THE OCCURRENCE OF CHROMATIACEAE IN WASTE TREATMENT LAGOONS AND THEIR UTILISATION TO TREAT FELLMONGERY EFFLUENT

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ABSTRACT

A study of the occurrence of Chromatiaceae in waste treatment lagoons was made. To determine the important factors leading to their dominance, an investigation of the effect of various environmental parameters on the growth of a Chromatium species was made.

Chromatium minutissimum was isolated and identified from an anaerobic lagoon treating meatworks effluent. An experimental design was used to screen the effects of temperature, pH, sulphide and acetate concentrations and light intensity on the batch growth of this bacterium in pure culture. Empirical models were developed which described the maximum population and the exponential growth rate as a function of these variables. Comparison of these models with lagoon data indicated that they provided a conservative estimate of the exponential growth rate and maximum population under lagoon conditions and that, under the range of environmental conditions expected in New Zealand, the hydraulic retention time is of major importance in limiting the development of this phototrophic bacterium in lagoons. The developed models may possibly be used to characterise the growth of other Chromatiaceae.

To study the growth of the Chromatiaceae in mixed culture various lagoon samples were incubated in daylight. A succession from anaerobic non-phototrophic bacteria to phototrophic bacteria to algae was observed in these batch cultures. Thus, in addition to low hydraulic retention times preventing the growth of the Chromatiaceae, competition from the algae precludes their dominance at longer retention times.

Seven lagoon systems in which the Chromatiaceae were known to occur were then investigated. The lagoons studied ranged from facultative to anaerobic. The wastes treated varied from domestic sewage to strong industrial and agricultural effluents. A succession from non-phototrophic anaerobes to Chromatiaceae to algae was observed in many instances and a three stage succession theory was formulated.

This theory was used to explain the occurrence of the Chromatiaceae in all the lagoon systems studied and it may be used to design lagoons in which the dominance of the Chromatiaceae is favoured or prevented.

The study of the lagoon systems indicated the potential of the Chromatiaceae for treating effluents containing reduced sulphur compounds. In N.Z., fellmongery effluent is the most important sulphide-bearing effluent. Experiments were therefore performed to develop criteria for the design of anaerobic lagoons using the Chromatiaceae to treat fellmongery effluent. Experiments were conducted to determine the effects of temperature and sulphide concentration on the performance of .088 m^3 laboratory lagoons, in which Thiocapsa roseopersicina was dominant, treating a synthetic fellmongery effluent. Temperatures from 10°C to 25°C and influent sulphide concentrations of 200 mg/l to 1,500 mg/l were studied. Good treatment was obtained under a wide range of conditions although inhibition of growth occurred at influent sulphide concentrations of approximately 900 mg/l. Concentrated fellmongery effluents may therefore be treated by these lagoons. COD removals varied from 66.1% - 87.1% and sulphide removals from 89.5% - 98.4%.

Design equations which described the performance of the laboratory lagoons were developed. To confirm the accuracy of these equations, pilot scale experiments were conducted on a 5.74 m^3 lagoon system treating actual fellmongery effluent. A good degree of treatment was again achieved and the laboratory-developed equations provided a good estimate of the pilot-scale effluent over the range of conditions studied. Suitable criteria have therefore been developed for the design of anaerobic lagoons using the Chromatiaceae to treat fellmongery effluent.

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