MODELING ENTERIC BACTERIAL DIE-OFF: A REVIEW

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(Received March 22, 1985; revised June 17, 1985)

Abstract. To protect surface and groundwater resources from enteric bacterial pollution, management practices must be devised based on a sound knowledge of the fate of these organisms in the environment. Areas covered in this article include the effects of physical and chemical characteristics of the environment, mathematical modeling approaches of bacterial die-off and a summary of past investigations of bacterial die-off in storage systems, soil and fresh/sea water environments. The greatest need for future research efforts was shown to be in determination of the relationships of environmental and physical parameters to bacterial survival so that the literature data could be unified.

1. Introduction

Contamination of surface and groundwater resources by pathogenic bacteria and viruses poses a potential health hazard where waste materials are applied to the land or discharged to watercourses. Determination of the die-off or inactivation of these organisms in the environment is therefore of critical concern if management practices are to be developed to minimize the contamination. The transport and reduction of enteric bacteria can be viewed as consisting of several unique pathways outlined in Figure 1. Common to all these cycles is the die-off of bacteria in storage units prior to

![Diagram](image-url)

Fig. 1. Pathways for transport removal of bacteria in the environment.

Journal Paper No. 6699, Oregon Agricultural Experiment Station, Corvallis, Oregon; Project 907. This work was supported in part by a grant from Tillamook Soil and Water Conservation District — USEPA.

treatment or land application, on and in soil or water following application or discharge and in runoff or groundwater following dislocation from the soil surface. The number of enteric bacteria lost from the soil system into the aquatic environment is therefore a function of (a) die-off, (b) infiltration and (c) pickup and transport mechanisms from the soil surface. The purpose of this review is to investigate the die-off of enteric bacteria and propose a model to unify the data reported by many studies in the past.

2. Factors Affecting Enteric Bacterial Survival

The die-off of enteric bacteria in the environment is controlled by many factors, a partial list of which is presented in Table I.

| TABLE I |
| Important variables affecting the survival of enteric organisms in the environment |

I. The organism and its physiological state

II. The physical and chemical nature of aquatic or soil system
   a. pH
   b. porosity
   c. organic matter content
   d. texture and particle size distribution
   e. elemental composition
   f. temperature
   g. moisture content
   h. adsorption and filtration properties
   i. availability of nutrients

III. Atmospheric conditions
   a. sunlight
   b. moisture (humidity and precipitation)
   c. temperature

IV. Biological interaction of organisms
   a. competition from indigenous microflora
   b. antibiotics
   c. toxic substances

V. Application method
   a. technique (surface or incorporated)
   b. frequency of application or discharge
   c. organism density in waste material

To summarize the literature as to the effect of these parameters is beyond the scope of this review and would only duplicate the efforts of many previous investigators. Reviews on this topic have been written by Burge and Marsh (1978), Dunlop (1968), Ellis and McCalla (1978), Gerba et al. (1975), Krone (1968), Lance (1976), Menzies (1977), Mitchell and Starzyk (1975), Morrison and Martin (1977), Van Donsel et al. (1967), Rudolfs et al. (1950) and Reddy et al. (1981). In general the factors of temper-