THE ECOLOGY OF WASTE STABILIZATION PONDS

by

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SUMMARY

Ecological interactions were studied in two waste stabilization ponds at Gumeracha, South Australia, to relate the dynamics of the major organisms present to effluent quality and, therefore, the efficiency of pond function. The roles of those organisms in algal control, the stabilization of organic material, and nutrient removal were evaluated to assess their usefulness as tools for the management of WSPs. In this manner, biological principles for pond management were evaluated.

The seasonal dynamics of the phytoplankton were related to effluent quality. Phytoplankton blooms were triggered by increasing water temperature and resulted in a significant decrease in effluent quality. Effluent concentrations of BOD, SS, TOC, and organic nitrogen exceeded influent values during phytoplankton blooms. Removal of soluble PO$_4$-P and NO$_3^-$ was highest during phytoplankton blooms. Estimated annual net production of the phytoplankton in pond 2 represented a nutrient store equivalent to over 100% of total nitrogen and total PO$_4$-P retained annually. The dynamics of filamentous algae (Cladophora) and the submerged macrophyte Potamogeton ochreatus were related to phytoplankton abundance and effluent quality. Floating algal mats and submerged macrophytes inhibited the development of phytoplankton blooms and improved effluent quality. Estimated annual net production of Cladophora in pond 1 represented a nutrient store equivalent to 47% of total PO$_4$-P and 12% of total nitrogen retained in the pond annually. Annual net production of P. ochreatus represented less than 3% of total PO$_4$-P and total nitrogen retained annually.

The population dynamics of the major zooplankton were related to phytoplankton abundance and effluent quality. Although temperature was the major factor determining the occurrence of zooplankton, competition and predation also appeared to be important in structuring
were terminated by zooplankton grazing. The dominant herbivore, *Daphnia carinata*, was a cold water form. High water temperatures increased mortality and reduced the growth rate of *D. carinata* and prevented it from controlling phytoplankton during the summer. The dominant zooplankter during phytoplankton blooms was the carnivore *Mesocyclops leuckarti*. *D. carinata* was a "facultative browser" and ingested the sediments during periods of low phytoplankton abundance. *D. carinata* and *Simocephalus exspinosus* were both food limited at high population densities. Total annual net production of *D. carinata* in pond 1 during 1977 (345 g dry weight/m²), calculated using the population turnover-time model, was the highest yet recorded for any planktonic cladoceran. Annual net production of *D. carinata* determined using the population turnover-time model exceeded annual production determined using the biomass turnover model by 100%. Overestimation of daily production rate was highest during periods of high egg mortality. Total annual net production of *D. carinata* (biomass turnover model) represented a nutrient store equivalent to less than 5% of total P₀₄-P and total nitrogen retained in the ponds annually.

A fish introduction experiment was conducted in enclosures within the ponds. *Carassius auratus* had no significant effect upon phytoplankton and zooplankton populations or on effluent quality. Growth of *C. auratus* increased after introduction to the pond despite decreasing water temperature. Annual net production of *C. auratus* was high compared to fish production in natural waters but probably represented a nutrient store equivalent to less than 2% of total P₀₄-P and total nitrogen retained in the ponds annually.

Filamentous algae and zooplankton (to a lesser degree) are useful for controlling unicellular algae in waste stabilization ponds. Harvest of unicellular algae is the most effective pathway of nutrient
removal, but reasonable removal could be achieved using filamentous algae. The harvest of submerged macrophytes, zooplankton, and fish is not useful for nutrient removal.