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Role of Protozoa in the Aerobic Purification of Sewage

DURING recent years, there has been increasing amount of evidence regarding the importance of protozoa in the aerobic purification of sewage[1–4] and, more recently, some quantitative observations on protozoa in determining the condition of sludge and quality of effluent have been recorded[5–10]. The evidence so far obtained has, however, been only indirect, chiefly owing to the difficulty in separating the protozoa from the associated bacteria. This has now been achieved and the object of this note is to show that the isolated protozoa can bring about practically all the changes associated with the purification. The part played by the bacteria is almost negligible.

We isolated the protozoa (Epistylis sp.) by first washing a part of the mucilaginous masses (adhering to the sides of the activation sludge tank) repeatedly on the centrifuge with the necessary precautions. A few living cells were then selected after microscopic examination. They were inoculated into vessels containing a sterilized, thin decoction of fæcal matter and vigorously aerated. After the sludge was built up, a fresh careful selection of cells was made. This operation was repeated a number of times until the associated bacteria (usually mechanically carried on the mucilage) were eliminated and the medium consisted exclusively of the active protozoa. The protozoa required fresh quantities of organic matter, together with liberal supplies of air, and so long as these were provided, there was no difficulty in maintaining them in an active condition.

That the isolated protozoa are at least as active as the normal activated sludge in the purification of sewage is shown by the following comparative study with sterilized raw sewage.

COMPOSITION OF THE EFFLUENT OBTAINED AFTER AERATION FOR 24 HOURS (IN PARTS PER 100,000).

	Raw sewage at start (control)	Activated sludge	Protozoa (*Epistylis* sp.)	Mixed bacteria
Oxygen absorbed from permanganate in 3 min.	1·87	0·26	0·21	1·23
,, in 4 hours	4·16	0·51	0·41	3·95
Free and saline ammonia	2·46	0·62	0·57	1·98
Albuminoid ammonia	1·02	0·20	0·12	1·00

Further evidence is available to show that the conditions affecting the life and activity of the protozoa also affect the efficiency of the purification. There is practically no sludge formation or clarification when (*a*) the medium is selectively heated to about 50° C. so as to inactivate or kill the protozoa; (*b*) partial sterilizing agents (dyes such as methylene blue and acridine yellow which act selectively on protozoa) are introduced; (*c*) Chironomus larvæ which primarily destroy the protozoa are introduced; (*d*) fermenting yeasts, which are inimical to the protozoa, are added. The necessity for steady addition of fresh organic matter and also adequate aeration—both of which are essential to the protozoa—are too well known to require repetition.

Examination of sludges from activated sludge and other aerobic systems of treatment from various parts of India have revealed the presence and active functioning of protozoa wherever the purification is proceeding satisfactorily. If the protozoa are absent or found dead or encysted, there is no purification.

Starting from the investigations of Russell and Hutchinson on soil sickness and partial sterilization of soil[11], there has been a general tendency to regard protozoa as being inimical to the useful aerobic bacteria and aerobic processes in general. The earlier observations of Fowler and other workers[12–15] in the field of aerobic purification of sewage also pointed in the same direction. Evidence on the other side has, however, been steadily accumulating, so that with these and the conclusive evidence now reported, it can be stated that aerobic purification of sewage is essentially due to the protozoan activity. Bacteria play only a secondary part.

Further evidence on the phenomenon of flocculation by protozoa has already been adduced by other workers. Hardin[16] has recently demonstrated the flocculating activity on the part of the ubiquitous freshwater and soil flagellate, *Oikomonas termo* Kent. Watson[17] has recorded that the soil ciliate, *Balantiophorus minutus*, shows a similar ability to cause flocculation to that reported for *Oikomonas termo* and for Epistylis and Vorticella.

There are still some outstanding problems such as the mechanism of flocculation by protozoa and their exact role in the production of sludge having a high fertilizing value and in the related oxidation changes. These and related aspects are now being studied and will form the subjects of later communications.

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