ON THE OCCURRENCE OF PROTOZOA IN LAND-FILTERED SEWAGE EFFLUENT

It has been shown that certain ciliate protozoa, particularly Vorticellids, are of special significance in the Activated Sludge Process and other artificial systems of sewage purification, and that these protozoa in the sewage tanks are originally derived from soil.[1-10] Further observations carried out during the last four years at

Madura (South India) have shown that these protozoa naturally develop in large numbers in the land-filtered sewage effluent and from an important link in the chain of life processes in the medium. The practice of land-filtration of sewage and the soil conditions at Madura, the mode of development of the protozoa in the effluent and related aspects are briefly described below.

Madura has now a population of about three and a half lakhs, and the sewage from more than half the population is discharged into the municipal sewers. The daily discharge of sewage from this population is about three million gallons, including a comparatively small quantity of liquid waste from the textile mills. About two million gallons of this volume of sewage is daily filtered, without any pre-treatment, on an area of about 113 acres of gently sloping land in the neighbourhood of the city. The soil is fairly porous and the efficiency of the soil drainage is maintained by having underdrains and also by periodically removing the sewage matter accumulating on the soil surface.[11] The underdrains consist of earthen pipes loosely jointed and laid in rows at a depth of 3 to 4 feet, the distance between two rows of pipes being about 33 feet. The bulk of the land-filtered liquid, which is fairly clear, flows down through these pipes into a specially constructed effluent channel. The effluent from this channel (the quality of the effluent generally conforms to the Royal Commission Standard) is finally utilised along with irrigation water for agricultural purposes. The land filtering the raw sewage is also cultivated and the principal crop grown is guinea grass which yields very well (about 120 tons per acre per year).

On either side of the effluent channel, as also attached to certain green algæ, may be seen large whitish fluffy masses of Vorticellids which are composed of a number of species of *Carchesium* and a few species of *Epistylis*. The dominating forms are the species of *Carchesium* and one of the commoner species is *Carchesium epistylis* Cl. & L. (Figs. 1 and 2). Species of the simple *Vorticella* and other ciliate protozoa, such as *Paramœcium*, also occur in the effluent. Along with the protozoa, worms, insect larvæ, especially those of

FIG. 1. Photomicrograph of a Colony of *Carchesium epistylis* Cl. and L. occurring in the land filtered sewage effluent at Madura. × 75.

FIG. 2. An individual of *C. epistylis* Cl. and L. enlarged × 350.

Chironomus sp., prawns, crabs, gastropods, frogs, fish and other forms also flourish.[11]

The protozoa and other fauna develop in large numbers in the effluent in all seasons of the year unless sewage irrigation is stopped for unduly long periods, as under the conditions of excessive and continual rains, when they slowly disappear; but when the sewage application is resumed, the fauna also gradually develop. Thus during October-December 1946, when sewage irrigation was stopped due to unusually heavy rains, from 30th October to 20th November and again from 30th November to 19th December, the protozoal growths and other fauna, particularly the fish, were largely absent from the effluent, but reappeared when sewage irrigation was continued.

We have made a similar observation in regard to the development of protozoa in the Activated Sludge tank, *viz.*, if aeration of sewage is continued without any fresh supply of raw sewage, the protozoa cease to multiply and become inactive and eventually disappear, presumably because of the lack of nutrients from raw sewage. In this connection it is of special interest to observe that examination of activated sludge from the purification plant at Bangalore over a period of several years has not revealed the presence of any species of *Carchesium*, while there is always a preponderance of *Carchesium* sp. in the land-filtered sewage effluent at Madura. The significance of this observation is still under study.

The occurrence of *Carchesium lachmanni* in oxidising filters was reported many years ago by Boyce.[12] Fowler[13] observed this protozoan in the effluents from the contact beds and percolating filters at Davyhulme, Withington and Gorton Sewage Works (Manchester). Recently Lloyd[14] has drawn attention to the more important ciliate protozoa occurring in percolating filters and these forms include *Carchesium, Vorticella, Epistylis, Opercularia, Aspidisca* and *Chilodon.*

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