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THE BACTERIAL PURIFICATION OF SEWAGE.

Sewage and the Bacterial Purification of Sewage. By Dr. S. Rideal. Pp. iii + 308. (London: Sanitary Publishing Co., 1901.) Price 14s. net.

THE practicability of effecting the purification of town sewage on the large scale by bacterial agency has now been abundantly proved. The process has passed beyond the experimental stage, and must now be acknowledged as the only method which can convert the putrescible matter of sewage on the large scale into inoffensive and harmless substances. Accordingly all trustworthy information respecting the results which have been arrived at from the lengthy experimental trials, and from the application of these results on the large scale, will be welcome to public sanitary authorities, and perhaps even still more acceptable to the professional advisers of these bodies. The treatise under review has been written by one who has carefully watched the progress, and who has had a long and varied experience, of bacterial treatment. The book is, therefore, undoubtedly worthy of careful perusal and consideration by those who are responsible for disposing of the sewage from houses, villages or towns.

The author covers a wide ground. He treats of the general character of sewage, and gives an historical sketch of the processes which have been resorted to for disposing of it. He also enters fully into the modern methods which have been recommended for the chemical examination of sewage and of sewage effluents, and states the standards of purity which have been suggested. Probably his description of the methods of collecting and examining these liquids will be of special value, since no such general description seems to be at present available. The summary of Dr. Houston's work on the identification of the bacteria present in raw sewage, a detailed account of which has appeared in the reports published by the London County Council, will also be useful, together with the account of the most important chemical changes which are brought about by bacteria. Naturally, also, some account is given of the treatment of sewage by irrigation and by chemicals, and of the "sterilisation" processes—processes which appear in the light of present knowledge of doubtful advantage, since they destroy the vast number of bacteria which effect or complete the purification of sewage, in order to make sure that a small minority of possibly injurious bacteria are disposed of.

The latter portion of the book will undoubtedly command most general attention, since here the author deals with bacterial purification. This is treated of in some detail, and the information which is given has been collected from the most trustworthy sources generally available. One can only regret that the large amount of useful matter accumulated has not been somewhat more systematically arranged and carefully summarised and compared; and, above all, that the author has not stated very clearly and emphatically the conclusions which he himself has arrived at from its careful consideration. The author has, however, apparently not been willing gener-

ally to act as assessor of the relative value of the different bacterial methods and apparatus, and due acknowledgment should be made of the time and trouble which he has expended in bringing together important information much of which, until now, has existed only in the form of scattered reports and papers. That the work which he has done in this direction is really valued is shown by the fact that a second edition of the book has been issued twelve months after the original publication; and it may be stated that the author has, as far as possible, availed himself of the opportunity which a new edition afforded him of bringing the matter up to date.

The author speaks in his preface "of the experiments on bacterial purification, which have now been carried out on a sufficiently large scale to establish the safety of embarking on the treatment of sewage on bacterial lines for even the largest centres of population." This statement proves that he is in touch with the recent experimental trials of the method at the sewage outfalls of our great towns. And it cannot be too emphatically stated that the near future is to see the adoption on the large as well as the small scale of this most rational process of "self-purification" of sewage. For after all bacterial purification is natural purification. It simply amounts to allowing the living agents of purification, which are present in the raw sewage in immense numbers, to carry out their useful function under the most favourable conditions. This adoption of natural methods must surely commend itself; and no one who looks at sewage treatment from a disinterested point of view will regret the approaching general relinquishment of artificial chemical or electrical treatment in favour of allowing natural agencies to have free course, provided only that reasonable efficiency and economy can be assured in making the change. This natural treatment may in some localities be effected on sewage farms by the development of bacteria in a suitable soil; but in most localities great advantage is obtained by substituting for the soil properly constructed bacteria beds, in which the treatment can be carried out on a smaller area and under more complete control than by means of the bacteria in the soil.

The experience and knowledge derived from several years' natural purification of sewage on the small scale in coke bacteria beds at the London and Manchester outfalls should suffice to give satisfactory assurance in these respects. After varied and continued trials it has been found independently at both these important centres that the raw sewage on its arrival at the outfalls should be roughly screened and then subjected to sedimentation without previous admixture with any chemicals. It has been shown that sedimentation may be appropriately allowed to take place in open tanks or channels in two stages. Much sand, road detritus and cellulose matter can thus be first removed, and this may be simply thrown out upon the land or dealt with in destructors without causing offence; while in the second sedimentation "sludge" consisting of fæcal and putrescible matter subsides. If the substances which are separated out by the latter sedimentation are simply left in contact with the sewage, which constantly flows over them, at least 40 per cent. of the solid sediment disappears

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by bacterial action. Accordingly by the double sedimentation an average of more than 60 per cent. of the suspended solid matter or "sludge," which was present in the raw screened sewage, has been caused to disappear. This implies a very considerable diminution of cost in sludge removal and disposal; but it secures the further advantage that the still impure liquid flowing from the settling tanks has become admirably adapted for undergoing adequate purification in the bacterial coke-beds. It is noteworthy that the full power of disposing of sludge is only developed in the sludge after it has remained in contact with the flowing sewage for some considerable length of time; and it is only stale sludge which is efficient in resolving the solid insoluble matter into soluble and gaseous forms. This delay is due to the necessity of cultivating in the sludge the necessary species of bacteria, which are derived from the sewage itself.

The most efficient and rapid method of dealing with the impure liquid, which flows from the settling or so-called "septic" tanks, has been found to consist in treating it intermittently in coke-beds, which have been primed with bacteria by being placed for some weeks frequently in contact with sewage. The complete cycle of treatment in the London beds consists in filling the coke-bed, emptying it after a couple of hours, and then leaving its coke contents in contact with the interstitial air for another period of two hours. It has been found possible to repeat this cycle four times in twenty-four hours, and using beds six feet in depth to purify the settled sewage at the rate of two million gallons per acre per twenty-four hours. By this purification an effluent is obtained which is saturated with dissolved oxygen, which remains entirely inoffensive in smell for an indefinite period in an incubator at summer heat, and which, therefore, when discharged into a water-course would maintain the respiration of fish and would never render the water offensive.

Chemical examination shows that the treatment in the coke-bed has reduced the readily oxidisable dissolved matter in the settled sewage by from 60 to 70 per cent., and the whole oxidisable matter in the unsettled raw sewage by more than 90 per cent.

Bacteriological examination indicates that the effluent contains large numbers of bacteria; but the presence of these bacteria is useful in effecting inoffensively the removal of the organic substances, which still remain in the effluent, as soon as the effluent mingles with the well-aerated river water.

It is noteworthy that the sewage capacity of a newly-made coke-bed progressively decreases for a time, while its purifying power is being developed by contact with settled sewage. But the capacity ultimately becomes equal to about 30 per cent. of the whole cubic space which has been charged with coke; and, if the treatment is carried out regularly under proper supervision, this capacity fluctuates by only a few units per cent. above and below this final capacity throughout the period of many years during which the bed has as yet been worked.

The decrease of capacity to 30 per cent. is the so-called "choking" of the bed. It is due to a bacterial jelly-like growth of bacteria and zoogloea upon the coke-surfaces. If this jelly is removed and exposed to air over

mercury, it will rapidly absorb oxygen from the air, and will therefore produce a partial vacuum. It appears that this growth is actually charged with oxygen during the aëration or resting of the coke-beds between the chargings with sewage liquid. The growth upon the coke-surfaces, which reduces the capacity of the bed, appears, therefore, to be the essential element of successful purification.

It is noteworthy that the growth may be unduly developed, with corresponding decrease in the sewage capacity of the bed, by over-frequently filling the bed; and by resting the bed, or reducing the number of fillings, the growth may be diminished and the capacity of the bed correspondingly increased. A great increase in the development of the jelly involves increased purification, but reduction in the amount of sewage dealt with, and *vice versa*. Accordingly a working rate which is most advantageous on all grounds must be arrived at by trial and experience.

Careful examination of the composition of the interstitial air, even at the bottom of a coke-bed thirteen feet in depth, proves that the air is not deficient in oxygen to an extent greater than 25 per cent. of that normally present in fresh air. It appears, therefore, that although oxygen is being rapidly absorbed during the resting or aëration of the bed, the oxygen which is absorbed is rapidly replaced by natural diffusion, and mechanical aëration of the bed is unnecessary.

It has been proved that the chemical refuse which is found in the sewage of manufacturing towns seldom exerts any prejudicial action on the action of the bacteria or upon the coke-beds. In some towns, however, a preliminary treatment of the sewage has been adopted in order to remove special chemical refuse when it is present in very large quantity. This is not the case either in London or in Manchester.

One hears occasionally of so-called failures in securing bacterial purification of sewage. It is not too much to say that such failures have been due to the improper construction or working of the bacteria beds. Apparently we have still to learn of want of success when an intelligent attempt has been made under competent and experienced direction.

Although the process of natural purification of sewage must eventually become general, its adoption will undoubtedly be delayed by the lack of knowledge on the part of the majority of our public bodies and even on the part of some of their advisers. Those who wish to see the satisfactory results of experimental inquiry usefully and advantageously applied on the large scale will accordingly welcome the appearance and success of such treatises as the one which has suggested the present review.

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FIFTY YEARS OF BIOLOGICAL STUDY IN AUSTRIA.

Botanik und Zoologie in Oesterreich in den Jahren 1850 bis 1900. Festschrift v.d.K.K. Zoologisch-Botanischen Gesellschaft in Wien. Pp. x+620; with 38 plates and 9 cuts. (Vienna: Alfred Holder, 1901.)

THIS magnificent work illustrates in every way the jubilee of the K.K. Zoological and Botanical Society of Vienna. Twenty-two authors have collabor-