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THE BIOLOGY OF ACTIVATED SLUDGE [1]

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Biochemistry, and specially the biology of water and sewage purification is not often the realm of the professional biologist, although, it comes under his purview and we have to consult him; it is also a subject difficult to include in a teachable syllabus as it is on a borderland of several sciences. The lecturer hopes, that by this lecture he may stimulate interest and study among the members of this association of Economic Biologists.

The biology of water and sewage purification is in fact intimately connected with the biology of the soil which is rapidly becoming a matter of great importance. The days of pure Chemistry and the ideas of chemical treatment for the soil that flourished in the days of Lawes and Gilbert have now changed in view of the recent work by Russell and Hutchinson on the bacterial activities going on in the soil. Their work has explained the rationale of the practice adopted by English gardeners in cooking their soil. The microbiology of the activated sludge thus presents an interesting picture of what goes on in well cultivated land.

In fact there is nothing essentially different in the two processes. There is the same carbon and nitrogen cycle, and worms if not moulds, play their part in the cycles, although all the organisms found in the soil are not necessarily found in the activated sludge.

The older forms of sewage purifications were by filtering through (1) contact beds or (2) percolating filters, before or after passing through tanks. In the first method, broken bricks or stones are used as the material, and by filling the bed at one end and drawing out at the other—after holding it in contact for some period—even distribution over the entire surface is ensured; the slimy colloidal portion was fixed on to the surface of the medium, during the period the liquid is in contact with the material; when the liquid was discharged oxidation changes which go on, convert the slime into a residue of brown humus, which is removed from time to time by washing the medium.

Filter beds for the town sewage at the Manchester works, main and subsidiary—were studied for their biology and interesting things were found. The subsidiary works for the suburb of Manchester, was the easier to study, as there was no trade refuse and one could easily follow the course without the disturbing factors which upset a natural order of changes going on. The following interesting things were in fact noted.

Some sewage water was collected in sterile conical flasks which were corked with cotton, and left to themselves; later, biological activity developed just as in a fertilised soil. One could find in the fluid, worms, protozoa, bacteria, and most curious of all, leeches—although one could not discover where the last came from. Evidently, the effluent flowing out of these beds was not too well purified (as it is in these days) and presented an intermediate

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stage of study. A remarkable thing was the presence of Carchesium of which single individuals were studied under and drawn with the help of the microscope, and which doubled themselves in the course of just three-quarters of an hour.

The next stage in sewage purification was the use of percolation beds, whereby the liquid trickled through the bed in presence of air—a set of circumstances different to that which obtained in the case of the contact beds—and hence slightly different observations were made by this method; there was a tendency for the slimy material to clog up the top layers, and on account of this, a great many of the sewage works even went out of use for a time.

It was then that a biologist H. D. Bell, seeing enormous number of little black creatures which began to appear at the exit, conceived the wonderful idea of catching them and training them to eat the slime at the top layers; this he succeeded in doing, and later, boxes of this crawling creature—*Achorutes viaticus*—were sent from place to place to open up the closed sewage filter; surely a very good example of the application of pure biology in the cause of humanity.

Other forms of higher life which these filter beds attracted in numbers, were spiders, birds (starlings) and even biting and flying insects, which last came to be a nuisance and which had to be got rid of by the use of chlorine.

It was while Doctor Fowler was asked to suggest a solution for the sewage of New York, that the idea of the activated sludge in its present form was first engendered. A city with one thousand million gallons of sewage, could not be brushed away with the filter bed system, and some other way had to be found out; and it was while watching the flowing of the sullage into the New York harbour, in the company of the Chairman of the Sewerage Commission that the idea came to him, of trying to clot it out, just in the same way as milk is curdled by the use of rennet. Experiments at the Lawrence Experimental Station gave a helpful hint in this direction, but it was in Manchester afterwards, that a culture of an iron bacillus was obtained and the sewage inoculated with this, and air blown through with the addition of a trace of iron salt, and wonderful to relate, the whole thing came down as a clot, leaving a brilliantly clear effluent. Certain iron bacteria—by the way—are rather a source of danger, tending to block up the water pipes, as they induce the formation of hydrated iron oxide which chokes the water pipes. The culture used in Manchester, for the first experiments in Activated Sludge, was discovered in a colliery work near Manchester by E. M. Mumford. Later the first plant was put up in 1913, and this organism which was the first step in the new process was after Mr. Mumford called M. 7. The novel and interesting idea was pushed through, and large carboys filled with dhal broth as the nutrient medium, were inoculated with the bacillus for multiplication and transport.

Clotting over, could one purify the supernatant liquid and if so how? Blowing air continuously through did this, and the sediment, which forms about 15% of the whole sewage, is removed then.

In the earlier years the process was thought by some American workers to be due to worms, the larvae of insects and so on. But now it is recognised and proved that the whole thing is of bacterial activity. Recent advances confirm this view; and the mass of zooglea jelly-like bacterial matter forming in the fluid is the most important phase of this activity and in the functioning

of the activated sludge. It gives enormous absorptive surface, for the proper carrying out of bio-absorption and osmosis, and for bio-chemical and bio-physical action.

The protozoa, however, though not responsible for the changes in the activated sludge, are important, because, their activity or inactivity is a test for the good condition of the sludge. The presence, for example of a good number of paramœcia, is an indication that all is right with the sludge. Again over-aeration of the sludge or as it is called burning, and the seasonal variations produce marked changes in these protozoic organisms, which are easily traceable, and help us to control the working of the sludge. The protozoa thus are passive and not active agents in the medium, important though they are.

Thus, the changes brought about in the sludge process are identical with those taking place in a fertile soil. The clear effluent from the works—rich in nitrates—the last product of bacterial metabolism—is good for irrigating paddy fields, and the sediment—activated sludge as it is called—is an excellent and efficient nitrogenous manure. It contains five to six per cent of nitrogen which is present in the proteid form combined with phosphorous, the form which is of such highly nutritive value for crops.

ASSOCIATION OF ECONOMIC BIOLOGISTS

The Secretary of the Association sends us the following for publication :–

The second meeting of the association was held on 26th August in the Freeman building with the president of the association Dr. T. V. Ramakrishna Ayyar, in the chair. Besides the members and a certain number of visitors, there were present a large number of students at the meeting. There were two papers on the agenda, one by Rao Bahadur T. S. Venkatraman on 'Sugarcane X Sorghum hybrid' and the other by Mr. V. Ramanathan on 'The position of the first fruiting branch in the Madras cottons'. Before starting on the regular business of the meeting, the Secretary of the Association made a brief statement regarding the strength and the financial position of the Association and appealed to such of the members as were in arrears of subscriptions to pay them up at an early date, and to the non-members to become members.

Rao Bahadur T. S. Venkatraman who was next called upon to address the meeting, gave a detailed and highly interesting discourse on the origin, and the economic significance of the sugarcane X sorghum hybrid, which he had succeeded in effecting. Sugarcane he stated, was a long duration crop, and in India occupied the land for a period equivalent to at least two other short duration crops, and there existed a definite need for sugarcanes shorter in duration than the existent kinds. There have been produced at the Coimbatore sugarcane Breeding station, certain seedlings of the types of Co. 214, Co. 281, and Co. 290, whose introduction in N. India, has given a longer working season for the white sugar factories. He considered a further shortening of the growth period might have far-reaching effects on the future development of the sugar industry, and to gain this object he had tried to cross sugarcane with various millets in 1929–30 and luckily, one of these, that between sugarcane and sorghum, the former as the mother and the latter as father, had succeeded. He then dwelt on the various characters of this hybrid, and how they compared with those of the two parents.