Invited Abstract

MICROBIAL PROCESSES INVOLVED IN NUTRIENT AND ENERGY FLOW THROUGH THE BASE OF THE FOOD WEB IN LAKE ERIE

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How are sunlight, carbon dioxide and inorganic nutrients converted into fish food? Research during the past decade has increased awareness of the significance of the microbial food web (MFW) in the transfer of nutrients and metabolic energy through the base of the food web in Lake Erie plankton communities. Recent research questions the views traditionally held regarding energy and nutrient dynamics in plankton communities, points to the need to identify as yet unrecognized prokaryotic species, and identifies new questions that need to be addressed. These changes are likely to alter the direction of management and management-oriented funding agencies, as they seek to identify indicators of ecosystem and community health.

The traditional, Lindeman-esque view of energy dynamics considers that because phytoplankton photosynthesis is virtually the sole source of metabolic energy, phytoplankton alone are significant carriers of energy to be delivered to higher trophic levels primarily through grazing by large-bodied microcrustaceans (grazing food chain, GFC). What photosynthate may be released from phytoplankton as dissolved organic carbon (DOC) is viewed as lost from availability to higher trophic levels, being respired by bacteria. Recent techniques have led to a series of investigations that question the universality of this view. Radiometric techniques have permitted a comparison of the rate of phytoplankton production, estimation of the portion of photosynthate released as labile DOC, and the rate of bacterial production in these communities. The advent of epifluorescence microscopy and fluorometric techniques has allowed enumeration of bacteria, estimation of the portion of bacteria that are alive (i.e. respiring), identification of bacterivorous predators (e.g. protists and rotifers), and estimation of the rate of bacterivory. Taken together, these studies indicate that alternate pathways of energy flow through the MFW may be significant and rival the energy flow through the traditional GFC in certain habitats and under certain conditions.

Energy flows from phytoplankton through both the GFC and MFW, but these two pathways are not equally efficient. The efficiency of energy transfer through the MFW and the factors that control it are poorly understood. Most likely, the efficiency of energy transfer through the MFW is lower, possibly much lower, than transfer through the GFC because of the multiple trophic links through which energy passes in the MFW. Therefore, the relative efficiency of energy transfer from phytoplankton to zooplankton required an accounting of the relative amounts of energy passed through the GFC and the MFW. Recent studies in Lake Erie indicate that the MFW is more important in

communities containing phytoplankton that are poorly grazed by microcrustaceans (e.g. communities dominated by cyanobacteria), and it is more important in offshore than in nearshore communities. Nearshore and offshore communities differ in taxonomic composition, seen from denaturing gradient gel electrophoresis (DGGE) analysis of polymerase chain reaction (PCR) amplified rDNA genes, but the identity of these taxa is largely unknown, and the significance of these taxonomic differences is not clear.

These findings indicate that future research on Lake Erie needs to concentrate on issues related to the structure and function of the MFW, especially as they may change along a nearshore-to-offshore axis. Many fundamental questions need to be addressed. Bacterial taxa, their distribution and abundance, and the factors that control their population size and growth rates need to be examined. Of particular importance is a continued evaluation of the relationship between phytoplankton production and bacterial production. Management scenarios need to re-focus from phytoplankton production per se and focus instead more broadly on the efficiency of energy flow from phytoplankton to zooplankton. Related to this, research needs to identify those factors that alter the ratio of energy flowing through the GFC and the MFW. Accordingly, management agencies and management-oriented funding agencies need to focus their efforts on activities in the MFW, and those factors that may alter bacterial activities (e.g. bacteriophage, organic eutrophication) and rates of bacterivory.