REPORT ON THE BACTERIOLOGICAL EXAMINATION OF THE WATER SUPPLIED TO THE DUBLIN MILITARY BARRACKS :

WITH OBSERVATIONS ON THE BIOLOGY OF COLIFORM ORGANISMS.

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I.—WHY THE EXAMINATION WAS UNDERTAKEN.

DURING the late autumn of last year the press, both lay and medical, contained frequent allusions to the prevalence of typhoid fever at several of the Dublin barracks. It will, of course, be within the recollection of many of your readers that some few years ago the heavy incidence of this disease at the Royal Barracks, Dublin, was a matter of common knowledge, and that several young officers contracted the disease whilst stationed there. After the sanitary condition of the barracks had been thoroughly overhauled and many grave defects set right, the number of typhoid cases underwent a great diminution. Towards the autumn of last year the disease began to crop up again in the Dublin garrison, but this time it was not the Royal Barracks which was to suffer most heavily—it was the Richmond, and above all Island Bridge Barracks, which had to bear the brunt of the attack. So serious did the state of health of the last-named barracks become, that early in the year it had to be evacuated by the troops. Under these circumstances the writer was requested to undertake the bacteriological examination of the drinking water supplied to the Dublin Barracks generally, and to report the result for publication in the BRITISH MEDICAL JOURNAL.

Accordingly, numerous samples were personally taken by the writer with the kind permission of the heads of the Army Medical Department, whose courtesy he desires gratefully to acknowledge. He is also greatly indebted to Surgeon-Lieutenant-Colonel Robinson, M.O. in charge of Portobello, Surgeon-Lieutenant Green at the Royal, Surgeon-Captain Gray at Island Bridge, Surgeon-Major Tuthill at Portobello, and to the Commanding Officer Royal Engineers, Dublin District, Lieutenant-Colonel Bagot, for the assistance and facilities they so considerably afforded him. Though the examination of the samples procured was at once proceeded with, serious delay was occasioned in the interpretation of the results by the frequent occurrence of pseudo-typhoid or coliform organisms, which required in many cases an elaborate system of check cultures to distinguish them from the real bacillus of Eberth. This fact, together with the interruptions consequent on other investigations and teaching work going on at the same time in the laboratory, have necessarily delayed the completion of the report which is now submitted to the British Medical Association.

II.—INCIDENCE OF TYPHOID IN THE DUBLIN BARRACKS.

The following return, for which I am indebted to the courtesy of the Principal Medical Officer in Ireland, Surgeon-Major-General Preston, shows the number of cases reported from each barracks during the whole of 1895 and down to the end of June of the present year. It will be observed that the little epidemic broke out quite suddenly in October, and terminated with equal suddenness in February, that the greatest number of cases occurred in November—the classic season for this disease—and that Richmond and Island Bridge Barracks were by far the most heavily affected.

III.—SOURCE OF THE WATER EXAMINED.

The Dublin Barracks derive their water from the city supply, commonly called "Vartry water," being taken from the small river Vartry, which rises near the Sugarloaf Mountain in co. Wicklow, and, running southwards, joins the sea at Wicklow. The river is dammed up 24 miles south of Dublin, so as to form an artificial lake about 2 miles long, whence it passes through well-constructed filter beds, and is carried by means of pipes to a series of open reservoirs at Stillorgan, about 4 miles from the city. Here it may deposit

any sediment that may still remain, and is screened before being finally admitted to the city supply pipes. The water is an excellent surface water, very soft, and always free from objectionable chemical features (save during the autumn of 1893, when the Roundwood Lake nearly dried up). I have found its bacterial contents under ordinary circumstances to be below 100 germs per c.cm. The organisms present are, as is generally the case with surface water, mainly "putrefactive" in character and quickly destroy gelatine plates.

Cases of Enteric Fever occurring in Dublin Garrison during 1895—June 1896.

Barracks from which admitted.	1895.												1896.					Total.
	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	
Pigeon House Fort ...	...	...	...	2	...	...	...	...	...	...	...	...	1	...	...	...	...	3
Ship Street Barracks ...	...	...	...	...	...	...	2	2	...	...	...	...	...	...	...	...	...	4
Wellington " ...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	...	...	...	2
Beggar's Bush " ...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	2
Island Bridge " ...	...	...	...	...	...	...	...	...	1	3	3	1	2	2	...	...	...	12
Marlborough " ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	5
Richmond " ...	...	...	...	...	...	...	...	...	2	3	3	...	4	1	...	...	...	14
Portobello " ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	...	2
Linen Hall " ...	...	...	...	...	...	...	...	...	...	...	1	...	...	...	...	...	...	1
Royal Infirmary ...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	...	...	...	2
Magazine Fort ...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1
Royal Barracks ...	...	...	...	...	...	...	...	...	...	...	...	1	1	...	1	...	...	2
Outside Barracks ...	...	...	...	1	1	...	...	...	...	...	1	1	2	...	...	2	...	8
	...	2	1	1	1	...	2	2	3	8	10	8	7	7	1	2	4	58

No case has occurred since May 23rd, 1896.

Certain of the barracks examined (Richmond and Island Bridge) possess a second water supply from the Grand Canal, which flows close by. This water, though very good when taken some miles west of the city, gradually undergoes pollution as it flows eastwards. At Island Bridge it supplies a horse trough in the principal square, and at the Richmond it is used for flushing urine buckets and similar purposes. Notices over the taps indicate that the water is not for drinking purposes.

It will be observed that the two barracks most severely attacked are those which possess this double water supply. It is quite conceivable that the canal water, despite admonitions to the contrary, may have been drunk by the men, and its bacterial characters indicate considerable and dangerous pollution.

Storage of water in cisterns, etc., is not practised in the barracks. Owing to the high pressure and constancy of the Vartry supply it would be quite unnecessary.

IV.—MODE OF COLLECTION AND METHODS EMPLOYED.

All the usual rules were adopted for the prevention of contamination. At the time of collection the temperature was always below 52° F., and an interval of longer than three hours was never allowed to elapse between collection and the pouring of plates. The numerical results given may therefore be looked upon as representing the real number of germs present capable of developing under aerobic conditions on the medium used for the plates—alkaline, 10 per cent., meat decoction gelatine with the usual addition of peptone and salt.

Bearing in mind the nature and object of the investigation, special methods were adopted for the detection of any typhoid or colon bacilli that might be present. The tests employed were:

(a) Parietti's: to 10 c.cm. sterile neutral bouillon in a test tube, a varying quantity—for example, 3, 6, or 9 drops (from a pipette delivering drops of known content) of a solution containing 5 per cent. carbolic and 4 per cent. hydrochloric acids are added. The broth thus acidified and carbolised receives the addition of 0.5 c.cm. of the water under examination, and the mixture is incubated at 37.5° for twenty-four hours—not longer, lest organisms not belonging to the typhoid group become acclimatised and develop. Should development have

Name of Barracks.	Date of Collection, 1896.	Source of Sample.	Result of Plate Culture (Colonies per c.cm. at 22° C.)	Result of Parietti's Test.	Result by "Method δ."	Abba's Method.	Remarks.
Beggar's Bush	Jan. 10	"Kitchen tap" [Vartry]	± 70 [mostly common grey, liquefying]	—	—	Not tried	An ordinary sample of Vartry water.
"	"	"V. House" [Vartry]	± 65 nearly all liquefying; one non-liquefying coliform, but with knot in centre; 2 B. mycoides	—	—	"	—
Royal ...	Jan. 14	"Lavatory" [Vartry]	± 40 [majority large liquefying]	—	+	"	A drop from turbid fermentation tube placed in highly charged Parietti's bouillon caused intense development after twenty-four hours, at 37.5°. Plating out yielded only coliform colonies (no other present) (=α).
"	"	"A.S.C. Mess" [Vartry]	± 70 [one like bacilli mycoides, others large liquefying]	—	+	"	Similar result.
Island Bridge..	Jan. 23	Drinking tap on north side of Upper Square [Vartry]	∞ [destroyed by liquefaction in three days, at 22° C.]	—	+	"	Abundant gas in fermentation tubes. Zoogloea over surface of liquid and luxuriant anaerobiosis in closed limb. Closed limb contained large "waggling" bacilli with smaller non-motile forms. Anaerobic plates (Buchner's pyrogallol + pump) yielded only a diffuse cloudiness; aerobic plates only a few small colonies. Result (?)
"	Jan. 27	"	No plates poured	+	+	"	Sample stood three days before examination. Coliform colonies obtained from Parietti's tubes and (after forty-eight hours) by "Method δ" (=β).
"	Jan. 28	Tap supplying horse trough in Upper Square [canal]	± 700 [a great many non-liquefying colonies, some coliform; number of species large]	+	Not tried	Not tried	Coliform colonies (and no others) isolated by plating out the Parietti tubes (=γ).
"	Mar. 30	Drinking tap in Upper Square; water had been turned off and was stagnant in pipes [Vartry]	± 40 [nearly all liquefying, putrefactive]	—	"	+ ?	On plating out the Abba flasks, which were only slightly turbid and decolorised, the majority of colonies were small, round, yellowish, and surrounded by a slight zone of liquefaction—hence not coli. One iridescent, veil-like colony of typical coliform appearance developed and attained a great size (=δ).
"	"	Ditto after high pressure had been turned on [Vartry]	± 32 colonies + 2 moulds [one typhoid-like colony of medium-sized motile bacilli, forming long filaments that progressed with a sinuous movement; thick, slimy, dirty yellow growth on potato at 37° C.]	—	"	—	Abba flasks not decolorised. Scarcely any development.
Richmond ...	"	Drinking tap largely used by men [Vartry]	± 19 [nearly all liquefying grey colonies; one doubtfully coliform proved not to be coli]	+	"	—	Coliform organisms readily isolated from 9-drop Parietti tube. This is a remarkable result, inasmuch as Abba's method gave no positive sign (=ε).
"	"	Canal water used for flushing urine buckets	± 720 [species varied and numerous; one coliform proved not identical with that organism]	—	"	—	Development occurred in both Parietti and Abba tests, but plating out revealed only liquefying organisms.
Portobello ...	Feb. 4	Stable tap opposite hospital [Vartry]	± 24 [all were liquefying, and rapidly extended over plates]	—	"	—	A good sample of Vartry water.
"	"	Drinking tap at M. building [Vartry]	± 12 [none coliform]	—	"	—	A very good sample of Vartry water.

occurred by the end of twenty-four hours, the tube is "plated out," and the resultant colonies studied.

(b) A modification devised by myself of a method lately¹ proposed by v. Freudenreich for the isolation of colon bacilli from drinking water. The method is based on the readiness with which *B. coli* ferments lactose with evolution of gas. v. Freudenreich uses ordinary flasks, and judges the intensity of the fermentation by the gas bubbles on the surface of the fluid. I employ fermentation tubes and judge of the activity of the process by the quantity of gas that collects in the closed limb expelling the nutrient fluid therefrom. I also use larger quantities of the suspected water. From 15 to 20 c.cm. of a bouillon containing 1 per cent. of peptone and 2 to 5 per cent. of lactose are introduced into a fermentation tube and sterilised. About 5 c.cm. of the suspected water is then added, and caused to mingle with the broth, the closed limb of the apparatus being quite filled with the mixture. The charged tube is then incubated for twenty-four hours at 37.5° C. Conditions highly favourable to the development of *B. coli* are thus created—warmth, scarcity of oxygen (the bacillus is facultatively anaerobic), and abundance of fermentable carbohydrate. Should gas have been evolved next day, the liquid is plated out, and the bacillus identified in the usual way.

(c) Abba's method: this plan, suggested by Abba,² is in principle the same as the last, but renders possible the em-

ployment of much larger quantities of the suspected water. A litre of the sample is converted into a nutrient solution by the addition of a tenth of its bulk of a concentrated solution of peptone and lactose. A drop or two of phenolphthalein and enough saturated soda solution to make the liquid a pale pink are then added. The fluid is distributed over a number of moderate-sized flasks, and put aside in the warm incubator. By the end of that time the flasks which contained colon bacilli may be recognised at a glance by their being decolorised and turbid. The development of lactic acid resulting from the fermentation of the milk sugar neutralises the soda and bleaches the phenolphthalein. This plan enables me to test large quantities of sample for bacillus coli without having to go to the trouble of passing it through a Pasteur or Berkefeld filter and plating the residue out on carbolised gelatine. Plating out the decolorised and turbid fluid should, however, never be omitted, for I have occasionally obtained a positive result (decolorisation) when plate cultures showed that bacillus coli was absent. Generally speaking, the conditions provided by the experiment favours *B. coli* alone, and are so unfavourable to ordinary water saprophytes that, in the absence of coli, the sample is but little changed by the end of the first day's incubation.

V.—RESULTS.

These may best be set forth in tabular form. The sign + indicates a positive, — a negative result.

It will thus be seen that Vartry water, as supplied to the Dublin Barracks, contains but few bacteria; that organisms

¹ *Centralbl. f. Bakt. d. Parasitenk.*, Bd. xviii, p. 102.

² *Centralbl. f. Bakt. u. Parasitenk.*, Bd. xix, p. 13, January 1896

producing coliform colonies on gelatine plates were obtained by indirect methods from the Vartry water supplied to the Royal, Island Bridge, and Richmond Barracks, and from the canal water supplied to Island Bridge.

VI.—COMPARISON OF THE COLIFORM ORGANISMS WITH B. TYPHOSUS (EBERTH) AND B. COLI COMMUNIS (ESCHERICH).

Before proceeding to consider what relation (if any) these coliform organisms bear to the typhoid outbreaks, it became necessary to contrast them with genuine typhoid and colon bacilli. The typhoid used for this purpose was obtained from the spleen of a soldier from the Royal Barracks who died of typhoid in April. The writer was thus in the favourable position of being able to compare the actual *materies morbi* with the suspicious organism in the drinking water used by the deceased. For the opportunity of examining the spleen he has to thank his friend, Surgeon-Major O'Sullivan, who performed the necropsy. Of colon bacilli there were used two races, one derived by plate culture from the "pea-soup" fæces of a patient at the Mater Hospital suffering from typhoid. Only *B. coli* and a few streptococcus colonies grew on these plates; no typhoid as judged by the usual tests. The other race was derived from the fæces of a suckling infant a few days old. They swarmed with typical bacilli of Escherich in pure cultivation. The typhoid and colon bacilli thus obtained were grown on all the ordinary substrata in parallel culture with the water organisms. Water was also artificially infected with true typhoid, true coli, and subjected to the above-mentioned special methods side by side with other samples to which the water organisms had been added, and their behaviour compared. The following results were obtained:

(a) *Morphology*.—The water organisms are extremely minute, very motile, rods shorter than typhoid and colon bacilli usually are; the individuals in some cultures of the latter were nearly as short, but then they were scarcely motile. When the water organisms are shorter than 2μ , they become rounded and are hardly distinguishable from cocci. In the disposition and number of flagella (van Ermengem's method) I could detect no constant difference between the water organisms and the true typhoid. Their number was usually about eight. They were very long and wavy, and placed all round the bacillus. I made no attempt to demonstrate flagella on *B. coli*. The water organisms had much less tendency to form filaments than true typhoid. They rather resembled *B. coli* in this respect. No spores were ever seen.

(b) *Gelatine Plates*.—The water organisms resembled typhoid very closely, forming thin translucent, veil-like, fringed expansions, which never liquefied. They were distinguishable from typhoid mainly by their much greater rapidity of growth at room temperature. The colonies viewed under a low power were often peculiarly cracked and radiately streaked. True typhoid sometimes presented an exactly similar appearance. Coli generally grew somewhat thicker and more opaque.

(c) *Streak Culture on Oblique Gelatine*.—Water organisms grow quicker than either typhoid or coli. Tendency in old cultures to formation of bunches of feathery crystals beneath surface, and to milkiness of surrounding gelatine, more pronounced than in either typhoid or coli.

(d) *Shake Culture in Unsugared Gelatine at 22° C.*—The water bacilli produced an abundance of gas bubbles by the end of the first day, as did also coli from both sources. True typhoid grew much more slowly and produced no gas.

(e) *Agar-agar at 37.5° C.*—Water organism, coli and typhoid produced very similar grey moist growths devoid of special feature. The motility of the first-named was much impaired in these cultures, and they only showed slight movements like those of coli when transferred to the hanging drop.

(f) *Bouillon at 37.5° C.*—Luxuriant growth; nauseous smell generally (but not always) given off from water organisms and coli; typhoid tubes inodorous. Same difference of motility as mentioned under (e). A pellicle usually formed on surface of broth inoculated with water organism; less often on coli: never on typhoid.

(g) *Unsugared Bouillon in Fermentation Tube at 37.5°*.—The water organisms gave a few bubbles of gas after forty-eight hours. Coli gave two inches of gas. Typhoid gave none.

(h) *Milk ("Separated" and Sterilised) at 37.5° C.*—True coli coagulated the milk completely, producing a firm clot and clear watery serum within twenty-four hours. The flasks inoculated with water bacilli were not coagulated at the end of twenty-four hours, but were so at the end of ninety-six hours, save one flask inoculated with water organism from horse-trough at Island Bridge (j), which never became coagulated. Typhoid never coagulated the milk.

(i) *Potato (acc. to Globig)*.—Sterility of Slices proved by previous incubation. Result after forty-eight hours at 22° C.

(a) Delicate, thin, almost invisible colourless line.

(β) Elevated, brownish yellow, dampish-looking growth confined to line of inoculation. Potato discoloured.

(γ) Not tested.

(δ) Like (β), but potato not discoloured.

(ε) Like (β), but growth thicker and somewhat more elevated, potato discoloured (pinkish brown).

True coli (from typhoid fæces): Growth almost invisible transparent; somewhat shining below.

True typhoid: Growth all but invisible.

Re-examination after 2 months.

(a) Growth dirty white, elevated, wet looking; streak narrow above, diffuse below; potato not much discoloured.

(β) Browner than (δ), and potato more discoloured.

(γ) Not examined.

(δ) Dirty white raised streak, potato not much changed.

(ε) Like (β).

True coli (from typhoid fæces): Yellowish brown, very thick growth; great discoloration of potato.

True typhoid: Growth hardly more distinct than it was 2 months ago.

(k) *Indol reaction*.—Cultures in peptone-bouillon up to 2 months old were tested in the usual way. The odour in each case was noted. Despite the varied ages of the cultures the results were singularly accordant. Where indol was demonstrated in one broth culture it was found in all the others of that organism, and *vice versa*. The test was performed as usual with 0.02 per cent. sol. NaNO_2 and pure concentrated H_2SO_4 .

Indol Reaction.

Organism.	Number of Tubes Tested.	Odour.	Presence or Absence of Indol.	Remarks.
Royal Barracks (a) ...	4	Very bad	—	No reaction, despite the stench.
Island Bridge (β) ...	4	Slight	+	Very faint reaction.
" (δ) ...	2	"	—	
Richmond (ε) ...	3	"	+	Turned almost purple. Tubes as young as 24 hours old gave a strong reaction.
True typhoid (soldier's) spleen ...	2	None	—	No trace of reaction.
True typhoid (from a culture of Kral's) ...	1	"	—	No reaction.
Coli from fæces of suckling infant ...	1	Rather bad	+	Reaction moderately strong.
Coli from typhoid stool	1	Bad	+	Reaction very strong.
Coliform organism from water of laboratory tap ...	1	Bad	+	Strong reaction.

(l) Reaction to special tests.

1. ABBA'S TEST.

A. A litre of Vartry water drawn direct from laboratory tap into each of three sterilised flasks.

Flask a received one small loopful of typhoid stool.

Flask b received half a loopful of a colony of *B. coli* from plate culture of fæces of infant.

Flask c received no addition.

All three were thus worked up according to Abba's plan, and 50 c.cm. of the reddened fluid were poured off from each, and kept in a cool place for comparison with the rest of the sample after incubation. The rest of each sample was then distributed between several flasks, and put in the warm incubator till next day.

Result.—After twenty-four hours at 37.5° C., *a* and *b* were quite decolorised and turbid; *c* showed hardly any growth, but, on comparison with the uninoculated portion of the sample, was somewhat decolorised. A loopful of the contents of each flask was then transferred to 10 c.cm. broth in a tube, and the needle (in the case of *a* and *b* without recharging) used for inoculating a gelatine tube, which was at once rolled out. Result: The roll tubes from *a* and *b* developed only veil-like coliform colonies on the surface, with small lenticular brownish ones, also coliform, in the depth. No liquefying colonies. The roll tube inoculated with a loopful from flask *c* was quickly destroyed by liquefying colonies.

This experiment confirms Abba's claim that his method encourages the growth of *B. coli* at the expense of the ordinary water organisms. Decolorisation of the phenolphthalein may, however, be partially affected independently of the presence of coli.

B. Litre flasks of unsterilised Vartry water from the laboratory tap were inoculated as follows :

- (a) received 1 loopful of 1 day old broth culture of *a.*
 (b) " " "
 (c) " " $\frac{1}{2}$ loopful gelatine colony of coli from infant's
 faeces.
 (d) " " $\frac{1}{2}$ loopful of typhoid stool.
 (e) " " no addition.

The flasks were allowed to stand in a press till next day, and were then worked up according to Abba's method. Result, after 20 hours, at 37.5° C.:

- (a) Not much growth; no decolorisation.
(b) Hardly any decolorisation; growth slight.
(c) Quite turbid and bleached.
(d) Like c.
(e) Like a and b.

These were all plated out, with the following results:

- (a) Some coliform colonies similar to *a*; some liquefying.
- (b) Nearly all colonies coliform.
- (c) Typical iridescent veil-like coliform colonies, occupied plate to exclusion of others.
- (d) Crowded with typical coliform colonies.
- (e) Riddled with liquefying colonies, which quickly destroyed the roll tube.

This experiment shows that while perfectly clear results are yielded by Abba's method, with water samples containing genuine colon bacilli, it does not react with the same distinctness to water containing the coliform organisms which occur in the Vartry supply.

2. METHOD B.

Twenty c.cm. of sterile broth containing 2 per cent. lactose mixed with 5 c.c. of the water in a fermentation tube, inoculated and set aside at 37.5° C. Result after two days:

<i>a</i>	contained	$2\frac{1}{2}$	inches of gas in closed limb.						
<i>b</i>	"	$2\frac{3}{4}$	"	"	"	"	"	"	"
<i>c</i>	"	3	"	"	"	"	"	"	"
<i>d</i>	"	I	"	"	"	"	"	"	"
<i>e</i>	"	I	"	"	"	"	"	"	"

The letters have the same meaning as in the last experiment. The remarkable feature of this result is that ordinary Vartry water without addition of any kind contains organisms capable of evolving gas from lactose. Growth under anaërobic conditions probably accounts for the fact that organisms α and β , which failed to cause fermentation in Abba's fluid, attacked the milk sugar vigorously in the fermentation tube.

The most remarkable result, however, furnished by this experiment is the evolution of gas from lactose by the water which had received no addition of coli or coliform organisms. This result will be further amplified lower down.

3. PARIETTI'S METHOD.

Ten tubes were charged with 10 c.cm. each of sterile nutrient bouillon. Five received 6 drops each and the other five 9 drops each of Parietti's solution from a pipette delivering 30 drops to the c.cm. Each received a loopful out of a litre of water, to which twenty-four hours previously a loopful of the organism (or fæces) had been added; a loopful, in fact, of the same material as had served for Abba experiment No. 2. The sign + indicates development, — its absence. Value of letters as before. Result after twenty-four hours at 37.5° C.:

			Six drops.		Nine drops.	
<i>a</i>	...	...	+	...	...	-
<i>b</i>	...	...	+	...	...	+
<i>c</i>	...	...	+	...	...	+
<i>d</i>	...	...	+	...	...	+
<i>e</i>	...	...	-	...	...	-

* Less growth than in the 6-drop tube.

This shows that the coliform organisms, though capable of developing in the carbolised and acidified fluid, do not resist the higher dosage as well as genuine *B. coli*; and that ordinary Vartry water does not react to the Parietti test.

To return to the experiment with "Method *b*," ten tubes, each containing 10 c.cm. sterile neutral bouillon, were taken, and to five there were added six drops each of Parietti's solution, whilst the other five received nine drops each. A loopful of the turbid fluid contained in one of the fermentation tubes used in that experiment was introduced in each one of a pair of Parietti tubes, and put aside at 37.5° to develop. Next day growth had occurred in all the Parietti tubes, which were then plated out. Organisms *a* and *β*, and the two strains of genuine coli were thus recovered, and from the fifth pair of Parietti tubes (inoculated from fermentation tube *e*) a new coliform organism similar to *a* and *β* was obtained. The writer has since isolated the same organism from the laboratory tap water by means of Abba's method. In its vigorous production of indol (see table of indol reaction) it closely resembles organism *ε* from Richmond Barrack water.

In conclusion I will sum up briefly the results which these experiments lead me to formulate:

1. The Dublin water supply known as the "Vartry water" contains "coliform" or "pseudo-typhoid" organisms.
2. These are probably identical with or closely allied to the forms isolated by Weichselbaum from the Vienna water supply, and called by him *B. aquatilis sulcatus*.
3. These organisms react positively though weakly to Parietti's test, and require to be present in some quantity in order to give the reaction.
4. Under certain circumstances they ferment lactose with evolution of gas and acid.
5. They produce gas in abundance from unsugared gelatine (probably by fermenting the inosite).
6. They are distinguishable from genuine typhoid bacilli by their more vigorous saprophytic growth, their power of exciting fermentation, and (usually) by the characters of their potato culture and their power of coagulating milk.
7. It is much harder to distinguish them from *B. coli*, which they more or less closely resemble. Their active motility when grown at low temperatures, and their weaker reaction to Parietti's and Abba's tests, are fairly constant characters.

8. No etiological connection between these organisms and the outbreak of typhoid in the Dublin Barracks has been established.

To these conclusions I wish to add one other which is founded upon a large number of biological investigations made by me during the last few years upon water suspected of being the vehicle of typhoid germs, namely, that these pseudo-typhoid or coliform organisms occur regularly and abundantly in water to which attaches the suspicion of causing typhoid fever—very seldom and in small numbers in water which is beyond the possibility of sewage contamination.

RUSSIAN WAR MEDAL FOR CENTRAL ASIA.—By imperial ukase to the War Minister, a medal is to be issued in the Russian army for services in Central Asia 1853 to 1895. In silver for troops, surgeons, priests, and sisters of charity who have served under fire. The medal in bronze will be given to soldiers, volunteers, and followers who have served during the campaign, but not in important engagements.

THE trustees under the will of the late Sir Edwin Chadwick propose, in the month of January, 1899, to give a shield worth £100, to be called the Chadwick Shield, to that local authority presiding over a population of not less than 50,000 inhabitants which, having adopted the most complete application of the separate system of drainage, shall during the preceding five years show the best reduction of the death-rate in its district, as indicated by its official statistics.