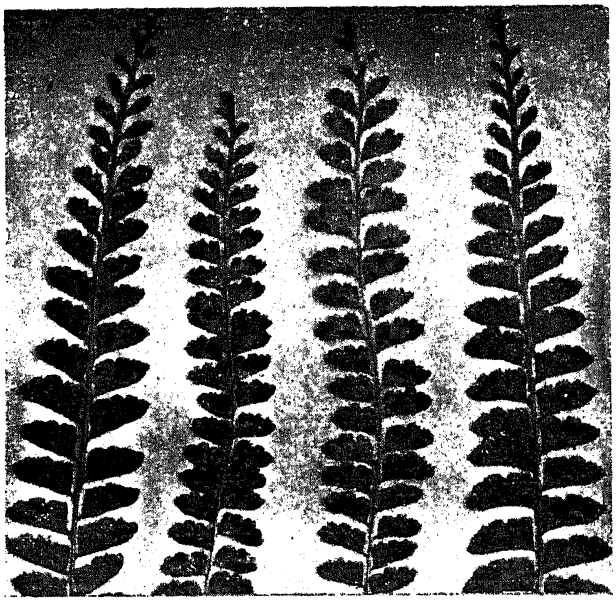
a sort of compact, dark brown to black, circular stroma outside, thus blocking the pore. A large number of stomata are found to be blocked by these stromata.



Infected leaves of *Lindsaya cultrata* showing spots due to the mycelial fungus *Ectrostoma*

No spores of any kind could be found. So the fungus may be provisionally placed in the group *Mycelia sterilia* of the *Fungi imperfecti*. As it is maculiform and produces black stromata on the leaves it is probably some species of *Ectostroma*. A fuller description of this fungus together with its specific determination will appear elsewhere.

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THE FUNCTION OF PROTOZOA IN THE ACTIVATED SLUDGE PROCESS

It is now generally recognised that the occurrence of certain forms of protozoa in the activated sludge tank is closely associated with the efficiency of the process of purification. It has also been conversely observed that, as the protozoa either diminish in numbers or occur encysted due to deficiency of aeration or other unfavourable conditions, sludge formation is poor and the resulting effluent unsatisfactory. Richards and Sawyer[1] reported that, in so far as the protozoa kept down the bacterial numbers they might be regarded as detrimental to the purification. They found, however, that the increase in bacterial numbers following suppression of protozoa by partial sterilization produced no improvement in the purification of sewage; on the contrary, both carbon and nitrogen 'fermentations' were seriously retarded. Furthermore, there was a change in bacterial flora, nitrifying organisms being suppressed by the treatment. Cramer[2] observed that, after reaching a certain stage of development, the protozoa die and disintegrate thus affording food for bacteria.

With a view to obtaining some direct information regarding the part played by protozoa, both singly and collectively, in activated sludge, a series of experiments were carried out isolating several prominent strains and by inoculating them in different ways into experimental bottles containing equal quantities (1½ litres) of sterile raw sewage (prepared according to Butterfield *et al*[3]) and bubbling air through them. These included four forms of protozoa and thirteen species of aerobic bacteria. The quantities of inocula were adjusted in each case to correspond to the numbers actually present under tank conditions. The extent of sludge formation and the composition of the effluent were determined in each case at frequent intervals.

It was observed that although all the bacteria that were tried showed some sludge-forming properties, the protozoa with the associated bacteria were much more efficient. They also produced clearer and cleaner effluents. None of the bacteria yielded more than 0·4 to 0·5 per cent. of sludge; the corresponding effluents were invariably turbid. Among the protozoa, the *Vorticella* were the most efficient: they not only yielded the highest percentage of sludge (2·5 per cent.) but also gave the cleanest effluent.

The foregoing observations, though essentially of a preliminary character, yet serve to bring out the importance of protozoa in sludge formation. By forming slimy aggregates with

high adsorptive power they help to collect the major part of the colloidal matter of the sewage. The vigorous flow of diffused air keeps the resulting sludge well dispersed in the form of granules and thus facilitates its interaction with the incoming raw sewage.

Further work is in progress with special reference to the relation of protozoa to nitrification and other oxidation changes in the activated sludge tank.

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A NEW ASPECT OF HYDROPONICS: "HANGING GARDENS" IN THE ACTIVATED SLUDGE TANK

THE art of farming without soil has recently awakened considerable public interest. By employing the familiar method of 'water cultures' a great deal of work has been carried out during the last two years particularly in California[1] and in England.[2]

The conditions obtaining in the aeration tanks of the activated sludge installation, the presence of practically all the elements of plant nutrition as also plenty of air, would show that it is suited to setting up what may be termed "Hanging Gardens". Suitable trays made of wood or tin or any other material which is not likely to be attacked by the liquid in the tank or the gases evolved therefrom may be used for growing the plants. Trays of convenient sizes, provided with strong open wire mesh bottom and filled with pebbles graded up to fine soil at the top or some fibrous material like *coir* fibre, would be suitable for the purpose; straw may also be used as bedding for the growing plants. Such boxes or trays with the desired plants may be hung, properly supported, in the aeration chambers of the tank so that the tank liquid reaches only up to the top of the pebbles or the bottom layer of the fibrous material, as the case may be. Provision may also be made for the boxes to float and maintain their position on the surface of the aeration tanks and adjust themselves with the rise and fall of the liquid, by having sealed tins filled with air attached to the bottom of the boxes.

At the suggestion of Dr. Gilbert J. Fowler, a systematic investigation into the possibilities of growing the various food plants and flower plants in the activated sludge tank at the Indian Institute of Science was undertaken. The growth of rice, ragi, tomatoes, chillies, roses, tuberoses and marygold by the system of "Hanging Gardens" has been studied and, in certain cases, highly promising results have been obtained. The plants showed highly luxuriant growth and were, in fact, almost giant specimens. Tillering and ear bearing in the case of rice and ragi were indeed phenomenal. Most of the rice plants put forth more than 50 tillers.

Work is being extended to other crops and flowering plants. It would appear that apart from the possible utilisation of the activated sludge process, especially large works, for agricultural and horticultural purposes, the system of "Hanging Gardens" will also prove an elegant technique for studying some of the fundamental problems of plant nutrition, more especially the nature of the microflora and fauna under the conditions of plant growth, since the microbiological changes which proceed in the activated sludge tank are essentially the same as those in the soil.

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