

THE BACTERIOLOGY OF WATER-BOTTLES; WITH THE DESCRIPTION OF ONE OF A NEW PATTERN.

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IN a paper by me, entitled "Enteric Fever: A Water-Borne Disease," which appeared in the May number of this Journal for 1906, stress was laid on the fact that the poison of enteric fever could survive for some time in water pipes or storage vessels that had once been polluted. The subject is one of great interest in connection with the fact that, according to some, before enteric fever can occur a pre-existing case must have been present. If 1,000 men, pronounced free of enteric fever after the most careful bacteriological examination, were allowed to pollute their drinking-water with their excreta, one cannot help thinking that they would still get enteric fever, although no specific origin for the disease could be traced. But even if the *de novo* origin of this disease be not admitted, if storage vessels are liable to remain polluted for some time we have at once a cause for enteric fever occurring in out-of-the-way places, where previous cases seemed impossible, and where the cause has seemed to be a mystery.

The following experiments made by me during the last six months seem to show that infection in this way has long been a common factor in the causation of this disease. These experiments have been made on the lines of the routine bacteriological examination of water, which consists in adding water to bile salt broth coloured blue by neutral litmus, and having a Durham's tube at the bottom to show the presence of gas; the water is incubated for twenty-four or forty-eight hours. If the broth remains blue no intestinal organisms are present; if, however, intestinal organisms, which include *B. typhosus*, *B. coli*, *B. dysenteriae* and *Vibrio cholerae asiatica*, are present, it becomes acid, with or without the formation of gas, according to the nature of the organism or organisms present. When it is stated that *B. coli* was found, by that is meant an organism which was slightly motile and did not stain by Gram, and which also gave the "flaginac" reaction of Houston, viz: (1) fluorescence with neutral-red media; (2) acid and gas with litmus lactose broth; (3) indol in five days on the addition of commercial nitric acid; (4) acid and clot with milk in forty-eight hours.

(1) *Examination of wooden water-bottles.*—These are of an old pattern, and form part of the equipment of most Militia battalions. They are about twenty years old, and between the trainings are kept in store at the Militia depôts. The examination consisted in adding sterile water, which was left in the bottle for twenty-four hours; at the end of that time 5 cc. were taken out and examined.

(a) Two bottles from Preston: both gave acid and gas reaction with bile salt broth. *B. coli* not found. Control remained unchanged; (b) eleven bottles from 5th Battalion Northumberland Fusiliers: all gave acid and gas reaction. From three *B. coli* was separated. In addition, two gave all the reactions of *B. coli*, except fluorescence with neutral-red broth. Control remained unchanged; (c) ten bottles from 3rd Battalion York and Lancaster Regiment: nine gave acid and gas reaction, one gave acid only. Control remained unchanged. *B. coli* isolated from two of these bottles; (d) six bottles from 4th Battalion the Yorkshire Regiment: five gave acid and gas reaction; one remained unchanged. Control unchanged; (e) twelve bottles from 3rd Battalion the Lincolnshire Regiment: ten gave acid and gas; one gave acid only; one remained unchanged. Control unchanged; (f) six bottles from Royal Army Medical Corps Militia, York: four gave acid and gas; one gave acid; one remained unchanged. Control unchanged.

No attempt was made to isolate *B. coli* from the last three sets of bottles. The great majority of these bottles had had no chance of being contaminated since the last training, so they must have been polluted for over a year. On inquiry I found that these bottles are seldom, if ever, used by the men.

(2) *Examination of enamelled iron bottles of circular pattern.*—

(a) Twelve bottles obtained from the Ordnance Department: all sterile as regards intestinal organisms; (b) three bottles from Royal Army Medical Corps, York: two sterile; one gave acid reaction; (c) five bottles from Lichfield: three remained unchanged; one gave acid and gas, but no *B. coli*; one gave acid and gas, and *B. coli* was separated.

The last bottle belonged to a man who was suffering from enteric fever; there was a clear history, however, that he had not used it, as he had not been able to get the cork out since it was issued to him, so it must have been polluted for at least a year.

(3) *Experiments with enamelled iron water-bottles of circular pattern.*—

(a) *January 15th.*—A sterilised bottle was filled with impure water taken from the Ouse near the entry of a drain, and left for two and a half months.

April 5th.—Impure water thrown out, sterile water put in and shaken

up. After a sample was taken for examination, this water was thrown out and fresh sterile water added, and this process was repeated four times in succession in the space of ten minutes.

Result :—Original impure water ; acid and gas. First, second, third and fourth washings, acid and gas. Control of sterile water unchanged.

April 6th.—Bottle washed out twice consecutively with fresh sterile water. Fifth and sixth washings, acid and gas. Control unchanged.

April 19th.—Bottle washed out three times. Seventh, eighth and ninth washings, acid and gas.

May 1st.—Bottle washed out three times. Tenth and eleventh washings, acid and gas. Twelfth washing, unchanged. Control unchanged.

May 2nd.—Twelfth washing re-examined ; acid and gas found. Thirteenth washing gave acid and gas.

May 8th.—Bottle washed out twice. Fourteenth and fifteenth washings, unchanged.

May 9th.—Fifteenth washing examined again, and found unchanged.

May 10th.—Fifteenth washing examined again and found unchanged.

May 12th.—Bottle put in incubator for four hours. Fifteenth washing examined again after incubation ; result, acid and gas.

July 13th.—Fifteenth washing examined again ; result, acid, no gas.

(b) *January 14th.*—A sterilised bottle was filled with impure water, which was left in contact for twenty-four hours.

January 15th.—Washed out three times in succession with sterile water.

Result :—Original water, acid and gas. First, second and third washings, acid and gas.

(c) *May 4th.*—A bottle was sterilised and filled with sterilised water which, when examined, was found to be unchanged. Bottle filled with impure water for two hours, then washed out twice with sterile water. Original water gave acid and gas. First and second washings, acid and gas.

May 8th.—Bottle washed out twice. Third and fourth washings gave acid and gas. Control unchanged.

July 17th.—Fourth washing again examined ; acid and gas found. Bottle washed out again, and acid and gas found, while control remained unchanged.

July 25th.—Fifth washing examined, and acid and gas found.

(d) *July 20th.*—A sterilised bottle filled with sterile water. Examined ; unchanged.

July 30th.—Put in incubator for twenty-four hours.

July 31st.—Examined ; unchanged.

These experiments seem to show that water-bottles of wood or of enamelled iron of the present pattern, once infected, may remain polluted for some time, although frequently washed out with even sterile water, and that the sterile water put in also gets polluted.

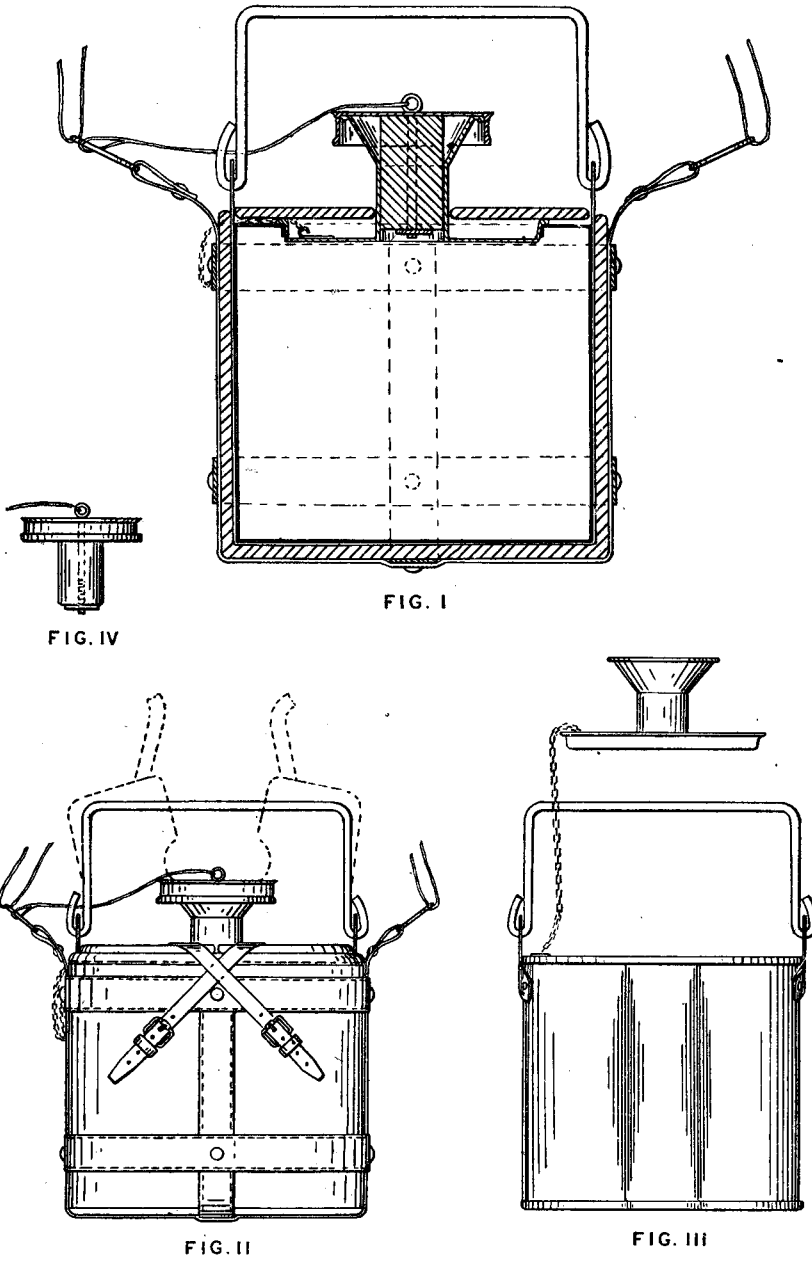


FIG. I.—Sectional elevation of water-bottle and sling.
FIG. II.—Elevation showing the bottle in the sling.
FIG. III.—Elevation of bottle alone.
FIG. IV.—Detail of cork.

It must also be noted that a bottle which had remained pure at laboratory temperature, became impure when incubated for four hours. The temperature of the incubator, viz., 97·4° F., is not an uncommon one in the tropics, and when it is remembered that the inside of a bottle is dark and dirty and cut off from the actinic rays of the sun, it is not surprising that organisms survive for long periods. Consideration of these facts seem to lead to the conclusion that a water-bottle, even of the latest pattern, is a perfect typhoid trap. Its defects appear to be: (1) It cannot be cleaned, with the result that it must become offensive, especially in hot climates. In talking this over with a brother of mine, who commanded a company of his regiment through most of the South African War, he said that men refused to drink out of their water-bottles on account of their offensiveness, but preferred to take their chance with water from the spruits. (2) A sterile bottle holding dirty water for two hours becomes polluted, and with no means of sterilising the bottles in use it would be useless to supply pure water without at the same time providing means of sterilising the bottles. (3) The funnel-shaped spout of the bottle of latest pattern catches dust very easily.

On account of these defects a bottle of a new pattern has been devised, and permission having been obtained from the Army Council, a provisional specification was sent in to the Patent Office in January, and the complete specification is now under consideration. The four main points about the new bottle are:—

(1) Instead of being of enamelled iron, it is made of block tin or aluminium; and, in addition to the spout, contains a press lid, which can be taken off, so that it can be thoroughly cleaned out by the hand. (2) The felt covering, instead of being fixed to the bottle, is fastened to the sling, so that the bottle can be taken out and sterilised by being put on the fire. (3) The top of the cork has a metal expansion which fits over the base of the spout and prevents the dust getting in. The cork is attached to the felt covering and not to the bottle, and therefore cannot be injured when the bottle is on the fire. (4) A handle is attached, by which it can be lifted off the fire.

A bottle of this description can be kept thoroughly clean, and water can be boiled in it if safe water is not available. It can be sterilised by heat or by chemical tablets; and in this connection it must be remembered that a clean bottle can be more easily sterilised than one containing putrescent slime. By its use detachments of men would be rendered independent of transport for the supply of pure water.