Sanitary Matters.

EFFICIENCY OF WATER-TRAPS.

(See page 252.)

We reprint below a portion of a paper by Dr. Carmichael, published in the *Sanitary Journal* for March, 1880.

"We now come to the much more important question. Do the organic particles, including germs, putrefactive or specific come through a sound water-trap? A simple but very crude method of examining the question consists in the microscopical comparison of water through which soil-pipe air has been aspirated, with water through which the air over the trap has been drawn. The former contained numerous organic particles of a very heterogeneous kind; in the latter no particles could be detected. This method is, however, not conclusive, as particles might readily elude observation.

"About five years ago, when experimenting on the germ theory of putrefactien, I performed the following experiment: into two glass test tubes (Fig 1), about four inches long, and having drawn-out necks, I introduced turnip infusion. The liquid in the tube was then boiled to sterilize it; and while steam was freely issuing from the drawn-out necks, a closed capillary tube, containing a putrid infusion, was passed into each tube. The body of each tube was then immediately dipped into cold water, and at the same time the neck sealed by melting it in the blow-pipe flame. The putrid infusion in the capillary tubes was then subjected to the boiling temperature for only a few seconds. The necks of the tubes were now connected by putting over each, while hot, a piece of India-rubber tubing, which adhered. A small portion of the neck of each tube was now broken off within the two tubes. In this way the whole apparatus was sterilized, except that one capillary tube in each larger tube contained putrid liquid, and the two tubes had an open connection through the india-rubber tubing. The apparatus stood for several weeks unchanged. I now violently shook one tube, so as to break the contained capillary at a constricted portion, and so inoculate the infusion. This putrefied developed a large fungus, and become muddy from the development of bacteria. I watched for some time, and daily expected to find that the germs would pass over and inoculate the liquid in the other tube; but they have not passed even in five years. This experiment, which did not turn out as I had anticipated, directed my attention to the subject of the relation of water to the behaviour of putrefactive particles. Some points in this investigation I now place before you.

"Into a glass flask, with long neck bent so as to form a trap, and also into this trap, I placed urine. Both were sterilized by prolonged boiling. The liquid in the trap, being exposed to the air, putrefied; the urine in the flask continued clear. To deal, however, more directly with soil-pipe air, the following experiments were performed. On a shelf across a window, so as to have a good light, a glass flask, having a neck bent so as to form a trap, was placed. Into the flask was put urine; in the trap, water. The neck of the flask was connected to a lead pipe joining the soil-pipe under the trap of the kitchen sink. There was an aperture in the neck of the flask, where this joined the body, for ventilation, and to permit a current of air. The urine in the flask and the water in the trap were sterilized by prolonged boiling. The aperture mentioned was closed with cotton wool while steam issued. The water in the trap being in direct connection with the soil-pipe air, in sixteen days developed fungi. The urine in the flask has continued unchanged. The experiment was started in July of last year, so that even in seven months germs have not been able to make their way from the soil-pipe through the little trap of water to the bent neck, into the urine. But, lest it might be objected that there was not a sufficient current of air to draw germs over the curve of the neck, I repeated the experiment with another flask similiarly arranged, except that it had two apertures for ventilation in the neck, and that it contained hay infusion instead of urine. A glass tube, plugged with cotton wool, projected through one aperture into the neck of the flask over the infusion. The infusion and the water were sterilized, and the apertures closed with cotton wool, as before. To the cotton-plugged tube projecting through the aperture was now attached the aspirator, which caused a current of air to rush through the cotton wool over the surface of the water of the trap, along to the neck toward the infusion, and out through the small tube. It will be seen from this arrangement, that any particles which might be dispersed from the surface of the water-trap must have been carried in the air current over to the infusion, and must have caused it to putrefy. It is still perfectly clear, although it has stood for five months. No particles, therefore, have come through that trap even in five months.

"Another flask, similar to the first mentioned of these two, containing urine in the body, and having the neck empty, was connected with the soil-pipe. This was sterilized as the others were. In a few days it began to putrefy and in a few weeks it was very foul and putrid. That in the soil-pipe air which caused putrefaction in this case was cut of by the water-traps in the other cases. These experiments seemed to me fairly conclusive; but, lest it should be objected that germs might rise from the liquid of the trap and fail to be carried over, or that an ordinary water-closet trap might behave differently from the glass one mentioned. I adopted the following methods of experiment, which I think you will consider crucial. Nitrogen bulbs (as in cut) were charged with Pasteur's solution (one of the best cultivating liquids). The liquid was boiled so as to sterilize it, and while steam was issuing, both ends were sealed in the flame. The bulbs were now wrapped in lint and placed in boiling water for half an hour, so as to insure perfect sterilization of the bulbs. The lead trap in the kitchen, already referred to, was now sterilized by placing under it, and raising so as to immerse the trap, a pot of oil heated to from 350° to 400° F. This caused the water in the trap to boil, and steam to flow out abundantly through both tubes. To one of these pipes an India-rubber tube was attached, and, while steam was issuing freely from the other end of this India-rubber, tube, one limb of the still closed nitrogen bulb was inserted into and firmly tied in it. The other still closed end of this nitrogen bulb was now inserted into the end of another India-rubber tube, plugged near its extremity with cotton wool which had been soaked in a solution of carbolic acid, and also firmly tied in. Both ends of the nitrogen bulb were now broken off (where they had been previously scratched with a file) within the India-rubber tubes. The aspirator was immediately set to work. The liquid in the bulb was now again boiled. Steam was still coming freely from the open tube entering the cavity over the trap. When this began to slacken a piece of cotton wool, which had been soaked in an etherial solution of carbolic acid, was tied over the end of this tube, and the whole apparatus allowed to cool. In this way the connection was made, while the whole apparatus was sterilized. The air, entering the cavity over the trap, was filtered by passing through the cotton wool of tube, passed through this cavity, passed out through the other tube, bearing with it, of course, any particles or gases which might come through the trap, bubbled continuously through the liquid in the bulb, and was discharged through the aspirator. The aspiration was continued for from twenty-four to thirty-six hours. At the expiration of this period the bulbs were, before removal, hermetically sealed by melting at each end, in the blow- pipe flame. The bulbs were now removed, and placed in a warm room in public work, at a temperature of from 75° to 100° F., and were left there for some months. This experiment was frequently repeated, with Pasteur's solution, hay infusion, and urine. Similar experiments were performed with flasks, arranged with two tubes passing through carbolized cotton wool in the neck, one tube entering the fluid, the other stopping short of it. Air passing over the surface of the water in the trap was, of course, caused similiarly to bubble through them. In repeating these experiments, it was not found necessary always to sterilize the trap for each experiment. When the bulb or tube was detached as described, the India-rubber tube connected with the trap remained closed at its free extremity by the hermetically-sealed portion of glass tube which had been removed from the bulb remaining in it, This was connected with a fresh bulb, still closed, under a carbolic acid solution, so as to maintain aseptic conditions. In this way experiments sometimes went on for several weeks without the renewal or the fresh sterilization of the water in the trap, which, of course, must in that time have absorbed a large amount of the impurities of the soil-pipe. The liquids in all those tubes and flasks, though kept for from two to five months at cultivation temperature have remained perfectly clear, and even when examined with a $\frac{1}{12}$ in Hartnack's immersion lens, multiplying 900 diameters, exhibited no trace of life. The conditions of these experiments seem to me crucial, and to warrant the conclusion that germs do not pass through a sound water-trap. If no germs pass through, them it is certain that no particles pass through. because the particles in a soil-pipe are putrid, and because the passage of organic particles through water necessarily impregnates them with germs. Clearly, therefore, such particles as epithelium from the bowels in typhoid fever, containing the typhoid contagium, are cut off and effectually excluded from the house by a