meso-, and eutrophic conditions. This conclusion was based more on species response to oxygen tension near the bottom than on actual production or trophic lake types.

Thus, it appeared that even a relatively undeveloped oligotrophic lake such as Bear Lake showed unusual changes in invertebrate community structure following settlement and agricultural development along one shoreline. Such changes would be expected from eutrophication and would appear first in the littoral zone, especially when areas are isolated from lake dynamics. These areas would serve as monitors of trophic status and provide a possible preview of events in the lake as a whole.

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