THE DRINKING WATER OF STEAMSHIPS.

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We intend to give in this paper a short account of (1) the laws concerning the supply of drinking water to ships in some of the chief civilised countries of the world; (2) the results of bacteriological examination of the water on steamships; (3) the chief deficiencies in supply and storage which have come under our notice, and (4) the reforms which we consider urgently necessary.

(I) *Laws regulating the water supply on board steamships.*

Great Britain[1]. Although in general no rules are laid down directly as to methods (1) of shipping, (2) of storing water in British ships, there are certain provisions which, by the threat of inspection or by penalties attaching to unsanitary methods, indirectly impose on Masters of ships the necessity of sanitary observances in these respects.

Under section 206, sub-section (2) of the Merchant Shipping Act of 1894:

"in the case of ships going or trading from any port of the United Kingdom through the Suez Canal or round the Cape of Good Hope, or Cape Horn, the Inspecting Officer may at any time proceed on board any ship to ascertain whether the stores and water provided have been duly inspected, or if not, whether they are of a quality fit for the use of the crew of the ship, and if he finds the same not to have been inspected, and to be deficient in quality, the ship shall be detained until the defects are remedied according to his satisfaction."

Under section 207, sub-section (4) of the same Act:

"If a seaman or apprentice is ill, and has, through the neglect of the master or owner of the ship, not been provided with proper provisions and water according to

[1] This information was obtained from M. C. Greig, H.M.'s Vice-Consul, Alexandria.

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his agreement...then the owner or master, unless it can be proved that the illness has been produced by other cause, shall be liable to pay all expenses (not exceeding on the whole three months wages) properly and necessarily incurred by reason of the illness...."

Under section 198, sub-section (1)—(2) of the same Act:

"If three or more of the crew of a British ship consider that the provisions or water for the use of the crew are at any time of bad quality, they may complain thereof to any of the following officers, namely, an Officer in command of one of His Majesty's ships, a British Consular Officer, a Superintendent, or a Chief Officer of Customs, and the Officer may either examine the provisions or water complained of, or cause them to be examined."

"If the Officer or person making the examination finds that the provisions or water are of bad quality and unfit for use, or deficient in quantity, he shall signify it in writing to the master of the ship, and if the master of the ship does not thereupon provide other proper provisions or water in lieu of any so signified to be of bad quality and unfit for use, or does not procure the necessary quantity of any provisions or water so signified to be deficient in quantity, or uses any provisions or water so signified to be of bad quality and unfit for use, he shall for each offence be liable to a fine of not exceeding twenty pounds."

In the case of emigrant ships special regulations are enforced with regard (1) to the issue of water during the voyage, (2) to the mode of carrying water, (3) to the shipping of water at intermediate ports.

(I) As regards the *supply and issue of water during the voyage* the Merchant Shipping Act of 1894 makes the following provisions:

Section 295 (1), "There shall be placed on board every emigrant ship, for the steerage passengers, provisions and water of good and wholesome quality and in sweet and good condition, and in quantities sufficient to secure throughout the voyage the issues required by this part of the Act (*i.e.* 'three quarts daily to each statute adult, exclusive of the quantity necessary for cooking any article issued under this Schedule[1] in a cooked state')."

(2) "In addition to the allowance of pure water for each steerage passenger, water shall be shipped for cooking purposes sufficient to supply ten gallons for every day of the length of the voyage, for every one hundred statute adults on board."

(3) "There shall also be shipped for the use of the crew and all other persons on board an ample amount of wholesome provisions and pure water, not inferior in quality to the provisions and water provided for the steerage passengers."

(4) "All such water and provisions shall be provided and stowed away by and at the expense of the owner, charterer, or master of the ship."

(5) "If any emigrant ship obtains a clearance without being provided with the requisite quantities of water and provisions in accordance with this section, the owner, charterer, or master of that ship shall for each offence be liable to a fine not exceeding 300 pounds."

[1] If necessary read Schedule XII of the list in question.

(6) "Before an emigrant ship is cleared outwards, the emigrant officer at the port of clearance shall survey or cause to be surveyed by some competent person the provisions and water by this Act required to be placed on board for the steerage passengers, and shall satisfy himself that the same are of good and wholesome quality and in sweet and good condition, and in the quantities required by this Act."

(7) "If the emigration officer considers that any part of the provisions or water is not of a good and wholesome quality, or not in sweet and good condition, he may reject and mark the same or the vessels or packages in which it is contained, and direct the same to be forthwith landed and emptied."

(8) "If the same are not forthwith landed or emptied, or if after being landed or emptied the same or any part thereof are reshipped, the owner, charterer, or master of the ship shall for each offence be liable to a fine not exceeding one hundred pounds."

Section 298 (1), (2), (3), of the same Act provides as follows:

"The master of any emigrant ship shall, during the voyage, including the time of detention at any place before the termination thereof, issue to each steerage passenger, or where the steerage passengers are divided into messes, to the head man for the time being of each mess, on behalf of and for the use of all members thereof, an allowance of pure water and sweet and wholesome provisions of good quality, in accordance with the dietary scales in the 12 Schedule to this Act which shall have effect as if they were contained in this section."

"If any requirement of this section is not complied with in the case of any emigrant ship, the master of the ship shall for each offence be liable to a fine not exceeding fifty pounds."

(II) As regards the *mode of carrying water* section 296 (1), (2), of the same Act provides as follows:

"The water to be placed on board emigrant ships as hereinbefore provided shall be carried in tanks or casks approved by the emigration officer at the port of clearance, and the casks shall be sweet and tight, of sufficient strength, and if of wood, properly charred inside, and the staves shall be made of fir, pine, or soft wood, and each cask shall not be capable of containing more than 300 gallons."

"If any requirement of this section is not complied with in the case of any emigrant ship, the owner, charterer, or master of the ship or any of them, shall for each offence be liable to a fine not exceeding fifty pounds."

(III) Concerning the *shipping of water at intermediate ports* section 297 of the same Act provides as follows:

"If an emigrant ship is intended to call at the intermediate port during the voyage for the purpose of taking in water, and if an engagement to that effect is inserted in the master's bond hereinafter mentioned, it shall be sufficient to place on board at the port of clearance such supply of water as is required by this part of the Act for the voyage to the intermediate port, subject to the following conditions; that is to say (*a*) the emigration officer at the port of clearance shall approve in writing the arrangement, and the approval shall be carried among the ships' papers,

and shall be exhibited at the intermediate port and delivered on the arrival of the ship at the final port of discharge to the chief officer of Customs, or British Consular Officer, as the case may be: (*b*) if the length of either portion of the voyage, whether to the intermediate port, or from the intermediate port to the final port of discharge, is not determined under this part of this Act, the emigration officer at the port of clearance shall declare the same in writing as part of his said approval of the arrangement: (*c*) the ship shall have on board at the time of clearance such tanks and water casks of the description this part of the Act requires, as are sufficient for stowing the quantity of water required for the longest of the aforesaid portions of the voyage."

In most of the ports of the United Kingdom, *i.e.* Glasgow, Tynemouth, Southampton, London, Liverpool etc., there are no special regulations regarding the supply and storing of water on ships; according to Dr Hubert Williams, Medical Officer of the Port of London, a certain number of ships are supplied by water-barges. These water-boats are kept under careful observation, and their tanks are cleaned out and limewashed at regular intervals, and whenever, in the opinion of the Inspectors of the Port, it is deemed necessary.

France[1]. There are no laws or regulations concerning the supply and storage of water on ships.

Inquiries made at Le Hâvre, Brest, Marseille, Boulogne, Dunkerque, and other French ports elicited the fact that the sanitary authorities did not concern themselves with the question.

Germany. We are informed by Dr Bumm, President of the Imperial Health Office in Berlin, that no imperial laws on the subject exist in Germany, but most harbour authorities provide stand pipes specially for ships. In Hamburg the port authorities give all captains a plan of the port, in which about twenty places, where good drinking water may be obtained gratis, are plainly marked.

On emigrant ships, iron tanks must be carried, the inner walls of which are coated with cement or some other suitable substance. In Hamburg, the water supply is under the direct control of the port medical officer, whose instructions contain a paragraph enjoining him: (1) to pay particular attention to the water supply of ships, (2) to see that water-boats carry water free from suspicion, and (3) that the tanks and pipes of such boats be always kept clean and in good order.

Similar instructions are given to the port medical officer of Bremen. The rules of Hamburg harbour forbid the use of Elbe water for drinking or cleaning the ship's eating, drinking and cooking utensils.

[1] Information obtained from M. Nettement, French Vice-Consul in Alexandria.

Russia, Belgium, Holland, Portugal[1]. There are no laws whatever on this point in these countries. In Russia, however, certain companies have drawn up rules for the guidance of captains, but there are no imperial laws.

Austria[2]. Passenger ships must carry water enough to supply each passenger with four to five litres of water per diem. The sanitary authorities pay special attention to this question, and from time to time examine samples of water both bacteriologically and chemically; if necessary, they order the water tanks to be emptied and cleaned. The medical authorities base their action on the fact that the law states that the captain is responsible for the good quality of the provisions of the ship; and drinking water is included under provisions.

Sweden[3]. The only law on this subject provides that every member of the crew and every emigrant must be provided daily with five litres of water for drinking and cooking purposes.

Norway[4]. According to Norwegian law, the drinking water should be stored in iron tanks, but this is compulsory in the tropics only. The tanks must be cemented or whitewashed inside and "perfectly clean."

The law states that iron-made tanks, which are used both as meat and water tanks, should be carefully cemented and should be cleaned with soda every year. Wooden tanks must be cleaned and whitewashed from time to time. There are also special recommendations regarding the place where water is taken, and with regard to boiling the water in harbours where there is yellow fever, cholera, dysentery, climate fever, beriberi or typhoid fever.

Bad water must be changed as soon as possible, and the tanks completely emptied and cleaned, before fresh water is taken in. This must be done also on ships going on a long voyage.

Italy[5]. In Italy, emigrant ships must carry enough fresh water to provide each person with five litres daily, unless there is a distilling machine on board. In any case enough water for three days must be stored always and in such a way that it cannot be contaminated. The reservoirs must be cleaned after each voyage and not refilled before the government medical officer or the "travelling commissioner" has inspected the tanks.

[1] Information obtained from M. d'Abazza, Russian Consul, M. Goor, Belgian Consul, Dr Demech, Dutch Delegate, Dr Mauri, Portuguese Delegate in Alexandria.

[2] Information obtained from Dr Osborn, Austrian Delegate in Alexandria.

[3] Information obtained from Dr Kartulis, Swedish Delegate in Alexandria.

[4] Information obtained from Dr Demitriadis, Norwegian Delegate in Alexandria.

[5] Information obtained from Dr Torella, Italian Delegate in Alexandria.

Inquiries made at various Italian ports (*e.g.* Livorno, Brindisi, Ancona, Venice) show that there are no local regulations regarding the water supply of ships in the chief Italian ports.

Ports in the Far East. A similar state of things exists in most harbours of the Far East. In some places, however, precautions are taken for the regular cleaning of water cisterns. In Rangoon for instance the floating cisterns are "occasionally" examined by the Port Health Officer. In Calcutta the tanks of water-boats are kept under lock and key. At Perim the tanks on the water-boats are regularly cleaned and coated with a cement-wash every three months. In all the other places from which we have been able to get information the rule seems to be that no special precautions are taken to insure pure water reaching the ships.

A similar state of things existed in Egypt, up to a few months ago. We were unable to get much information with regard to America. The Port Medical Officer of New York, however, states that there are no laws concerning the water supply of ships in New York harbour.

(II) *Bacteriological examination of ship water.*

During the year 1906 the water of ships calling at Port Said, of a certain number of pilgrim ships calling at El-Tor, and of a few ships at Alexandria, was examined bacteriologically. In each case, notes were taken of the source of the samples, the methods of storing, of filling the tanks and the possibility of contamination on board.

Data bearing on the possibility of contamination could not always be obtained for various reasons; and in many ships the tanks were so situated that inspection during the voyage was not possible.

The water was plated out as soon as the sample, taken in a sterilized vessel, had been carried in an icebox to the laboratory. The plates were made on agar and gelatin in Petri dishes, and on Conradi-Drigalski's medium in some cases.

Three agar and gelatin plates were used as a rule, each containing respectively 0·1 c.c., 0·05 c.c. of the sample, and 0·1 c.c. of a 1 % dilution in sterilized water.

During August, gelatin was not used, and later on 50 %, 40 % and 20 % gelatins were prepared. The gelatin plates were usually left for 72 hours in the dark at the temperature of the room. The concentrated gelatins impeded the growth of some bacteria, so that our numbers are sometimes too low.

In all cases a flask containing peptone solution was inoculated at the time of taking the sample, and tested for indole at the end of five days at 37° C. No attention was paid to vibrios, as Dr Zirolia has already studied that subject.

No attempt was made to isolate particular species, except in a few instances. *Bacillus coli* is specially mentioned as having been present occasionally, and when this is the case, attention had always been drawn to its presence by the strong faecal odour, emanating from the peptone flask. This organism must have been present in many other samples, as when actually found no special methods had been necessary for its isolation.

It was easily recognised on Conradi-Drigalski plates and the diagnosis verified by the usual biochemical tests.

The table on pp. 514—519 shows the main results of our investigations.

Discussion of results.

The fact is to be borne in mind that many of the ships, from which samples of water were taken, were not cargo-boats or ocean tramps, but liners belonging to the best English, French and German companies. The water on such high-class passenger ships was as bad, if not worse, than on other ships.

The main results of this investigation therefore are that in only one ship was the water fit to drink, that not unfrequently there was evidence of faecal contamination, and that in some it was little better than diluted sewage.

In some cases, the water provided to the passengers had been filtered on board, but although the number of colonies was markedly diminished by this process, yet the water was by no means bacteriologically clean.

Source of contamination of the water.

The water supply of ships may be contaminated at three different times:

(1) *The water supply of the harbour may be contaminated.*

(2) *The water may be contaminated between the shore and the ship.* This, owing to various reasons, is very often the case.

(*a*) *Deficiencies in hose.* When the water flows directly or is pumped through a hose from a standpipe to the ship, the hose may be the source of the evil. In harbours, the hose is often dragged along the ground,

through mud and dust, and screwed on without cleaning. Ruge (see Nocht, p. 223) has seen human excrements lying close to the standpipe. The hoses are frequently leaking and dirty water finds its way into them.

On one government ship we saw the men washing their heads and feet in the water which was flowing direct from the hose into the ship's water tank. Soapsuds, dirt, water and all went down together into the tank. Moreover, in many ships and harbours, there is no proper place for the storage of hoses.

(*b*) *Deficiencies in water cisterns.*

The danger is much greater when the water is taken on board ship by means of floating cisterns, owing to the dirty condition and faulty construction of the latter. In some instances, these are practically open tanks; the size and unprotected condition of the man-holes allowing direct contamination of water.

The wooden covers (for some boats are still provided with such) often fit badly and not uncommonly are absent altogether.

In one case, for instance, we saw a water lighter steaming slowly past a ship which was being washed down, after coaling. As the hose was raised, a stream of dirty water poured through one of the man-holes directly into the water tank.

It is not uncommon to find a thick layer of coal dust, and a plentiful crop of weeds on the surface of the water. The walls of the cistern are often covered with an adhering viscid material.

A few bacteriological examinations of the cisterns will show how greatly the water in them may be contaminated.

No. of water tank		Number of colonies in 1 c.c.
I.	(Suez)	5580
II.	(,,)	3720
III.	(Port Said)	44470
IV.	(,,)	13050
V.	(,,)	14400
VI.	(Alexandria)	500
VII.	(,,)	800

The worst water was found in the water tanks supplying passenger ships trading with the East. That this water was unfit for drinking purposes was evidenced by the scum which was floating on its surface.

It can be shown that the water may become contaminated in the floating cisterns. In the following table, for instance, we have registered the number of colonies at the standpipe, and that of the same water after three days' storage on board water cisterns.

	Date....29th March	30th March	April 1st
	Number of colonies		
Standpipe (*a*)	20	20	20
,, (*b*)	25	25	25
Water tank A (*a*)	280	380	740
,, ,, (*b*)	170	290	800
,, ,, B (*a*)	140	210	560
,, ,, (*b*)	125	235	520
,, ,, C (*a*)	240	350	640
,, ,, (*b*)	255	345	620
,, ,, D (*a*)	270	370	870
,, ,, (*b*)	255	330	?

In another series of the experiments the number of colonies obtained was greater still, in one case rising from 5 per c.c. at the standpipe to 1920 per c.c. after three days.

(3) *The water may become contaminated on the ships themselves.*

(*a*) Deficiencies in supply pipe.

In many ships, particularly cargo-ships, the opening of the intake, or supply pipe, is flush with the deck and closed with a screw cap. In Eastern ports, these screw caps are usually removed when the ship is in port, in order to prevent their being stolen; and a wooden plug, usually wrapped round with a piece of dirty cloth or canvas, does duty instead. Often the supply pipe is simply left open.

We noticed for instance a ship which was taking in water and coal at the same time. The intake pipes of the above type were placed at the same level on the port and starboard sides of the ship. Both were open and the starboard tank was being filled from the lighter lying along the port side of the ship. The hose was leaking freely as is usually the case, and as the ship had a heavy list to port, the water from the hose, after washing the very dirty deck, was pouring into the unprotected port tank. In some ships the ventilating pipes, conveying air for the ship's suction pumps, are insufficiently protected, or omitted altogether, the air pressure being then obtained from the top of the tank.

(*b*) Deficient protection against outside contamination.

The tanks, though water tight as a rule, are not always protected against outside contamination. In some cases we have seen pilgrims and fourth class passengers camping over the tanks, their dirty bedding being spread over the man-hole. As this was not hermetically closed, faecal contamination must have taken place. In one ship indeed where this state of things was noted the water contained 243,400 colonies per cubic centimetre, including many colonies of *Bacillus coli*.

(*c*) Inefficient methods of cleaning.

The methods of cleaning ships' tanks are extremely crude. Generally the only method is that men enter the tank with bare and presumably dirty feet and possibly dirtier habits.

Whether all the stories told in this connection by naval officers are true or not we cannot say, but no one who has had experience with ships' crews will think them exaggerated.

(*d*) Faults in distilling machines.

These dangers are not nullified on ships, *e.g.* war ships, which carry distilling machines. Not to speak of the possibility of the water being contaminated after being distilled, it is a fact that many distilling machines are badly made and that the water is contaminated during the process of distillation. This fact is indeed well known to engineers. We have heard complaints, from crews of British war ships, regarding the foulness of the distilled-water provided on board.

Many ships, although carrying a condenser, also take a certain quantity of water on shore and fill up with distilled water from day to day, when at sea. The resulting mixture may be appalling, although the passengers fondly believe that they are drinking distilled water.

(*e*) Faulty construction of tanks.

Most water tanks are so made that they cannot be emptied completely, and a residue amounting occasionally to several inches remains when the water is allowed to escape for cleaning purposes. This is due to the fact that there are no taps in the floors of the tanks. As a result, water, however clear and pure at the time of introduction, is immediately fouled by the residue of the old water left in the tank.

The distribution of water to passengers on board ships also leaves much to be desired. The water is generally unfiltered and when there is a filter on board it is often a useless, if not dangerous, charcoal filter. The bottles of water are frequently far from clean and the water is often allowed to stand in bottles from one voyage to the other, during the ships' stay in port. We have seen more than once larvae of mosquitoes and insects in the washing and drinking water on ocean-going steamers. Lastly, on some ships carrying emigrants and pilgrims from Eastern ports, deck passengers can only drink by sucking water up through tubes in direct communication with water tanks. The danger of this proceeding need not be emphasised.

No.	From what Port	Source of sample taken	Method of filling tanks	Method of stowing water on board	Possibility of contamination on board
1	Bombay	Aden	Hose from lighter	In iron tanks cemented	Improbable
2	Colombo	Colombo & Port Said	Hose from lighter	Iron tanks cemented	Probable
3	Calcutta	Calcutta	Hose from quay	Iron tanks cemented	Probable
4	Manilla via Bombay	Suez (mixed)	Hose from lighter	Iron tanks cemented	
5	Colombo	Colombo	Hose from lighter	Iron tanks cemented	Probable, opening of intake pipe flush with deck
6	Nagasaki Singapore Colombo	Colombo	Hose from lighter	Iron tanks and double bottom	Improbable
7	Singapore	Singapore	Hose from quay	Iron tanks cemented	Probable, unprotected air pipe communicating with tanks, flush with deck
8	Surabajia	Condensed		Iron tanks cemented	Probable, opening of intake pipe flush with deck
9	Yokohama	Colombo & Penang	Hose from lighter	Iron tanks cemented	Possible
10	Karachi	Karachi	Hose and hydrant from quay	Iron tanks cemented	
11	Bombay	Bombay	Hose and hydrant from quay		
12	Yokohama Burma Colombo	Mixed	Lighter containing casks and small iron tanks in Colombo	Iron tanks cemented	Intake pipe opening on wooden block about 2½ inches above deck
13	Karachi	Karachi	Hose and hydrant from quay	Iron tanks cemented	Probable, opening of intake pipe flush with deck
14	Calcutta	Calcutta & Colombo	Hose from lighter	Iron tanks cement washed	
15					
16	Port Said	Port Said Water-lighter			Large man-holes on deck communicating directly with interior of tank, supplied with ill-fitting wooden covers which appear to be habitually unused. Scum on surface of water
17	Odessa	Clazomene	Hose and lighter	Iron tanks cemented	Highly probable, intake pipe through port-hole in steerage and through large iron man-hole in floor of deck below steerage, which was full of Russian pilgrims, and in a very dirty condition
18	Sinope	Distilled			Improbable
19	Hamburg	Hamburg	(Water steamer)	Iron tanks cemented	Improbable. Intake pipes on outside opening well protected and communicating directly with tanks
20	Bremen	Bremen		Iron tanks cemented	Improbable. Intake pipe as in no. 19
21	Hamburg	Hamburg	Company's lighter	Iron tanks cemented	Improbable, vide 19 for one tank, for other tanks opening of intake pipe on top of tank, abaft engine room raised some 4 feet from floor of deck, and with proper iron covers
22				Vide 35	Vide 35
23	Birkenhead	Birkenhead	Hose and hydrant from quay	Iron tanks cemented cleaned out 3 weeks ago	
24		Condensed			

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Number of colonies		Reaction on Conradi Drigalski plates		Gas	Indole	Month	Remarks
Agar	Gelatin	Acid	Alkaline				
058 unfilt. 260 filt.					3	Aug.	Contains a few vibrionic forms and a very vigorous growth of *B. fluorescens putidus*. Impossible to count colonies in gelatin owing to rapid liquefaction by *B. fluorescens* and heat combined.
10056					3	Aug.	Contains *B. fluorescens*. Temp. of laboratory too high to admit of accurate counting of gelatin colonies.
30132					2	Aug.	
24200				+	3	Aug.	Contains approximately 1 *B. coli communis* to the drop. Had previously taken water in Yokohama and Bombay.
6130		+			1	Sept.	
242 filt. 280 unfilt.					filt. 0 unf. 3	Sept.	Troopship.
28340	32430				3	Sept.	Numerous vibrios, no cholera-red reaction.
4004	12465				0	Sept.	
8900	16700				½	Sept.	Water supply renewed in Shangai, Penang, and Colombo.
3829	11875				2	Sept.	
7990	15435				0	Sept.	
38170	65430				2	Sept.	Some Yokohama water left in tanks, condensed from Burma to Colombo. Sample contains Port Said water mixed with above.
2196	8050				½	Sept.	
3480	14086				0	Oct.	
8440					2	Oct.	Numerous rose-red chromogenetic bacteria.
44470	2090				3	Oct.	
7620 filt.	20480 filt. 660 liquefying colonies		+	+	3	Dec.	This ship coming from cholera infected port passed through in quarantine, but had not had any case of cholera on board. Peptone solution showed no vibrios.
890	110	−	+	−	0	Dec.	Had taken on Russian pilgrims from the "Gregory Merck" and had had cholera on board since leaving Sinope. Vibrios isolated from one case. Culture taken at time of our visit. Water distilled in apparatus said to be of English make, no vibrios in peptone solution from sample of water.
4320	630	trace	−	−	0	Dec.	Supply taken on in Hamburg from Company's own well by Company's water steamer.
9400 5200	220	−	+	−	1	Dec.	
9750 filt.	21400 filt.	+	−	+	2	Dec.	
0320 filt.	40940 filt.	+	+ +	+	3	Dec.	
5615	16060 liquefying 420	+	+	0	0	Dec.	The growth appeared only after 48 hours incubation, examination also showed majority of bacteria present to be sporogenic bacilli.

No.	From what Port	Source of sample taken	Method of filling tanks	Method of stowing water on board	Possibility of contamination on board
25		Condensed, but from tanks which had contained Malta water			
26		Condensed			
27	Jeddah	Suez	Hose and lighter	Iron tank cemented of 135 tons capacity divided into 4 sections, each cut off from the others	Possible, owing to improper protection of intake pipe
28	Jeddah	Distilled		Iron tanks cemented, not inspected	
29	Jeddah	Port Said	Hose and lighter	Iron tanks cemented	Probable, large man-hole leading directly to tanks in the main deck in the midst of the pilgrims' quarters. Opening closed by wooden cover only slightly raised above level of deck
30	Jeddah	Constantinople	Hose and lighter	Iron tanks cemented	Probable, the opening of the intake pipe into one tank raised on block about 2 inches above the deck, the other pipes open flush with deck
31	Jeddah	Odessa & Sevastopol		Iron tanks cemented	Probable, opening of intake pipes flush with deck
32	Port Said	Port Said			Vide no. 16
33	Port Said	Port Said			Vide no. 16
34	Bombay	Bombay	Hose and hydrant from quay	Iron tanks cemented	Improbable, opening of intake pipe raised 1 foot above level of deck
35	Yokohama	Mixed	Lighter	Iron tanks cemented	Highly probable, intake pipes flush with deck, tanks aft in ship's double bottom, closed with ill-fitting iron lids, accessible to contamination by carpenter or carpenter's mate (Chinese)
36	Bombay	Mixed	See Remarks	Iron tanks cemented	Probable, intake pipes flush with deck
37	Brindisi	Brindisi well	Hose and lighter	Iron tanks cemented	
38					
39	Java	Sumatra	See Remarks	Iron tanks cemented	Probable, opening of intake pipes flush with deck, brass caps to same, replaced while in port with ill-fitting wooden plugs wrapped in dirty clothes, these not removed while deck was washed down
40	Colombo	Colombo	Lighter and hose	Iron tanks cemented	Probable, opening of intake pipe flush with deck
41	Colombo	Mixed	See Remarks	Iron tank cemented	Possible, opening of intake pipe flush with deck
42	Kobe	Calcutta	Kobe, closed lighters Calcutta, hose and hydrant from quay	Iron tanks cemented	Improbable

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Number of colonies		Reaction on Conradi Drigalski plates		Gas	Indole	Month	Remarks
Agar	Gelatin	Acid	Alkali				
12430	25935 liquefying colonies 790	0	+	0	0	Dec.	24, 25 and 26 are warships.
15860	10800 no liquefying colonies in gelatin						Sample shows heavy precipitate of AgCl with $AgNO_3$ showing presence of NaCl: there had been complaints on board as to taste and smell of this water which was distilled from Port Said harbour water (Naval basin).
2400	13200	−	+	−	−	Feb.'08	Pilgrim ship from Jeddah. Had taken no water since leaving Suez on the 22nd Dec. '07. No vibrios present. Ship very clean.
3800	26300	+	−	−	−	Feb.'08	Pilgrim ship from Jeddah. Had taken water in Constantinople. No vibrios present. Ship moderately clean.
9100	37400	+	−	+	3	Feb.'08	Ship conveying pilgrims from Jeddah. Was in a very dirty condition. This sample contained no vibrios, but large numbers of *B. pyocyaneus* and *B. coli communis*. The latter species constituted the majority of organisms present.
							Pilgrim ship, very dirty. Sample contained no vibrios, but a very large number of *B. coli communis* and *B. pyocyaneus*. The latter producing a large amount of deep green pigment.
							Pilgrim ship, very clean. No vibrios.
13050	16130				3	Oct.	
14400	5195				3	Oct.	
7870	20048				3	Oct.	
18494	14050				3	Oct.	Ship had taken water in Yokohama, Kobe, Hong-Kong, Saigon, Singapore, Colombo and Suez, the sample taken consisted of probably the remains of all these waters and distilled water which had been used to replenish the supply. There was a visible scum on the surface of the water in the tanks. Vigorous growth of *B. pyocyaneus* present.
7420	5595				2	Oct.	*Pyofluorescens* present. Sample consisted of water from Bombay, Chittagong, and Colombo, taken in from hose and hydrant at Bombay and from covered lighters at Chittagong and Colombo.
144500	50125				3	Oct.	Next to no liquefying colonies on gelatin.
36190 glucose agar 259875	7845				2	Oct.	This would denote an excess of anaerobic bacteria.
11570	925 liquefying colonies. Total number not estimated				3	Sept.	Ship had taken water in Surabajia (Java) and Penang, from closed lighter in Surabajia and from hose and hydrant in Penang, vibrios present in water. Peptone solution did not give cholera-red reaction. There had been a certain amount of diarrhœa among the crew during the voyage, two men were still suffering from it. On glucose agar 209250 colonies per c.c.: *i.e.* excess of anaerobic bacteria.
7595 glucose agar 2760	2530				0	Sept.	
8655 filt. glucose agar 1600 filt. 2313 unfilt.	773 filt.				3	Sept.	*Pyocyaneus* very deep green pigment present. Ship had taken water in Hamburg, Antwerp, Cape Town, Sydney, Freemantle and Colombo. Sample taken probably represented remains of all these waters. Water had been taken in from lighters in Hamburg, Freemantle and Colombo, in other ports by hose [and hydrant.
575 glucose agar 550	983				0	Sept.	Contains *B. subtilis*.

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No.	From what Port	Source of sample taken	Method of filling tanks	Method of stowing water on board	Possibility of contamination on board
43	Singapore	Singapore	Hose from quay	Iron tanks with a special patent cement	Improbable
44	Singapore	Distilled		Iron tanks with a special patent cement	Improbable
45	Karachi	Karachi	Hose and hydrant from quay	Iron tanks cemented	Improbable
46	Batavia	Singapore	Hose from quay	Iron tanks cemented	Probable, opening of intake pipe flush with deck
47	Calcutta	Calcutta & Colombo	Lighter and hose	Iron tanks cemented	Probable, opening of intake pipe flush with deck and brass caps replaced while in port with ill-fitting wooden plugs
48	Zanzibar	Zanzibar & Aden	Hose and lighter	Iron tanks cemented	Very improbable, intake pipe fitted to side of ship
49	Bombay	Bombay & Karachi	Hose and hydrant from quay	Iron tanks on deck cemented	Possible, intake pipe flush with bridge deck
50	Calcutta	Calcutta	Lighter and hose	Iron tanks cemented	Possible, opening of intake pipe flush with deck
51	Bombay	Bombay	Hose and hydrant from quay	Iron tanks cemented	Opening of intake pipe raised 2 ins. above the deck
52	Surabajia	Surabajia	Lighter and hose	Iron tanks cemented	
53	Calcutta	Calcutta	Hydrant on quay Giddipore Docks	Iron tanks cemented	
54	Sydney	Aden	Lighter and hose	Iron tanks cemented	
55	Surabajia	Aden	Iron tanks sealed in lighter	Iron tanks cemented	Improbable, opening of intake pipe in engine room
56	Karachi	Karachi	Hydrant and hose from quay	Iron tanks cemented	Improbable
57	Bombay	Bombay	Hose and hydrant from quay	Iron tanks cemented	
58	Brisbane				
59	Marseilles	Marseilles		Iron tanks cemented	Improbable, intake pipes protected
60	Yambo	Suez	Hose and lighter	Iron tanks sealed and cemented	Intake pipes flush with deck
61	Yambo	Suez	Hose and lighter	Iron tanks cemented	Tanks under main deck, forward and aft. Large hatches in main deck, securely fastened and caulked. Underneath a properly fitting iron man-hole, closed rubber washer and dog clamp. Ventilating pipe. Not much likelihood of contamination through above. Intake pipes flush with deck
62	Yambo	Suez	Hose and lighter	Iron tanks cemented	Main storage tanks down in fore-peak, under main deck. Tanks are simply protected by ill-fitting wooden hatches, not caulked or rendered water tight in any way: on top of this Arab firemen etc. have their quarters. Under the wooden hatch in a direct line are the usual iron man-holes, which are not properly closed. The ventilation is effected by a hole in the covers, directly under the rotten hatches mentioned, opening directly into the tanks and not protected from contamination in any way. There is no ventilation pipe upon deck. The tanks, of which there were several, are connected together by pipes awash in bilge water, so that contamination in one tank is liable to spread to all

Number of colonies		Reaction on Conradi Drigalski plates		Gas	Indole	Month	Remarks
Agar	Gelatin	Acid	Alkali				
8635 glucose agar 16140	8520				½	Sept.	Excess of anaerobic bacteria.
40	12				0	Sept.	
9780 glucose agar 7350	8273				1	Sept.	Captain landed at Port Said and died of enteric fever.
115950 glucose agar 61200					3	Sept.	Had taken water Batavia, Samarang and Singapore. Contains numerous liquefying colonies, which liquefied the gelatin plates too rapidly to permit accurate counting.
6520 glucose agar 10450	11666				2	Sept.	
580 glucose agar 990	7220				2	Sept.	In gelatin, much liquefaction and numerous chromogenetic colonies.
8270	6640	+	+	+	2	Oct.	*B. fluorescens* prominent but little liquefaction of gelatin.
7600	37345	−	+		1	Oct.	
28380	12216	+	−	+	2	Oct.	
200460	181440	+	−	+	4	Oct.	
76416	38610	trace	+	0	0	Oct.	
156240	179050	+	−	+	3	Oct.	
73444	210688	−	+	0	0	Oct.	
5200	12000	trace	+	0	trace	Oct.	
11962	9870	+	+	+	2	Oct.	
66950	43560	+	+	+	2	Oct.	
63160 unfilt. 4990 filt.	93100 unfilt. 19053 filt.	+	0	+	2	Dec.	Indole present in both. On evaporation samples left a brown deposit which charred on ignition. *B. coli communis* present.
97400	124600	+	+	−	1	Mar.'08	Pilgrim ship, no vibrios.
67600	117300	+	−	+	3	Mar.'08	*B. coli communis* present. Pilgrim ship. No vibrios.
176700	243400	+	+	+	5	Mar.'08	*B. pyocyaneus* and *B. coli communis* present, the latter in enormous numbers. The ship was very crowded and in an extremely filthy condition. No vibrios.

state of things are as follows:

(1) The source of the water must be above suspicion. Ships therefore should be allowed to take water only in places licensed by the medical officer of the port.

(2) The hoses, pumps, water-boats, etc., should be the property of the port sanitary authorities, who would then be responsible for the proper storing and cleaning of such apparatus. Should this be impossible, no apparatus or water tank should be used, until it has been examined and declared satisfactory by the said authority. All the apparatus should be examined and tested once a month.

(3) Intake pipes flush with the deck should be absolutely prohibited. They should be replaced by upright iron pipes, three feet high, of standard gauge, having their free ends bent downwards and fitted with screw cap chained to the pipe. When in use the cap should be removed and the hose screwed on. Some simple device would indicate when the tank was full.

(4) All water tanks on board ships should be made of iron, and coated inside with cement.

(5) All water tanks should be placed so as to allow inspection at any time during the voyage.

(6) All water tanks should be so closed as to avoid all chances of contamination during the voyage.

(7) All water tanks should be fitted with ventilating pipes which should be carried up to a sufficient height to prevent contamination.

(8) One or more taps should be placed through the floor of tanks to insure the latter being completely emptied at regular intervals. The tanks should be constructed with "round corners"; the floor of the tanks should be sloping towards the taps used for emptying the tanks.

(9) The tanks should be completely emptied and disinfected after each voyage. The methods used at present for this purpose are extremely unsatisfactory. Some form of gaseous disinfection would probably give the best results.

(10) In order to insure these rules being carried out, an international agreement is necessary.