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MARINE HYGIENE AND SANITATION

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MARINE HYGIENE

AND

SANITATION

A MANUAL FOR SHIPS' SURGEONS AND PORT HEALTH OFFICERS

BY

GILBERT E. BROOKE

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To

THE MEMORY OF

CAPTAIN LANCASTER

AND

SURGEON RAPHE SALTER

OF THE EAST INDIA COMPANY'S SHIP "DRAGON"

WHO, ON A VOYAGE TO INDIA IN A.D. 1600,

FIRST ATTEMPTED TO TACKLE THE

PROBLEM OF SCURVY

AND LAID THE KEEL OF MARINE HYGIENE.

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FOREWORD

THIS volume is the outcome of a need which I early felt, both as a Ship's Surgeon and as a Port Health Officer, for some chart to keep me clear of the quicksands of marine work.

Public health problems, whether by land or sea, have, of course, the same object in view; but in organisation and practice marine work is highly specialised, and differs materially from health work ashore.

With the exception of a few books on limited aspects of the subject—such as Gatewood's "Naval Hygiene," Doty's "Prevention of Infectious Diseases," Melville-Davison's "Ships' Hygiene," etc.—the Marine Health Officer has no precedent or practice to guide him.

Armed with a D.P.H., bubbling over with ideas on food analysis, septic tanks, housing problems, and so forth, at the beginning of my career I went afloat only to find myself "at sea"! Within a very short time I had missed a smallpox patient hidden in a ventilator, and a case of cholera secreted in the chain-locker; I had mistaken a case of plague for measles; nearly broken my legs over alley-way combings; and had killed a Captain's dog during a disinfection.

This is my apology for launching the book.

It has no pretence to rank as a textbook, but simply aims at providing a handy manual of "sailing directions" in as practical and colloquial a setting as possible.

Apart from the great movement of passengers by ocean travel-routes, the fact that the British Mercantile Marine consisted of 292,057 officers and men in 1913, and the British Navy of 150,000 officers and men in 1914, is sufficient to

emphasise the need for vigilance and efficiency in all matters concerning the health of our floating population.

As this book is going to press, the long-needed Ministry of Health has become an accomplished fact, and will presumably supersede the polymorphous medical control formerly vested in the Board of Trade, Local Government Board, etc. We can but hope that, under the new régime, the problems of marine hygiene will meet with the meed of attention which their importance demands; and perhaps, eventually, the Universities of our seaport towns, such as London, Liverpool, Bristol, etc., may be induced to institute a D.P.H. (Marine) —which might be insisted on as a necessary qualification for the posts of Port Health Officer or Ship's Surgeon, or for the acceleration of promotion in the Naval Medical Service.

GILBERT E. BROOKE.

BATH,
November, 1919.

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MARINE HYGIENE AND SANITATION

CHAPTER I

THE SHIP'S SURGEON

' Who hath desired the Sea ? Her excellent loneliness rather
Than forecourts of Kings, and her outermost pits than the streets where men gather
Inland, amongst dust. . . ."

The Sea and the Hills.

THIS chapter chiefly concerns the work of the Medical Officer in the Mercantile Marine—the busy life of the mail steamer, the potentialities of a human cargo of 1,000 pilgrims or 2,000 coolies, or the possibilities on a tramp at eleven knots with her load-line awash. There are but few rules or precedents to guide such surgeon, and he has to steer clear of the shoals as best he can.

The naval surgeon, on the other hand, is made fast with red tape, with his duties clearly defined and well understood. For this reason, things essentially naval are only partially broached.

Historical Review.

The connexion of the medical profession with the sea is an old one, and, as might be expected, began in the Navy.

Although cannon were first used on ships in the year 1338, yet this weapon of war was not generally adopted until some fifty years later; and even then, medicine and surgery were hardly sufficiently advanced to provide for the resulting surgical needs of the seaman.

The seaman's life of those days was not a particularly enviable one. If he stole an oar he was hanged; and even if he didn't, he probably died of scurvy!

About the middle of the sixteenth century, however, surgeons were occasionally appointed to men-of-war; and in the naval records of that time we find their pay stated to be £1 per mensem. This is not far short of a seaman's wages a few years later. In 1626 the latter got 15s. per mensem, and had to give 2d. of this to the Surgeon, and 4d. to the Chaplain! although one would have thought that a man's body would have been worth twice as much to the nation as his soul; but perhaps the Surgeon killed him! The Surgeon's pay had by that time been raised to £1 10s. a month, and he had as assistant a "Surgeon's Mate" at £1. Both boatswains and carpenters got more pay than this, but the "powers that were" soon adjusted the matter. In 1653 the Surgeon's pay was raised to £2 10s. per mensem and in 1693 to £5.

The first mention that I can find of surgeons being appointed to the Mercantile Marine is in the Council Minutes of the first East India Company, on December 1, 1600. They were then fitting out four ships for India, and agreed to have "surgeons ffor ech shipp twoe and a barber," and they even sanctioned, for the surgeon on the commodore ship, £32 "for the furnishing of his Chest wth all kinde of necessaries and remedies belonging to a Chirurgion to be vsed in this viage." It was on this voyage that the control of scurvy was first successfully attempted.

From that time we lose sight of the Surgeon on the non-armed ship, or at most get but chance references to his occasional presence, until it became compulsory, in 1844, that he should be borne in specified circumstances. It is otherwise in the Navy, where we have a fairly continuous history of the department and its organisation from the middle of the seventeenth century onwards. The naval Surgeon of those days was not always a desirable specimen! An officer writing to a friend (*temp.* Car. I.) says: "There are few surgeons, and these few haunt the taverns every day." The control of the department in 1653 was vested in a Board of four "Com-

missioners of Sick and Wounded," whose office was situated in Little Britain. Their chief claim to fame lay in the sanctioning of medical comforts to each ship, to the value of £5 per 100 men each six months, and the retention on the "pay-bill" of those invalided to shore, until recovery or death.

In 1664 the control passed to a new official, who was appointed by the Lord High Admiral, and called "Surgeon-General to the Fleet." With the exception of an order (in 1703) to the effect that journals and records of cases were to be kept, very few beneficial results followed from his régime; in fact, one can faintly imagine the language of the Surgeons when it was ordained that all medicines, drugs, and instruments had to be personally taken to the Apothecaries' Hall for approval before being embarked!

In 1740, Admiralty readjustments took place, and medical matters were entrusted to a committee of three, with offices on Tower Hill. Their specific duties were: (*a*) Care of sick and wounded seamen: (*b*) supply of medical stores to the Navy; (*c*) management of naval hospitals ashore and afloat; (*d*) examination and appointment of naval Surgeons; and (*e*) [*sic*], the maintenance and exchange of prisoners of war.

It was about this time (1740) that Smollett got a warrant as a "Surgeon's Mate." This cost him about 30s. The Commissioners at the Navy Office gave him a recommendation (price 2s. 6d.) to the Surgeons' Hall; and examination, certificate, and tips came to a further 10s. 6d. The Surgeon and Chaplain had very ill-defined positions in the ship's social economy in those days. The wardroom mess only included the Lieutenants and the "Master," and occasionally the Surgeon; but the Chaplain and Purser very rarely. The Surgeon's Mate had a horrible time, however, and Smollett describes the six feet of mephitic and gloomy cockpit in which he messed with the "loblolly-boy" or sick-berth attendant.

From about this time until the middle of the nineteenth century, the official nomenclature of medical appointments seems to have been changed. Instead of Surgeon and Surgeon's Mate, we have Fleet Physicians, Physicians, and Medical Officers. In 1782 a Fleet Physician became entitled to share

prize-money on the same scale as Lieutenants. (The Fleet Physician in Rodney's flagship was Sir Gilbert Blane.)

Before 1795 the Surgeon had always been allowed 15s. per patient for the cure of venereal disease, and, judging from the history of the time, must have made a good income from this source. But the old rule was then done away with, and, in lieu of the fee, £5 per annum was given to the Surgeon for each 100 men borne in his ship, or £4 if the number of the complement was less than fifty. At the same time, widows of Surgeons were granted pensions of £30 per annum if their husbands had been on the half-pay list.

We are now getting to more modern times. On January 22, 1805, uniforms were sanctioned for surgeons. In 1832 the Navy and Victualling Boards were abolished and replaced by five separate departmental officers, one of whom was called "Physician-General." Nine years later this official had his title changed to "Inspector of Naval Hospitals and Fleets," another change being made in 1843, when he received the title he now holds of "Director-General of the Medical Department."

That year was memorable in that it saw the transmutation of Surgeons, Paymasters, and Chaplains from warrant to commissioned officers.

At that time "Physicians" wore a dress sword with a rapier blade, and had an "anchor and twisted serpent" on the collar of their uniform. "Medical Officers" had the device only on their buttons.

The year 1860 saw the birth of the magic curl on the gold braid of the executive officers' sleeves; while, three years later, the distinctive coloured stripes were inaugurated for the other branches of the Service.

Then came the change of title from Fleet Physician, Physician, and Medical Officer, to Fleet Surgeon, Staff Surgeon, and Surgeon; with the higher grades of Deputy Inspector-General, and Inspector-General of Fleets and Hospitals. The two latter titles were subsequently altered to Deputy Surgeon-General and Surgeon-General.

After a long period of years these titles (in common with

those of the Pay branch) were again changed, as from November 8, 1918, the ranks now being: Surgeon-Lieutenant, Surgeon-Lieutenant-Commander, Surgeon-Commander, and Surgeon-Captain.

With regard to the **Mercantile Marine,** as already stated, we hear but little of the medical profession until recent times.

As on the occasion quoted, in the year 1600, a surgeon was probably occasionally employed for long, important, or semi-official voyages; but crews were generally given over to the tender mercies of the Master.

For a good many years down to 1844, it had been compulsory to carry a medicine chest (*vide* the Merchant Shipping Act of 1835—5-6 W. IV., cap. 19, sec. 18); but the consolidated Act of **1844** was the first to recognise the importance of the subject, and to impose legal obligations *re* surgeons (7-8 Vic., cap. 112, sec. 18). This Act made it compulsory to carry a duly qualified Physician, Surgeon, or Apothecary if there were (*a*) 100 persons on board; or (*b*) more than 50 passengers, and the voyage one of twelve or more weeks' duration. The same Act laid down that, for ships to ports outside Europe, or foreign-going ships, not only was it necessary to carry a supply of medicines for disease and accident, but lime or lemon-juice had to be provided for the crew at the rate of $\frac{1}{2}$ ounce per diem per man, and vinegar at the rate of $\frac{1}{2}$ pint per week.

The next amendment of the Merchant Shipping Act was in 1854 (17-18 Vic., cap. 104, sec. 230). This Act omitted requirements for passenger ships (which were dealt with by another Act), and only insisted on a qualified Surgeon if there were more than 100 souls on board.

The Passengers Act of 1855 (18-19 Vic., cap. 119, secs. 41 and 42) laid down that a practitioner duly qualified to practise in some part of H.M. dominions must be rated on the ship's articles when: (*a*) the number of passengers exceeded fifty, and the duration of the voyage was over eighty days (sail) or forty-five days (steam); or (*b*) the total souls on board exceeded 300.

The Passengers Act was later absorbed in consolidations of the Merchant Shipping Act.

The Merchant Shipping Act of 1867 (30-31 Vic., cap. 124) was very much on the lines since followed by the subsequent amendments of 1876, 1894, and 1906. Section 4 required foreign-going ships to carry proper medicines and medical stores; and, if their voyage were outside Europe or North America, to carry lime-juice sufficient to supply 1 ounce per diem to each man after the ship had been at sea for ten days. Sections 9 and 10 authorised the Board of Trade to appoint a Medical Inspector of Seamen. Section 130 required every foreign-going ship to have a duly qualified medical man on board if her population was 100 or more. In this Act also, for the first time, crew space was dealt with—*vide* Chapter III.

The current Merchant Shipping Act requires a medical practitioner, as in the section above, for foreign-going ships. But for an "emigrant ship," only if there are 50 emigrants on board or more than 300 souls all told.

Governing Bodies dealing with Marine Matters.

The Admiralty is, of course, the body which controls the Navy and its affairs, but for the beginning of official control we must go back to the time of Edward I. As a result of his crusade to Palestine, that monarch was evidently much impressed with the possibilities of sea power; and, in 1286, he appointed W. de Leybourne, under the title "Admiral de la mer du Roy d'Angleterre," and put him in charge of maritime matters. The duties were later divided between an "Admiral of the North" and a similar official "of the West." In 1361 Edward III. made the then Warden of the Cinque Ports—Sir John de Beauchamp—"High Admiral of England."

For the next forty or fifty years the duties of this post covered the control of mercantile as well as naval matters, both administrative and judicial; and the scheme was continued for a further period after Henry IV. had created the holder "Lord High Admiral" in 1406.

At last, in 1709, the office was put into commission, and

has so continued (with one short exception) down to the present day. Amongst the various duties of this Board of Commission, under control of the "First Lord," who is a kind of Secretary of State, the "First Sea Lord" appoints the senior officers, the Second Sea Lord appoints the junior officers, and the Fourth Sea Lord is responsible for victualling, etc. The Director-General of the Naval Medical Service is the responsible adviser to the Admiralty on naval medical matters, and the administrative head of that department.

The Board of Trade.—A "Committee for Trade" was first appointed in 1622. This was split up by Charles II. into two Councils, one for "Trade" and one for "Foreign Plantations," only to be amalgamated in 1672 and its duties transferred to the Privy Council in 1675.

In more or less its present form it emerged in 1786. Besides an immense work in trade—railways, trams, water, gas, etc. —the Board is the chief controlling factor of the Mercantile Marine. The work in this department was so great that it was constituted into a separate branch in 1850. The duties of this "marine" department cover: Survey of ships (54, Victoria Street, S.W.), registry for engagement and discharge of seamen (Tower Hill, E.C.), examination of masters and mates (68, Victoria Street, S.W.), examination of engineers (79, Mark Lane, E.C.), etc.

The Local Government Board.—This is the modern evolution of the old "Poor Law Board," being created by the L.G.B. Act of 1871. Its life has been rather like a snowball in the constant increase of its supervisory powers over local government —so much so that a humorist has said that "England is ruled by an order of the Local Government Board"! Its main energies find vent in the supervision of Poor Law, public health, and local finance.

As a Health Authority, it approves of Medical Officers of Health, inspects school children and foodstuffs. It supervises the work of Local Authorities in connection with the administration of Public Health Acts, and thus is closely bound up with the subject of Marine Hygiene.

The Regulations issued by the Board to prevent the intro-

duction of plague, yellow fever, and cholera, are the Bible of the English Port Health Officer, and correspond with the quarantine laws of the Colonies and other countries.

Trinity House.—This Society was incorporated in 1514 by Henry VIII. In its early days it was largely interested in the control of naval dockyards and the superintendence of naval construction, as well as in the erection of beacons round the coasts. At the present day, in addition to nautical advisory work in the Admiralty Courts, it is the chief controlling body for Pilotage and Lighthouses, and in the latter capacity is therefore connected with our subject.

Medical Admission to the Navy.

Candidates must be 21-28 years of age, with a registrable qualification; and must produce proof of pure European and British descent and a certificate of good character. A physical examination must first be passed, a slight correctable myopia not disqualifying a candidate.

An entrance examination is held twice yearly in the following subjects: Medicine, Pathology, Therapeutics, Surgery, and Clinical Surgery, in each of which a minimum of 50 per cent. marks is necessary.

Successful candidates have two months at the Greenwich Medical School in Tropical Medicine and Hygiene, followed by four months at Haslar studying Naval Hygiene, Recruiting, Physical Training, Anæsthetics, Dentistry, etc.

A final examination is held, the marks being added to the entrance marks to determine the seniority. The pay of a Surgeon on entry is £255 10s. per annum, and he is promoted to Staff Surgeon on £365 after eight years' service and the passing of a promotion examination. Further promotion to Fleet Surgeon on £492 15s. is by seniority, but the higher grades of Deputy-Surgeon-General (£821 5s.) and Surgeon-General (£1,300) are filled by selection.

A naval Medical Officer can, if he wish, retire after four years' service with a gratuity of £500; after eight years, £1,000; after twelve years, £1,500; or, after sixteen years, £2,250—in lieu of a pension.

An Officer is entitled to a pension of £365 after twenty years' service if he has reached the rank of Fleet Surgeon.

Temporary Surgeons R.N.

In time of war or emergency temporary surgeons are taken on in the Navy (King's Regs. and Adm. Instrucs., Appendix XII.).

Candidates must be registered, of good character, physically fit, and not over forty years of age.

They must provide themselves with—

1 Pocket case of instruments.
1 Stethoscope.
3 Clinical thermometers.

They must also provide themselves with the following uniform:

1. Frock-coat, waistcoat, and trousers.
2. Undress coat.
3. Uniform cap.
4. Mess jacket and waistcoat.
5. Sword and undress belt.

Towards this the Surgeon will get an equipment allowance of £20, payable when called up for active service.

Pay is at the rate of 22s. per diem, or £401 10s. per annum.

Half-pay is only given for extra leave or sickness, and is at the rate of 10s. per diem, or £182 10s. per annum.

Allowances correspond with those of permanent officers.

A shore billet (with quarters) carries an all-in allowance of £39 per annum (or £108 per annum if abroad). If the shore billet is without quarters, a lodging allowance of £50 per annum (3s. 6d. per day) and a ration allowance of £24 per annum (1s. 6d. per day) is permitted.

Medical Admission to the Mercantile Marine.

For this service there is no examination, and no requirements of any kind except that the applicant's name must be on the British Medical Register.

There are various ways of obtaining appointments. A personal visit to shipping offices in London or at Liverpool may result in finding and filling a vacancy—if with a letter of introduction from a shareholder, *tant mieux*.

A friend amongst the company's directors may lead to a still quicker billet.

Or again, the applicant's name and address may be entered in the registers kept by several wholesale chemists who supply shipping firms (*vide* medical press), which will probably soon lead to employment.

The larger passenger lines are more exclusive. Instead of taking Surgeons for a single voyage, as do many of the smaller lines, they usually take men on a few years' agreement, or even more permanently still. Such lines are the Cunard, White Star, P. and O., B.I., Union-Castle, etc. Billets in the larger ships of a line are usually filled by seniority promotion from the smaller ships. To enter such a line it is necessary to enter one's name at their head office, and then possess one's soul in much patience.

After a successful issue, the matter of uniform will have to be thought of. This is naturally more elaborate on the larger lines, but these lines usually issue a Book of Regulations which will contain the necessary details. If they do not, each line has, as a rule, its recognised outfitter, who will be able to do the necessary for the embryo Surgeon.

Speaking generally, a double-breasted blue reefer-suit, a mess jacket suit, and a uniform cap, constitute the nucleus. In the tropics a white uniform is usually *en règle*, consisting of a white drill buttoned-up tunic (under which a vest only is worn), white drill trousers, and white canvas shoes. In default of definite regulations, the above may be recommended; and, in addition, three white drill mess jackets, some white waistcoats, and white covers for uniform cap. For ordinary long tropical voyages, at least twelve pairs of white drill trousers, and the same number of evening shirts, with a plentiful supply of collars and underwear. Flannel should never be worn next to the skin in the tropics. It is very irritating, and is a fruitful source of "prickly-heat." Cotton is by far the most sensible and comfortable material.

A large number of lines now do washing on board, and many of them very well; while in the tropics native dhobies are cheap, and very good indeed, and will often wash and return clothes in twenty-four hours.

Preliminaries to Sailing.

The Surgeon should visit the Medical Superintendent of the line as soon as possible after being appointed. Most of the larger lines have their own M.S., who may or may not be

one of their own retired Surgeons. This officer will give the Surgeon his instructions for the voyage; will issue such forms, books, returns, etc., as may be required; and will instruct him where and when to get signed on and examine the crew.

On the day appointed the Surgeon will attend at the Shipping Office of the Board of Trade, with the other officers and men, and will there get signed on and examine the men as required.

This examination should be carefully done; and for new hands might well be on the lines of the naval examination (Art. 1312, Form M93). This is as follows:

1. Note if any of following conditions exist to such an extent as to disqualify for efficient discharge of duty:

Deformity.
Lameness.
Speech impediment.
Head injuries.
Defective sight.
Defective colour-vision.
Defective hearing.

2. See that there is no disease of the eyes, eyelids, ear, nose, palate, throat, tonsils, or spine.

3. Note if:

Teeth.—Good, strong, and sufficient.

Chest.—Good form and capacity. Heart and lungs normal.

Abdomen.—No visceral disease, hernia, varicocele, or venereal disease.

Arms.—All movements normal. Whole weight of body can be borne by each hand for five seconds.

Legs.—Equal length. Movements normal. Can walk quickly, and hop easily.

Urine.—No sugar, and no albumen.

Glands.—Absence of bubos.

Vaccination.—Should invariably be done, whether the man has scars or not.

For those who are not joining the line for the *first time*, the examination need only comprise heart and hernia, unless appearances suggest it advisable to examine the lungs and urine.

All those not vaccinated during the preceding five years (including officers) should always be revaccinated.

When examining native crews in the tropics, make sure that there are no enlarged glands; and feel the chest of each man

carefully, putting on one side those who feel feverish, for further examination by thermometer and blood-smear, etc.

At this stage, I should like to recommend an innovation prompted by experience as Port Health Officer. I should like to see furnished to every seaman, on first entering the Mercantile Marine, a "*Medical History Sheet*" such as is given in the Navy (Art. 1310; printed form M190). On this would be noted the man's name (and, in the case of natives, his left-thumb impression), and any scars or peculiarities of his person.

It would contain particulars of his first medical examination, signed by the surgeon conducting it, also date, time, and result of the vaccination or revaccination performed at that time.

Subsequent details of later vaccinations, examinations, illnesses, change of ship, etc., would be entered and signed by the Surgeon as necessary.

The history-sheet should be kept by the Captain or Surgeon, and only handed to the man when leaving to join another ship.

In this way, when a ship arrives at any port infected, the P. H. O. would be in a position to know the medical antecedents of all the crew, which may save both time and money to the Agents and Company. I recommend the idea most earnestly to all Shipping Medical Superintendents.

On the bigger lines there is usually a muster-day, a couple of days or so before sailing, when the crew are paraded for the Marine Superintendent of the Line.

Some time before sailing there is also an examination of the instruments and drugs by a Medical Inspector of the Board of Trade. The Surgeon should be always present at this inspection and have everything ready. The Medical Superintendent, or the Shipping Company's Office, should notify the Surgeon as to the time at which the inspection may be expected.

The Surgeon should finally go aboard the night before sailing, and should report himself to the Captain.

[NOTE.—At the conclusion of the voyage the Medical Superintendent will make an inspection of surgery, instruments, etc. The Surgeon should then hand over his log-book, lists of drugs, instruments, etc., and at the same time give in his indents for the next voyage.]

Status of the Surgeon on Board.

It has been held that the Surgeon on board a ship is not a certificated officer within the meaning of the Board of Trade Regulations; but, like the purser or cook, is just an ordinary

member of the crew rated on the Articles. This rather anomalous position, as compared with Navigating Officers and Engineers, is due to the fact that, in case of misdemeanours, such as drunkenness, etc., while the Board of Trade can endorse or cancel a Mate's or Engineer's certificate, they naturally have no power to deal with a medical diploma or University degree. The question arose in October, 1909, when a Master fined a Surgeon for intemperance, entering it in the log as would be done for an ordinary member of the crew. The matter, however, has never been legally decided.

Be that as it may, the Surgeon fills a very peculiar and delicate bunk in the microcosm of the ship.

Apart from any other individual or personal considerations his unique position among the ship's officers—his quintuple responsibility to the Board of Trade, the Company, Captain, passengers, and to the various Port Sanitary Authorities, the specialised nature of his work, the freedom of his social intercourse with the passengers—alike and together serve to require of the Ship's Surgeon not only sound professional ability and judgment, but a high standard of morality, and an inexhaustible fund of good-nature and tact.

It is quite right that the Surgeon afloat should take himself seriously—no job can be properly done otherwise; but a man without a saving sense of humour had better steer clear of the billet altogether.

Life on Board and Duties at Sea.

The accommodation for the Surgeon will vary very much on different ships.

Older vessels often provide a combined cabin and surgery, which is not as it should be. All modern ships have a surgery either leading out of or alongside the Surgeon's cabin.

The doctor will have his own steward to wait on him, clean out cabin and dispensary, etc. On the larger lines an orderly is often appointed in addition.

The drugs, instruments, etc., are provided in accordance with scales laid down by the Board of Trade (*vide* Appendix III.). Any special drugs, dressings, or medical stores required

by the Surgeon during the voyage should be requisitioned on interim indents, which should be endorsed by the Captain, and given to the Agents of the ship, who will see that they are supplied and sent off. Local laws in certain ports may prohibit the sale of hypodermic syringes, morphia, cocaine, etc.—in which case the Surgeon should call on the Port Health Officer at his office, where he will get the necessary permit.

There is one indispensable article which every ship's Surgeon should keep in his surgery—a drying bottle. These bottles have a wide mouth, and in the lid is kept a supply of quicklime.



FIG. 1.—DRYING JAR.

It will be found invaluable for keeping steel instruments in. People who are used only to Britain, where a pair of scissors can be kept half a lifetime without rusting, would be astounded to find every steel article covered with rust after a single week in the moist heat of many tropical regions. The alternative to the above is, of course, the smearing of everything with a coating of nasty vaseline.

Soon after the voyage has begun, the Surgeon should consult the Mate and the Chief Engineer as to the daily surgery hours most convenient to both of them. A notice stating these hours should be drawn up, signed by the Captain, and posted in the surgery; and the Surgeon should always be in attendance at these fixed hours daily.

In the last paragraph I have used the word "Mate," referring of course to the "*First, or Chief, Mate,*" but it would be more than your life is worth to address that officer as Mate on a modern passenger steamer. He is the Captain's deputy, and a very important person on board, whose title is now "*Chief Officer*"; within two minutes of getting aboard you can tell whether he is efficient as well as important.

Equally wrong would it be for you to address him simply as "Chief" (much as *he* might like you to!), for that term has appertained to the Chief Engineer ever since the dawn of the

marine engine, and the practice would certainly result in "hot bearings." Either "Mr. So-and-so," or "Chief Officer," is the usual mode of address to the Mate.

Another important matter is that of the Surgeon's *Log-book*. This should be kept carefully day by day, and should form a complete record, not only of cases, treatment, special diets, etc., but also periodical remarks on the sanitary state of the ship; the traced origin of any infectious outbreak, and means adopted to prevent its spread; dates of arrival at, and departure from, ports; infectious disease present at such ports; how much water and provisions taken on board at the ports. Concise meteorological observations should also be included —as is required of Naval surgeons (arts. 1308 and 1309, K.R.). Such observations should be taken at 9 a.m., and should include: (*a*) approximate course and position of ship; (*b*) direction of wind; (*c*) maximum and minimum shade temperature in open air on deck; (*d*) ditto in ship's hospital; (*e*) sea temperature. If 'tween-deck passengers are carried, the thermometrical observations should also be taken there; and the relative humidity (by wet and dry bulb) observed in addition. These observations are intimately connected with the subject of ventilation.

With regard to the form which the log-book should take, many companies will have printed books for the purpose, often unsuitable. If they have not, the Surgeon cannot do better than get the Company to print him some "Rough" and "Fair" Journals, of the naval type (Forms M179-181).

In any case he should always have the two—the "rough" one being left open on his surgery desk, and posted up in pencil; the "fair" one being properly entered up in ink each Sunday, and subsequently initialed by the Captain.

A *ship's hospital* is now provided on practically every passenger steamer. By Board of Trade regulations, made under Section 17 of the Merchant Shipping Act, 1906, "emigrant" ships must have an ordinary hospital and an isolation hospital (see Chapter V.). Apart from this there is no obligation, under British law, to provide hospital accommodation; although various Colonial enactments require it for

pilgrims, etc. The ordinary hospital is, of course, intended for medical and surgical cases, and *not* for infectious disease.

The Chief Steward will sometimes try to appropriate an empty and tempting hospital as a subsidiary storeroom and food-locker. This, of course, should under no circumstances be allowed.

The Surgeon should see that it is freshly painted at the beginning of the voyage, and that one berth at least is always kept ready for immediate use.

With regard to the more *routine duties :* There will be boat-drill probably once a week. The Surgeon is usually either in the Captain's boat or else in charge of one himself. The signal is given by steam whistle, and the Surgeon should set an example of promptness to the passengers.

Then there will be an inspection trek. On the bigger boats it is usually held daily at about 11 a.m., but on smaller boats only on Sundays. The Captain makes an inspection of crew's quarters, galleys, cabins, etc., and is accompanied by the Surgeon, Chief Officer, and Chief Steward. The inspection, which aims at securing cleanliness and tidiness, is too often, alas ! rather perfunctory, and will in no case excuse the Surgeon from making his own sanitary inspection of all parts of the ship daily, especially when steerage or deck passengers are carried. The need for getting to know his ship thoroughly cannot be too often impressed on the ship's Surgeon, as I have mentioned in the remarks to Assistant Port Health Officers in Chapter XII. Two useful pamphlets are the Board of Trade " Instructions as to the Survey of Master's and Crew Spaces," and their " Instructions relating to Emigrant Ships." They can be obtained from Wyman and Sons, Fetter Lane, E.C., at a cost of 2d. each.

With regard to *professional work* on board, the matter will come under the heads of " Passengers " and " Crew."

For ordinary cases the crew will turn up at the surgery at the appointed time. A certain number of sore-heads and some venereal disease are common at the beginning of the voyage. After some time in the tropics, bowel complaints and malaria often crop up—contracted ashore in a tropical port. Some-

times prickly heat is rather intractable. I had one stewardess who was simply covered all over with it from the time she cleared Port Said eastward until she got back there.

Tropical voyages generally prove of much greater medica interest than cold climate ones.

Sometimes, in passing down the Red Sea with a following wind, the temperature in the stokehold becomes nearly unbearable, and cases of heat-stroke occur amongst the stokers. I have had several of such cases.

The *symptoms* usually are: a speedy hyperpyrexia with some cyanosis and injection of the conjunctivæ. Coma or delirium, with embarrassed or stertorous breathing. Skin hot and dry. Pulse thready. Reflexes sluggish. Death frequently occurs from cerebral hæmorrhage, syncope, or respiratory failure. *Treatment* of cold bath and ice to head should be prompt; $\frac{1}{75}$ gr. of hyoscine should be given hypodermically; also $\frac{1}{100}$ gr. digitalin if the pulse demands it.

One thing the Surgeon should always be on the look-out for, and that is malingering. There are no reliefs in a ship's crew. Every man is useful, and can ill be spared.

Of surgical cases he may or may not see much. It will usually be minor surgery—fractures, dislocations, etc., in bad weather.

I shall never forget my first North Atlantic voyage. It was winter-time, and very rough. The steward and the cook were both powerful men, and apparently divided their allegiance between the gods Poseidon and Dionysus, with a prepossession distinctly in favour of the latter. After a difference of opinion between the two worthies, I was hurriedly called in one day to repair a large area of the cook's face. His condition required the steadying services of four able-seamen, and most of the time I had myself to hang on to a bunk-board with one hand! Eventually, however, matters were satisfactorily adjusted.

Another not uncommon accident is the bursting of a gauge-glass. This is liable to cause nasty wounds of the face and eyes. On one occasion, I remember, the Second Engineer got his radial artery severed, though I was fortunately not far off at the time.

Occasionally you may get bad cases of typhoid or dysentery,

or some urgent surgical case, etc. In such cases you should get the Captain to arrange with the ship's Agents to land the case for treatment in the civil hospital, on arrival at the next port.

So much for the crew.

Professional work amongst the passengers will often demand much attention.

After a few days out it is as well for the Surgeon to go over the passenger-list and find out the names of those absent. The Chief Steward or Stewardess will be able to say if the absentees are ill enough to want attention.

Cases of serious or prolonged illness amongst cabin passengers are often very awkward to deal with, owing to absence of proper nursing facilities. It may be necessary to detail two stewards or a stewardess for nursing duties. In such case the Surgeon would arrange the matter with the Chief Steward, after consulting with the Captain.

The subject of *fees* may be one of some difficulty.

Some lines do not allow the Surgeon to accept fees, but this prohibition could not be expected to cover venereal disease or non-urgent operations. In such cases the Surgeon should arrange the matter with the patient before beginning treatment.

Imperative major operations which cannot await arrival at the next port should, in like manner, mean a fee for the Surgeon, whatever may be the Company's rules. If the patient himself does not pay, the Surgeon would be justified in asking a fee from the Company at the end of the voyage, and the Medical Superintendent should endorse the application.

Where fees *are* allowed, the usual custom is to leave the amount to the patient himself, except in the special cases mentioned previously.

If, however, a definite scale of fees is laid down by the Company, then a bill should be rendered to the passenger-patient a day or two before the conclusion of his voyage.

With regard to *deck passengers* very little can be said in the compass of a short chapter like this. They, like the crew, are of course treated gratuitously by the Surgeon.

Amongst a big crowd of European emigrants, and still more amongst a couple of thousand Chinese coolies or Indian pilgrims, many ailments may have to be dealt with, and a fruitful nidus for infectious disease will exist.

Such a shipload will require the most careful attention of the Surgeon. He should vigil them at least twice a day. The general sanitation, water and food supplies, ventilation, etc., should be carefully looked into. Any sick, especially cases of fever, should be promptly isolated for observation, as also any suspicious diarrhœas or eruptions.

It is unlikely that the Surgeon will quickly recognise plague, cholera, or yellow fever, until he has had some tropical experience; but many ship's surgeons, unfortunately, have not even a working knowledge of smallpox. It behoves them, therefore, to act with wary caution.

And here I would earnestly urge one thing: *Take six dozen* (3 × 1) *micro-slides with you, and keep them in a wide-mouthed stoppered bottle of methylated spirit.*

If you have a bad case of fever, or bubo, or diarrhœa, take a couple of smears of the blood, or gland-juice, or stool. Let them dry in the air. Wrap in a piece of clean paper and make a pencil note thereon. Your patient may very likely die and be buried at sea. You come into port and the Health Officer who boards your ship will want to know what the person has died of. You tell him what you think. You are surprised when he quarantines all the coolies? When you have had a little more experience you will be surprised if he *doesn't!* And all this delay and expense to the Agents would very likely have been avoided by the simple precaution of taking a smear on a micro-slide (before or after death), and giving it to the Health Officer for diagnosis! It sounds simple, yet scarcely one surgeon in a hundred ever does it!

Entering and Leaving Port.

Here, again, you can help the Health Officer—in fact, it is one of the Surgeon's most important duties.

Briefly, the situation is this:

The Port Health Officer has a main twofold task. He has

to prevent the introduction of infectious disease into his port; and, if the ship is infected, he has so to deal with her that she is no longer a source of danger to anyone elsewhere.

Now the details of this quarantine work will vary in different ports. In some places every arriving ship, from whatever port, will be expected to fly the yellow flag and anchor in a quarantine anchorage for inspection; in other places, only arrivals from ports which have been declared infected will be expected to go to quarantine; in another group (a small minority) no quarantine is ever expected unless there has actually been a case of infectious disease on board.

The question then arises: How is a ship to know what to do when approaching a port? It is quite simple. When the ship clears from a port, the Captain should ask at the Harbour Office what will be required at the next port. *It should be the duty of every Marine Department to make itself cognisant of the conditions, requirements, and orders of any neighbouring port, and to communicate the same to any ship taking clearance papers for such port.* If the Harbour Office is unable to give information, the Captain should lodge a formal protest with the Agents, who, if they are worth anything, will ask for regular returns.

As a matter of fact, with ships on a definite run, the requirements of each port are pretty well known to the Captain; but he should not on that account fail to ask at the Harbour Office for the latest particulars of the requirements of his next port.

You are now nearing a port, and we will imagine it to be ascertained that a Q flag and quarantine anchorage are necessary, and that your ship has duly anchored.

When you see the Health Officer's launch approaching you should see that the crew are all piped up and ready mustered for inspection.

You should then go to the head of the gangway to meet the Officer on his arrival. In the best lines the Captain will also be there, as is fitting for the head of the ship, who is legally responsible for everyone and everything on board. In other cases the Chief Officer will take his place. The purser should

also be present, with a full "passenger-list," showing origin, destination, and names of all passengers on board, and a manifest of cargo, in case the H. O. may wish to see it.

The Surgeon himself should have ready the following papers:

(*a*) Bills of Health from previous ports of the voyage.
(*b*) Pencil note of number of the crew, giving totals of officers and men.
(*c*) Pencil note of number of passengers, showing number *of each class* who are disembarking, and the number of transit passengers of each class.
(*d*) Note of any infectious disease, special cases, or deaths, which are present or have occurred during the voyage.

The Health Officer will then fill up his Entry Declaration, which is signed by the Ship's Surgeon and Captain, and will subsequently examine the crew. The Surgeon should always accompany him; as also should the Chief Engineer when the engine-room hands are being inspected, and the Chief Officer when the deck-hands are being gone through.

On a big line (which ought to know better) I have seen "decks cleared for action" because the Surgeon himself dismissed the crew after the H. O.'s inspection, instead of communicating the order to the irate heads of the departments concerned, who, by the way, did not in that case take the trouble to turn up! This is one of the uncharted sandbanks for which the Surgeon should keep his weather-eye open.

The H. O. will then inspect such of the passengers as he wishes. In certain cases there may be passes to be written and issued to disembarking cabin passengers, in which case the Surgeon should lead the way to the saloon or smoking-room, and see that blotting-paper, ink, etc., are provided, and that the purser summons such of the passengers as may be required.

Pratique is then probably given, and that form should be handed personally by the Surgeon to the Captain after departure of the H. O. If the ship is infected, or if there are deck

passengers to be landed, it is of course a different story, and the H. O. will give his instructions, which should be loyally carried out.

It is always as well for the Surgeon to ask for information from the H. O. (while he is on board) as to the prevalence of cholera, dysentery, or typhoid in the port. If any of these diseases are present to any extent in a tropical place with a large native population, it would be most unwise for the Chief Steward to take on supplies of salad or other fresh vegetables, such as are usually consumed without being cooked. In such an eventuality, the Surgeon should report to the Captain that, in his opinion, it would be unwise to take on board such and such stores in that port, and the responsibility then rests with the Captain to issue such orders as he likes. The same remarks apply to a certain extent to the water-supply; but on that point it is as well to be guided by the H. O.

If any infectious disease breaks out while the ship is in port, isolate the case promptly, and communicate with the Port Health Officer without a moment's delay.

The formalities on *leaving port* are not so formidable. There may or may not be an examination of crew and deck passengers, and disinfection of effects.

Then a Bill of Health will probably be required, and the Surgeon should satisfy himself, by a visit to the Agents, that one has been duly obtained; if not, he should extract the necessary fee from them, and procure the document himself from the Port Health Office.

If a subsequent port happens to be in the territory of a foreign country, it will be necessary to get the Bill of Health endorsed by the Consul concerned.

Social Aspects on Board.

The Surgeon should, amongst other things, never go on the bridge or in the engine-room, except on business.

He will usually have charge of one of the tables in the saloon, and, if the Chief Steward is a friend of his, he can generally arrange for congenial company.

On the Surgeon also will fall the onus of organising sports

or dances, etc. If the number of passengers is large, he should select half a dozen as a committee to assist him.

Owing to his peculiar position in having a "free run" of the passenger life of the ship, it is needless to say that it behoves the Surgeon to walk very warily. Special attentions to any one lady passenger are greatly to be deprecated.

There is no harm at taking a hand at bridge in the evening, but gambling and continually drinking with passengers are habits which cannot be too strongly condemned.

If there is a medical man amongst the passengers he should take an early opportunity of leaving a card on the Ship's Surgeon, who, of course, would return the compliment.

It is not etiquette for such medical passenger to prescribe for other passengers without consulting the Surgeon; but you will often find it done, and will, of course, ignore the lack of taste.

CHAPTER II

THE STRUCTURE OF SHIPS

'See you the ferny ride that steals
Into the oak-woods far?
O that was whence they hewed the keels
That rolled to Trafalgar."

Puck's Song.

THIS chapter is not an attempt to impart the principles of ship-building to medical men. My object is to take the ship as a unit, and to discuss various structural details from the point of view of marine hygiene.

With this object in view I will deal with the subject under the following headings:

1. What is a ship?
2. Outlines of hull structure.
3. Crew spaces.
4. Passenger spaces.
5. Subsidiary compartments and spaces.
6. Structural sanitary surveys.
7. Glossary of marine terms.

Ships.

By Section 742 of the Merchant Shipping Act, 1894, a *ship* "includes every description of vessel used in navigation not propelled by oars"; while a *vessel* is defined as "any ship or boat, or any other description of vessel used in navigation."

Every British ship is bound to be registered under this Act by the proper registration officer at any British port.

The only exceptions to this are: Under Section 3, the following two classes are exempted entirely from registration:

1. Ships not exceeding fifteen tons net register employed solely for river or coastal navigation in the United Kingdom

or a British possession, where the managing owners are resident.

2. Ships not exceeding thirty tons net register, and not having a whole or fixed deck, which are employed solely in fishing or coastal trade in Newfoundland, or the Gulf of St. Lawrence, or adjacent Canadian coasts.

Also, under Section 90, ships of sixty tons net register or less can obtain a terminable certificate in certain British possessions. These certificates are renewable every six or twelve months, and are made under local enactments, but have the same force as the home Act.

The evolution of the modern ship is full of interest, stretching, as it does, from the logs and rafts and canoes of a prehistoric and misty past, right up to this century of grace with its monster Atlantic liners and super-Dreadnoughts.

Although the Egyptians and Chinese had some seafaring knowledge many centuries B.C., neither race could be called in any sense maritime; and the earliest real navigators were undoubtedly the Phœnicians, who could claim a maritime predominance for nearly thirty centuries—a result not attained by any other race before or since.

One of the landmarks in development sprang from the rivalry between the Romans and the later Phœnician colony of Carthage, which gave rise to the very large fighting galleys which were then for the first time often completely decked—the prototype of the modern ship.

After the decline of Rome, seafaring superiority passed to the Norsemen, but with some retrogression rather than advance. Their ships were clinker-built open boats up to 70 or 80 feet in length, and having a beam of some 12 to 17 feet. They had a single fine mast, about 40 feet high, and spaces for sixteen rowers a side.

The second real landmark occurred at the opening of the fourteenth century, when the mariner's compass was rediscovered by *Flavio Gioio*. A vista of ocean navigation was thus opened up, which stimulated the development of rigging and ship-construction.

The next landmark was associated with *Phineas Pett*, who

founded the Shipwrights' Company in 1612. He introduced the first three-decker—the *Sovereign of the Seas*—in the face of much opposition, and also introduced the light and fast "frigate" into the British Navy.

The fourth landmark arose in the person of *S. Robert Seppings*, who again revolutionised the methods of construction. He reduced the long "beak heads"; abolished the high square sterns; introduced diagonal inner ties and riders; and strengthened his ships by adopting "filling pieces" between the lower frames of the ship.

At the beginning of the nineteenth century the practical adoption of steam as a motive power for ships was in the nature of a revolution. In 1802 the *Charlotte Dundas*—a stern-wheel steamer—was launched on the Forth and Clyde Canal; and ten years later a side-paddlewheel steamer, named the *Comet*, appeared, and became a commercial success. A paddle-steamer, the *Royal William*, built in Canada in 1833, was the first to cross the Atlantic, taking seventeen days over the journey.

It is interesting to record the first air-crossing of the Atlantic (after an interval of eighty-six years), which has been accomplished in about as many hours as in days on the first occasion.

Progression now became rapid. The first sea-going *iron* ship—the *Rainbow*—was launched in 1838. In 1839 *Pettit Smith* designed the first screw-propelled steamer, named the *Archimedes*.

The compound engine introduced in 1870, and the triple expansion type in 1878, and the turbine engine in 1902, have been epoch-making innovations in marine engineering.

Outlines of Hull Structure.

From the point of view of marine sanitation, the primal problem was undoubtedly propounded when the frames of the open boat were first boarded over to form a smooth bottom to the vessel, thus making a bilge or hidden space in which bilge-water could collect.

The next feature of importance was the decking of the ship, which introduced the problem of ventilation.

This problem was accentuated when the ship space was divided up, first by further decks for fighting purposes, and then by bulkheads for purposes of cargo-stowage or safety; and, later, was still further complicated by the permanent intrusion of a central engine-room space.

Consideration of a wooden ship will best illustrate the first point, as will be seen in the accompanying diagram (Fig. 2).

The *keel* is the key to the whole structure. To it, at the after-end, is attached the *stern-post;* and, at the for'ard end, at an angle varying from 80 to 100 degrees, the *stem*. Between these two terminal structures curved ribs, known as *timbers*, are attached at intervals. The timbers in the bow are known as "cant-timbers"; the rest as "main-timbers," or *futtocks*,

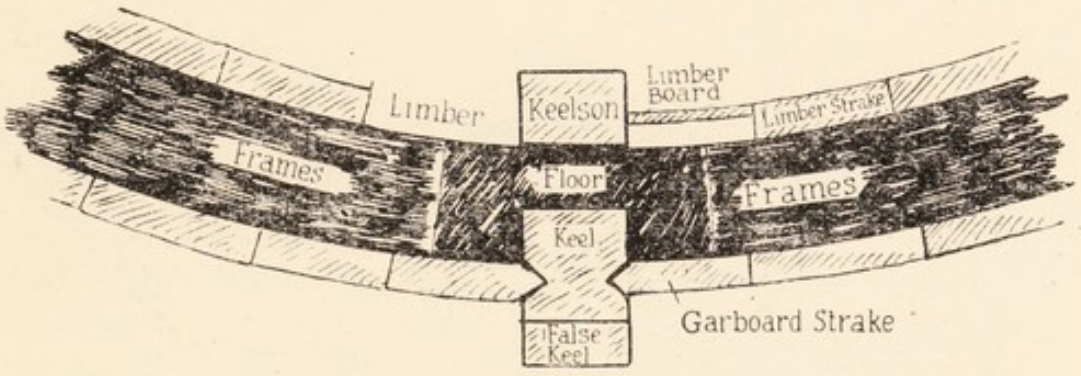


FIG. 2.—THE KEEL OF A WOODEN SHIP AND ITS SURROUNDINGS.

or *frames*. On the outside of the frames is fixed the longitudinal planking which forms the outer shell or hull of the ship; while, to make the interior satisfactory, further planking is fixed on the inside of the frames, thus forming an inner shell, or skin. There will thus be a space between the outer and inner skin which, in the intervals between the frames, will go right down to the keelson, and the lower part of this space will form the *limber*, or bilge. Sometimes, for the sake of strength, this space is obliterated in its lower portion by wood-filling known as *seppings*. If it is not, the internal drainage of the ship—bilge-water—will collect there.

The frames are tied together by horizontal beams, and on these beams the deck planking is laid. They are fixed to the frames by longitudinal structures called *shelf-pieces*, on which

they rest; and, above, by similar structures known as *waterway-pieces*.

The outside skin of the ship is variously named according to the situation.

The cross-planking fixed to the stern-post is known as the *transom*.

In iron or steel ships the same general ideas are carried out; but, being stronger, the structural details are less bulky and prominent than in the case of wood (Fig. 3).

The majority of modern ships are fitted with a double-bottom, which serves the twofold purpose of an additional safeguard to the hull and also of a water ballast tank. In

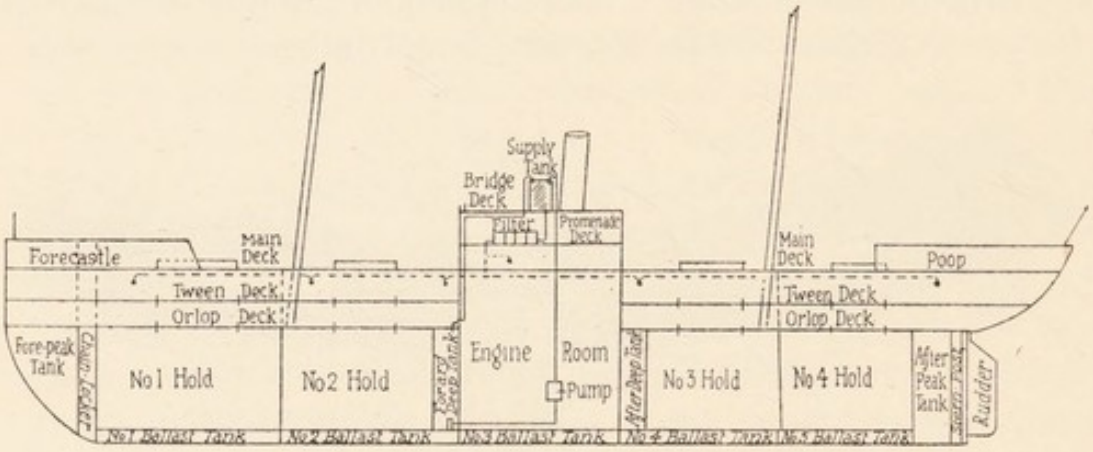


FIG. 3.—SECTION OF A STEAMER.

such case the bilge will be on the upper surface of the inner skin, and it is drained by a large pipe running the length of the ship—known as the *main drain*. This main drain is situated either above or below the inner bottom, and not only receives the bilge drainage but also water from the bunkers, etc. It can be emptied by means of bilge-pumps, with which it is connected.

It is a great pity that the sketch of a ship cannot be submitted to an expert in public health before the keel is laid down. Any owner can get a ship designed and built, and as long as he complies with the indifferent requirements of the Merchant Shipping Act and of the Board of Trade he need care for nothing else. It is a matter of complete indifference to him whether his ship is intended only for cold-

climate service, or entirely for tropical voyages, or for mixed routes. From a hygienic point of view the details of structure, arrangement, ventilation, etc., should be in each case quite different.

The late Dr. Hossack, of Calcutta, who investigated this point during a recent visit to Europe, pointed out that in France the plans of every ship which it is proposed to build must be submitted to a Board of Construction constituted as follows:

1. The Administrator of the Marine Department (*President*).
2. The Inspector of Navigation.
3. One long-voyage Captain.
4. One mercantile marine Engineer.
5. One Bureau Veritas expert.
6. The Director of Public Health.
7. One Electrician.
8. One Sailor (sail).
9. Ditto (steam).
10. One Agent of the General Service.
11. One Naval Architect.
12. One Shipping Owner.

An improvement has been effected in several directions in the recent "standard ships," built under the direction of the "Controller of Auxiliary Shipping," as mentioned in the next chapter. The new Ministry of Health should now be able to carry out extensive experimental work by its marine department.

Crew Spaces.

The air-space of crews' quarters will be more fully dealt with when dealing with ventilation in the next chapter.

The cubic space laid down by Section 64 of the 1906 Act is now 120 cubic feet per head, and a superficial space of not less than 15 square feet.

Deductions are, however, taken off this space for messrooms, washing-places, etc., which will appreciably reduce the space which each man ought to have.

Lascars and native crews are still only allowed the 72 cubic feet and 12 superficial feet as laid down for all seamen in the Act of 1894.

When one comes to think of it, that is only about three times the size of a large coffin!

Moreover, owing to faulty structural arrangement and lack of proper routine supervision, I have no hesitation in saying that the crews' quarters in more than 50 per cent. of British ships are a disgrace to our country, and a menace to the health of our mercantile marine.

In the Royal Navy, crews are usually berthed between decks; occasionally, in smaller cruisers, in the fo'c'sle.

There seem to be no regulations laid down by the Admiralty as to the cubic space necessary either on men-of-war or on transports. The total complement would appear to be determined by "hammock space" (Fig. 4).

The total length of the hammock is 9 feet. They overlap the neighbouring hammocks by 18 inches at each end.

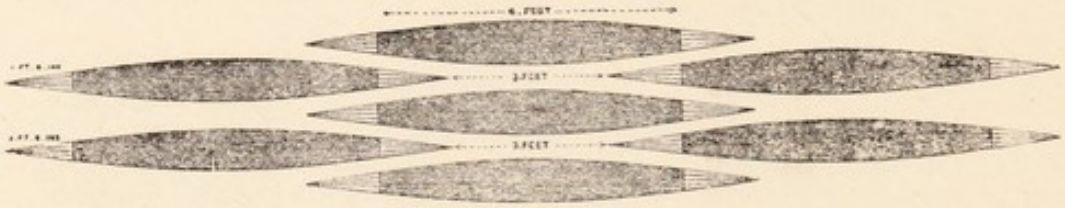


FIG. 4.—HAMMOCK-SPACING ON MEN-OF-WAR AND TRANSPORTS.

The hammock hooks are 18 inches apart for petty officers, seamen, and marines, and 16 inches apart for troops—a distinction which would appear to reflect badly on the bulk of a soldier compared to a sailor!

The *composition* of mercantile crews can be roughly classified as:

(*a*) Officers, executive and engineer.
(*b*) Deck-hands, or sailors.
(*c*) Engine-room hands, or firemen.
(*d*) Stewards and cooks.

The officers are usually housed amidships, either on the main or one of the upper decks.

The stewards and cooks are also usually berthed amidships, more or less distributed amongst passengers and officers. Occasionally they still have the old-fashioned "glory-holes" (stewards' quarters) allotted to them. These are generally either aft or amidships, and are only rarely situated for'ard.

The sailors and firemen are still in the large majority of cases housed in the fo'c'sle; but in many of the bigger liners some are in the fo'c'sle and some in the poop. In coasting vessels a lower fo'c'sle (below the main deck) is often found. This is a most undesirable situation.

An interesting series of papers on Sanitation in the Merchant Service, by *Romeril*, appeared in the *Sanitary Record* in 1906, which (amongst other things) classified the situation of crew spaces in many types of vessels. A most interesting report by *Getting* of Sydney was also issued in 1906, dealing with a sanitary inspection of a large number of steamers for the N.S.W. Department of Public Health.

In addition to the air-space, overcrowding, ventilation, and lighting of crew spaces, we have to consider the following structural and other details:

1. Structural material of compartment.
2. Bunks—material and situation.
3. Heating arrangements.
4. Effluvium and drainage.
5. Contents and routine supervision, etc.

In most modern ships the structural material of the sides and ceiling of a crew's compartment will be either steel or iron. Owing to the good conductivity of this metal, the cold of the outside atmosphere or sea will frequently cause condensation of moisture from the air inside on the surface of the metal, with consequent dripping of moisture. Covering the decks above with wood, as a means of obviating this condensation, is strongly to be deprecated; the sheathing can never fit closely, and will therefore give the bugs and other vermin the time of their lives.

The best procedure is to cover the metal surfaces of the compartment with "cork cement." The way to do this is to give a coating of paint to the surface and then blow a thin layer of finely powdered cork evenly all over the paint while it is still wet. The cork adheres, and, when dry, the whole corked surface is painted.

If the ceiling is of steel or iron, the Board of Trade lay down that the upper surface (which forms the deck above) must be sheathed with wood 2½ inches thick, the planks being securely fastened and *caulked*.

The operation of caulking is carried out by driving oakum (shredded rope) into the space between the planks, with a special tool. The packing is very tightly inserted, but stops short of the surface, the last part of the seam being filled with a composition composed of 10 pounds of pitch, boiled, gradually mixed with 1 pound of rosin, and then filled into the seam, while liquid, by a special ladle. This makes the seam quite waterproof and tight.

In yachts, launches, etc., in order to obtain a prettier effect, white caulking is often applied instead of black. In that case the material used to close the seam is composed of ordinary whitelead paint thickened with common whitening to the consistency of putty. It is then filled into the seam with a putty-knife, and hardens when dry. Decks which form the floor of crew spaces must always be made of wood at least $2\frac{1}{2}$ inches thick, properly laid and caulked. Loose wood sheathing is never allowed by the Board of Trade.

The bulkheads of the crew space, if made of wood, must be well seasoned, tongued and grooved, and battened over the seams with felt under the battens. If the bulkhead adjoins a galley or cargo-space it must be doubled.

The *bunks* must be at least 6 feet in length. If in tiers, the bottom of the lower bunk must be at least 12 inches from the floor; the bottom of an upper tier must be at least 2 feet 6 inches from the bottom of the tier below; while the bottom of the uppermost bunk must be at least 2 feet 6 inches from the deck above.

Each bunk must be arranged so that it can be entered from the side, without necessitating access across an intervening bunk.

There is no special regulation to determine either the position of the bunks or the material of which they are to be composed, although the fitting of iron bunks is encouraged.

Ninety per cent. (or more) of the bunks as now fitted are made of wood, and are so located as to follow the outline of the ship's side and of the central partition which divides the fo'c'sle into two longitudinal divisions. The whole scheme of this is wrong. The wooden bunks, full of cracks and cre-

vices, get full of bugs, and the boards themselves get soaked, foul, and insanitary. Moreover, as they are built against the curved side, much dirt and filth accumulates behind them, which is very hard to get at and deal with. Bunks should invariably be made of angle or tubular iron, and should occupy the centre of the fo'c'sle space, thus leaving a clear alley-way round the curve of the ship's side. I recommend this to all shipbuilders.

The *heating arrangements* are important in cold-weather voyages. The Board of Trade lay down the alternatives of a steam-heater or a stove, and allow it to be located in a mess-room, if a separate messroom is provided.

A steam-heater is apt to dry the air too much. From a hygienic point of view a stove is preferable, but should be so constructed that no leakage of CO_2, CO, etc., can occur.

With regard to *effluvium* and *drainage* considerable care should be taken.

Effluvium which may reach the crew's quarters may originate from offensive cargo, bilge-water, latrines, oil-fuel, galleys, or chain-lockers (decomposing mud).

The bulkheads required by the Board of Trade go far towards preventing this nuisance; and further regulations prohibit, absolutely, direct communication between crew's quarters and compartments for oil or ballast pumps, or oil-fuel spaces.

With regard to the drainage of upper fo'c'sles and deck-houses, it is laid down that a sufficiency of holes must be provided through the cant or combing, of a sufficient size to allow the ready escape of water. Each hole must be fitted with a chained plug.

With regard to the *contents of the crew's compartments*, the official regulations require that the space be kept free from all goods and stores of any kind which are not the personal property of the crew in use during the voyage. If ship's stores are kept there, the Master is liable to a fine.

My experience, however, is, not that the crew's quarters are used for ship's stores (although in some ships the Chief Steward has a great affection for an empty hospital!), but that no

control is exercised over the amount of personal effects with which the crew are allowed to fill their quarters.

The quantity of boxes, clothing, and litter of all kinds which fill the native crew's quarters on mail or other steamers not only curtails the scanty air-space, but collects dust and dirt and vermin, and renders cleaning operations extremely difficult. Every owner should provide a properly fitted and commodious steel locker for each man, who would then be expected to store his empty box in the hold.

The Board of Trade, in Regulation 31, require all crew spaces to be kept in a clean condition by daily sweeping, quarterly washing, and two-yearly painting. To anyone who knows crews' quarters intimately, such a regulation would cause a shudder!

Every Chief Officer would be well advised to see that the following procedure is adopted as a *minimum:* The decks should be swept daily, the bedding aired for an hour on the hatch, the bunks being meanwhile gone over thoroughly with a cloth soaked in Sanitas Okol Solution.

At least once a month the quarters should be entirely emptied, scrubbed, and douched. They should be whitewashed every six months, or painted once a year (or at the end of each voyage).

The Board of Trade would be well advised to insist on an SO_2 fumigation after each voyage, to get rid of all the vermin; but that can hardly be expected until the whole subject is treated more seriously.

Passenger Spaces.

The spaces for first and second class cabin passengers need cause but little hygienic disquiet. They are sufficiently well catered for in practically every modern ocean-going steamer, and are therefore negligible for the purposes of this chapter. It will be sufficient if I state that the Board of Trade definition of a cabin passenger is, "a person who is allotted 36 superficial feet for his exclusive use, provided he has paid a fare of £3 5s. for every thousand miles of voyage, with a minimum of £25"!

The Admiralty transport regulations for cabin passengers

require the cabin to be at least 6 feet high, bunks to be 6 feet by 2 feet in the clear, and the following provisions as to deck-space:

	1st Class.	*2nd Class.*
Cabin for one	30 sq. ft.	30 sq. ft.
,, two	42 ,,	36 ,,
,, three	62 ,,	50 ,,
,, four	74 ,,	62 ,,

"Third-class" is in many lines synonymous with a deck passage. In the bigger liners, mail steamers, troopers, etc., third, and even fourth, classes may have cabin accommodation, and I shall not therefore consider them here as being deck passengers. The accommodation provided for them is usually ample, and is kept fairly clean. The cabins are, as a rule, however, overrun with bed-bugs. Owners should see that all such quarters are properly treated and fumigated at the end of each voyage.

The Admiralty rules for third-class women and children in transports are as follows:

121. In *freight ships* (men).

Each berth is to hold one woman or two children, but girls and boys between 8 and 10 are not to be berthed together.

Each woman is allowed a bed, pillow, and two blankets. Each child, a pillow, a blanket, and half a bed.

Girls over 10 are considered as adults for sleeping accommodation, and boys over 10 sleep in hammocks outside the quarters.

122. In *transports*, girls and boys over 10 are to be treated as adults, and girls and boys between 8 and 10 are not to be berthed together.

Each berth can accommodate one woman and one child under 2 years, or else two children; but a woman having no children of her own is allotted a berth to herself.

The most important passenger spaces, from a sanitary point of view, are undoubtedly those allotted to deck emigrants and immigrants, whether European or native.

I cannot do better than quote here some of the Board of Trade rules with regard to structural requirements, omitting those that have no public health interest, or which come under the head of ventilation, etc., dealt with elsewhere. It must be remembered that these rules deal with European steerage passengers. Native deck passengers will be referred to later on.

(*a*) No emigrant ship may under any circumstances carry more steerage passengers than 1 adult to every 5 square feet of available deck promenade space.

(*b*) An adult must have 15 square feet of 'tween deck for his occupation; or 18 square feet if the deck clearance is less than 7 feet.

(*c*) On a deck below water-line each adult must have 18 square feet; or 25 square feet if deck clearance is less than 7 feet and air apertures below standard.

(*d*) Decks of wood must be properly fastened and caulked, and must be continuous from side to side.

(*e*) Iron decks must be closely woodsheathed, or covered with an approved non-conducting composition.

(*f*) The deck clearance must be not less than 6 feet.

(*g*) Only two tiers of bunks are allowed on any deck; the lowest must have a clearance of 6 inches below and 2 feet 6 inches above; and the upper bunk must have a clearance of 2 feet 6 inches from the deck above.

(*h*) Each bunk must be 6 feet × 22 inches.

(*i*) All steerage passengers to have bunk accommodation.

(*j*) Hatchways leading to steerage compartments must be fitted with a substantial booby hatch.

(*k*) Ladders should be pitched fore and aft, if possible not more steep than 37° from the vertical.

The accommodation for native immigrants varies somewhat, especially in the fact that separate bunks need not be provided. The passengers either sleep on the deck in the 'tween-decks; or, if the available space allows of it, continuous sleeping benches are fixed along the ship's side at a height of about 5 feet. This accommodates an additional tier of sleepers.

The regulations of the Hong-Kong Emigration Ordinances may be taken as fairly typical for this type of passenger:

(*a*) The ship must be clean, and if necessary disinfected.

(*b*) Upper 'tween deck passengers must have 9 square feet and 54 cubic feet.

(*c*) Lower 'tween deck passengers must have 18 square feet and 126 cubic feet per adult (over 12 years of age) or for 2 minors (between 1 and 12).

(*d*) If carried on deck they must have a proper awning and screen; and at least 16 square feet per adult.

(*e*) 'Tween decks must have a clearance of at least 6 feet.

(*f*) 'Tween deck passengers must each have a clear promenade space on upper deck of 4 square feet.

Subsidiary Compartments.

Fore- and After-Peaks.—These are spaces at both ends of the ship, separated by bulkheads from the holds—that of the fore-peak being known as a "collision bulkhead."

The *chain-locker* is a separate compartment, situated just abaft the fore-peak.

The hatch giving access to the fore-peak is usually situated in the lower fo'c'sle, and any effluvium therefrom might thus prove a menace to the crew.

Nowadays, however, these compartments are not left in the same state as they used to be; and in a large proportion of steamers either or both of them are used as water-tanks or ballast tanks, for which purpose they are well adapted, if not used for drinking and ballast water alternately.

Stokeholds.—The situation of the stokeholds, far beneath the water-line, in the bowels of the ship, renders the matter of ventilation one of some difficulty. Owing, however, to the draught occasioned by the combustion in the furnaces the supply of air must be well maintained, and the purity of this air will be less a matter for anxiety than will the heat, which may reach 115° to 140° F. The matter of the air supply is dealt with in the chapter on Ventilation.

Owing to the heat, the enclosed location, and the absence of foodstuffs, both engine-room and stokeholds are not as highly favoured spots for rats as are other parts of a ship, and it is not often necessary to include them in a ship fumigation.

Paint-Lockers.—In small vessels on coasting trade, paints are stored ashore and not on board. In others, a box lashed on deck serves the purpose.

In most larger vessels there is a separate compartment, known as the paint-locker, where paint and oil stores are kept.

In about 55 to 60 per cent. of vessels the paint locker is well constructed, and so placed as to cause no nuisance or inconvenience to the crew.

In a small percentage the compartment is located close to the

crew's quarters, and is so constructed that fumes of open paint and oil can permeate them.

Such a condition of affairs is highly injurious to the health of the crew.

Latrines.—There is a wide variation in the type and structure of ship latrines, especially those for the crew.

Cabin passengers are usually provided with modern valve closets having automatic flushes. With the structure of these I have no fault to find, but they admit of some improvement in accessory detail. As a rule, they are constructed amidships—unless the cabin accommodation happens to be aft—and are fairly close to the engine-room casing. This, together with a lack of proper artificial ventilation, makes them insufferably hot, especially in the tropics. Another objectionable feature is that the outlet on the ship's side is well above the sea, and is usually only valved and not properly "lipped," as it ought to be. The discharge therefore shoots out horizontally with some force. This would not so much matter were it not for two unfortunate circumstances, one being that passengers apparently have an irresistible desire to defer their daily pilgrimage until the ship has anchored and launches are alongside; and the other, that the designers nearly always secure a coincidence of situation between the latrine outlets and the gangway ladder. I have more than once had my launch chair and books spoilt in this way, after coming alongside a ship—and my subsequent inspection was perhaps rather more severe than it ought to have been! A proper lip fixed to the outlet would save such situations, but builders consult no sanitary expert on such matters of small size but great importance.

Although not connected with latrines, a similar matter might be mentioned here. Most deck scuppers discharge by a simple vent at the deck level and the scupper contents dribble down the side of the ship. The material is often filthy beyond words, and is naturally picked up by the hands of the men when they stave off their cargo-lighters alongside. These lightermen are often natives who eat with their hands on board their boat, and their food is often liable to be contamin-

ated in this way—in fact, I am not sure that cholera is not sometimes contracted thus. The insanitary situation could easily be obviated by carrying the scupper drain down through the 'tween decks and discharging it nearer to the sea; but here again it seems a matter of indifference to owners.

But to return to our latrines.

In the Navy, seamen are allowed three seats per 100 men. This is the smallest number that occurs in any regulations! Emigrants and transport troops are allowed four seats per 100 up to 300 persons, and two seats per 100 above that number; while the Board of Trade require for Mercantile Marine crews as many as ten seats for the first 100 men, and four seats per 100 above that total.

The Admiralty transport regulations for troops are so extremely specific and sensible with regard to the structural details of the latrines that it is worth while quoting them at length:

(*a*) They must be on upper deck, each 7 feet high by 7 feet wide.

(*b*) Bulkheads, doors, and top to be of 1½ inch deal, tongued and grooved.

(*c*) Stanchions 3 inches × 3 inches, and placed 3 feet apart.

(*d*) 6-inch openings to be left above and below bulkheads for ventilation.

(*e*) Hoppers of ⅛ inch iron; of semicircular section; 10 inches deep at ends; 2 feet 6 inches deep at central outlet; each to take five seats.

(*f*) Outlet to be 6 inches in diameter.

(*g*) Angle-iron to be riveted on hopper to take front and back wooden rails, 3 inches × 2 inches, intended to receive the seats.

(*h*) Seats to be of 1½ inch deal; grooved and tongued; 18 inches wide; hinged on back rail with galvanised hinges.

(*i*) Holes to be oval-shaped, 9½ inches × 11 inches, and 24 inches from centre to centre.

(*j*) Dwarf bulkhead of 1 inch matchboard between each seat.

(*k*) Water supply from ship's salt water service by 2½ inch pipe, with spreader at each end of the hopper.

(*l*) Hopper soil-pipes to be 5 inches in diameter; to be carried down inside the ship, and discharge 2-feet above the water-line, with a 5 inch gun-metal non-return valve.

(*m*) Deck of latrine to be covered with tiles, granolithic, or as ordered.

(*n*) Handpaper box to be supplied for each seat, and screwed to bulkhead.

(*o*) For children, two portable seats to be provided, of 1-inch yellow pine, clamped at ends. Oval holes 7 inches × 8 inches. Chocks on underside to fit them in permanent seats.

After the lucidity and excellence of these rules, the Board of Trade regulations for the water-closets on emigrant ships are certainly disappointing, omitting, as they do, all details as to construction and water service. For the sake of comparison I quote them here verbatim:

38. (i.) Every emigrant ship shall be provided, to the satisfaction of the Emigration Officer at the port of clearance, with water-closet accommodation which shall be at least sufficient to provide four water-closets for every hundred passengers up to 300 passengers, and two water closets for each additional hundred passengers beyond that number.

The water-closets shall be placed on a passenger deck other than the lowest, as required by the Emigration Officer.

Separate water-closets shall be apportioned to, and conspicuously marked for, the use of males and females.

In addition, urinals shall be provided for the male passengers.

(ii.) All such water-closets shall be firmly constructed, properly lighted and ventilated, and maintained in a serviceable and cleanly condition throughout the voyage, and shall not be taken down until the expiration of twenty-four hours after the arrival of the ship at the final port of discharge, unless all the steerage passengers quit the ship before the expiration of that time.

(iii.) The Master of the ship shall alone be liable to a fine for breach of the regulations as to water-closets.

We now come to latrines for the use of crews.

These conveniences for the crew should be so situated as to be near the men's quarters, but not so constructed as to constitute a danger to their health.

Many types prevail.

The simplest of all is the "*cage*" *type* (Fig. 5) frequently found on launches and small mosquito-fleet steamers in the tropics. I have even seen them as a more permanent fitting in two vessels of 800 tons odd, in that case being suspended outside ports specially cut on both sides of the main-deck for'ard. Both ships had a fore-and-aft upper deck, so that the main deck resembled a 'tween deck. The principle of these cage latrines is merely that of a skeleton semicircular iron cage, hinged on its diameter to allow of its being folded inboard. It is surrounded with a canvas screen to ensure privacy, the occupant squatting within and discharging the soil through the open grating into the sea below. It is either

hung over the stern, or over the cut-away bows, so that the sides of the ship do not receive unwelcome additions to their paint. The system is primitive, but is of high sanitary excellence, even if æsthetically repulsive.

The next most primitive type is the *pail-closet*, seldom found now except in smaller coasting vessels. There is no excuse for it on any steamship.

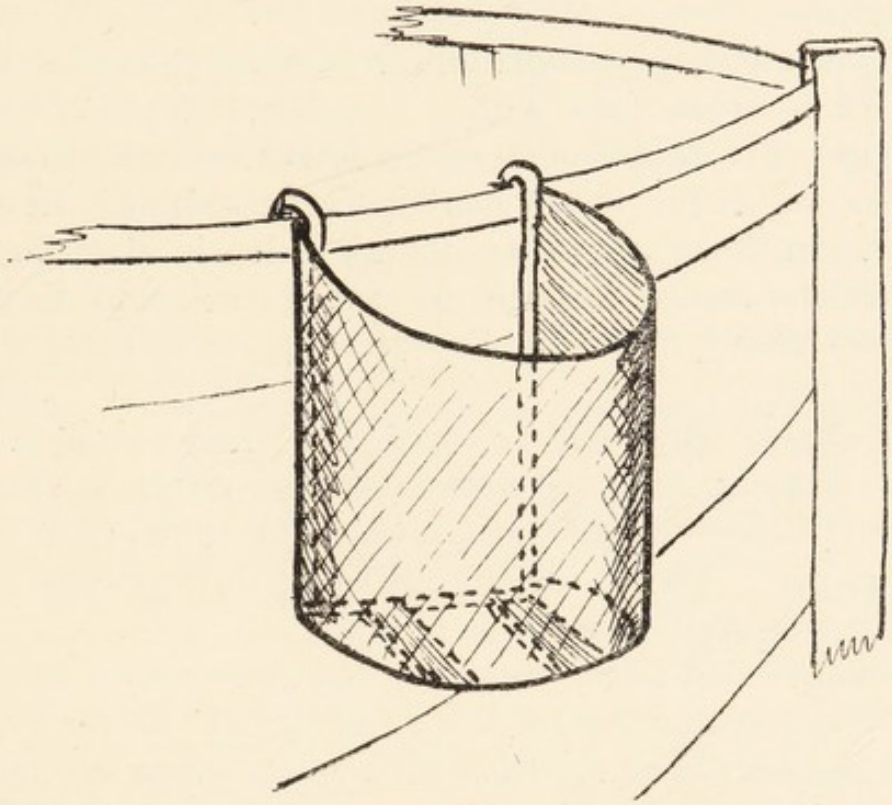


FIG. 5.—CAGE LATRINE WITH CANVAS COVER SUSPENDED FROM GUNWALE OR BULWARKS.

The sanitary requirements for sound crew latrines are:

1. Properly constructed compartments.
2. Sensible type of installation.
3. Available water-flush (even in port).
4. Proper system of discharge.
5. Good ventilation of compartment.
6. Systematic cleanliness.

The compartment, if adjoining the crew's quarters, should have a steel dividing bulkhead, shutting off communication completely. If the bulkhead is of wood it should be of two thicknesses, tongued and grooved, with a layer of felt and coal-tar between.

The floor should be of cement, reinforced with expanded metal to prevent cracking, and should be provided with a proper drainage vent for the exit of water when the compartment is cleaned.

If the latrine is entered from a passage-way leading to crew spaces, the Board of Trade require that the w.c. door be solid and closely fitting, and that the passage-way be suitably ventilated.

With regard to the installation, an iron trough latrine should be fitted in every case, with a hinged wooden seat of five openings. For detail, one cannot do better than follow the specification as previously quoted for troopships. The soil-pipe should in no case be less than 4 inches in diameter, and it should be carried through the 'tween decks and discharge not more than 3 feet from the water-line, being fitted with a suitable valve.

The water-flush should be continuous, except at night.

One of the great drawbacks to all ship privies is that the sea-water service usually ceases when the engines are closed down in port. Owners should insist that the service be maintained by donkey-boiler while in port.

For native and lascar crews, the trough system is also suitable, but no seats are provided, as serving the native custom. The troughs for them should be made of earthenware (not iron) and should be let into the cement of the floor, and not raised above floor level. In calculating the accommodation, a linear measurement of 18 inches may be taken as equivalent to one seat.

The compartment should be ventilated directly to the outside air, and not into any other compartment or alley-way. If the location demands, artificial ventilation should be properly installed.

The matter of cleanliness is one which is often overlooked. I regret to say that, in my experience, more than 50 per cent. of crew latrines are kept in a disgraceful state. This is partly due to the inadequacy or faultiness of the flushing system, and partly to lack of proper supervision by the ship's officers. A daily inspection should be made, and a weekly trial overhaul.

The compartment should never be painted, but should be whitewashed once a month, and 1 ounce of Sanitas Okol or Izal should be stirred into one gallon of whitewash before application.

Hospitals.—The sick-bay in the Navy is located in various positions, according to the type of vessel. It is, of course, immaterial where it is placed as long as adequate ventilation is secured. The bed accommodation is reckoned as 3 per cent. of the complement, and a superficial area of 20 to 30 feet is allowed per patient.

The Admiralty Transport Regulations are also on a basis of three beds per 100 troops:

The sick berths are to be single-tier iron bunks, well secured. Length 6 feet × 2 feet 3 inches in the clear, with 4-inch mesh lattice bottoms. The compartment is to be fitted up in the most suitable part of the vessel, and to be specially well ventilated. The structural details are as follows: To be built of fir stanchions (3 inches × 3 inches), not more than 4 feet 6 inches apart, well secured top and bottom. A cant (3 inches × 3 inches) is to run round the outside, bolted to the deck, and caulked. Bulkheads to be carried up 5 feet, solid, with 1-inch fir boards, planed, grooved, tongued, and "V"-jointed. The second board from the bottom to be left out, or panels cut between the stanchions. The upper part is to be fitted with sash frames. Sashes are to be glazed with ground glass, and to be hinged to the frames on lower part with 2-inch brass butt-hinges, in order that they may be let down flat against the bulkhead; to open outwards, and to be kept in place by two iron segments, and, when closed, each to be secured with a brass shutter-bolt.

Doors to be 3 feet wide in the clear, and in two parts, the lower part to be secured on the inside by a strong shutter-bolt, and the upper part with a 6-inch rim and spring lock, both to be hung with 6-inch butt-hinges.

The Board of Trade regulations for hospitals on emigrant ships allow for about 2½ beds per 100 steerage passengers. No specification is given as to details of material, etc., which is left to the Emigration Officer. The following is Rule 39, which covers this:

39. *Hospitals.*—(i.) Sufficient space shall be set apart in every emigrant ship for use exclusively as hospital accommodation for the steerage passengers, being properly divided off from other living quarters to the satisfaction of the Emigration Officer at the port of clearance.

At least one hospital shall be set apart for infectious diseases.

(ii.) The spaces set apart for such hospital accommodation shall be on or above the uppermost passenger deck, and shall be placed to the satisfaction of the Emigration Officer at the port of clearance.

The space set aside as an infectious hospital* shall be in as isolated a situation as possible.

(iii.) The space so set apart shall contain not less than 18 clear superficial feet for every 50 steerage passengers whom the ship carries; and shall be fitted with bed places, and supplied with proper beds, bedding, and utensils to the satisfaction of the Emigration Officer at the port of clearance, and shall throughout the voyage be kept so fitted and supplied.

In no case shall the hospital space be less than 100 superficial feet, but in vessels where the steerage passengers do not exceed 200 in number there need not be more than two hospitals, including the one for infectious cases.

Hospitals should not contain more fitted beds than one to every 15 superficial feet, and must be properly ventilated, fitted, and arranged. One lying-in or double berth should be provided.

The Rules made under the Merchant Shipping Ordinance of the Straits Settlements have the following requirements with regard to hospital accommodation on *pilgrim ships* proceeding to Jeddah.

It will be noticed that the number of bunks is fixed, irrespective of the number of pilgrims on board.

The larger ships will carry as many as 1,600 pilgrims on one voyage—in which case hospital accommodation would only be provided for 0·5 per cent.

M. S. O., 1910. *Pilgrim Rules Under.*

28. A permanent hospital shall be provided on every pilgrim ship, containing *not less than six bunks*, and having a *floor area of* 144 *square feet*, and a height of not less than 6 feet.

When more than fifty female pilgrims are carried, there shall be a separate permanent hospital set apart for them, containing not less than *two bunks*, and having a *floor area of not less than 72 feet*, and a height of not less than 6 feet.

The women's hospital may also be used for children under 12 years of age.

No case of smallpox, cholera, yellow fever, or plague shall be treated in a permanent hospital.

29. Such hospital shall be on the upper deck† and form part of the permanent structure of the ship. It shall be lighted and ventilated to the satisfaction of the Port Health Officer and the Surveyor.

* Presumably a "hospital for infectious cases" is intended!

† This means, of course, the "main deck."

30. Every pilgrim ship shall have on board material for the construction, on the upper deck, in a situation approved by the Port Health Officer and Surveyor, of a separate temporary hospital for cases of sickness that it may be considered desirable to segregate (such as small-pox, cholera, yellow fever, or plague). The material for the construction of the hospital shall be of a substantial character, and to the satisfaction of the Port Health Officer. Approved arrangements for light and ventilation shall be provided. The minimum floor space and height shall be the same as for the permanent hospital for males.

There is no obligation in the Mercantile Marine to provide any hospital accommodation for the crew. Most of the better lines do provide a hospital, however; and, if so certified, it is included with deductions made on account of crew space from the tonnage of the vessel.

It would be advisable that in their next edition of " Instructions as to Survey of Master's and Crew Spaces," the Board of Trade should lay down definite requirements in this direction.

Structural Sanitary Surveys.

During our work in Singapore in the last seventeen years we have had occasion to inspect several thousand vessels of many different types. These inspections were made either as quarantine inspections, routine sanitary inspections, or as disinfection surveys.

A few years ago it occurred to me that it was a great pity that I had kept no structural notes of all these different ships.

A structural sanitary survey of a large number of ships would have been a very valuable asset for many reasons. For instance, the large amount of relative data would have shown up weak points, exposed pernicious tendencies otherwise not noticeable, and gradually crystallised experience in such a form that it could be of universal, as well as of local, or personal, value.

Again, a ship has to be fumigated for rats. In your own office you look up that ship in your Survey Register. You find that she has " so many " holds, that there are bulkheads between each, and that there are no bulkhead doors, but that the 'tween deck has a through alley-way; and so on. You are able at once to issue complete instructions for fumigation without wasting any time in visiting the ship.

FIG. 6.—STRUCTURAL SURVEY (Sanitary).

Registered No.———— *Nationality* ————

Ship———— *Net tonnage* ————

Usual Voyage ———— *Max. Complement Cabin Passengers* 1*st cl.*———— 2*nd cl.*———— 3*rd cl.*————

ACCOMMODATION.

	Maximum Complement or Accommodation.	Location of Quarters Forward, Aft, or Centre.	On which Deck.	Iron or Wood Flooring.	Cubic Capacity.	Floor Space.	Height.	Number of Portholes.	Size of Portholes.	No. of Cowl Ventilators.	Any Artificial Ventilation. Vacuum or Plenum.	Lamps or Electric Light.	Iron or Wooden Bunks.	Lateral or Central Bunks.	How often Quarters cleaned.	By Whom cleaned.
Stewards, including cooks																
Sailors, including quartermasters and carpenters, etc.																
Firemen, including coal trimmers																
Hospital																
Deck passengers ..																

HOLDS.	Number.	Any Bulkheads between each?	Bulkhead Doors present?	Separate Ventilating Cowls to each Deck.	Any Artificial Ventilation.	Through Alleyways Present Fore and Aft.
'Tween decks						
Orlop decks						
Lower holds						

LATRINES.	Type (W.C. or Cage).	Situation.	No. of Compartments.	Flushing Constant or Voluntary.	Flushing maintained while in Port?	Are outlets Lipped?
Cabin passengers ..						
Deck passengers ..						
Crew						

WATER SUPPLY.

Number of Tanks.	Position of Tanks.	Total Capacity.	Number of Days' Supply at 1½ Gals. per Head for Max. Ship-load.	How often Tanks Cleaned.	How are Tanks Cleaned.	Filling and Sounding Pipe Coamings: Flush or Raised.	Any Central Filtration: Vacuum or Pressure?	Any Terminal Filtration: Porcelain or Electrical?	Any High Level Storage Tank?	Distilling Capacity (if any) of Pure Cold Water per 24 Hours.	Fore Peak or After Peak used for Fresh Water; or as Ballast Tanks?

Disinfection.

Number of steam machines ——————————

Type of steam machines ——————————

Total capacity ——————————

Any SO_2 apparatus installed ? ——————————

Bilges.

Number of independent bilges ——————————

How often pumped out ——————————

Ever disinfected ? ——————————

Paint-locker.

Situation ——————————

How ventilated ——————————

Communication with living spaces ? ——————————

Chain-locker.

Communication with living spaces ? ——————————

Miscellaneous.

Is each member of crew vaccinated before being signed on the articles ? ——————————

Is the ship regularly disinfected ? ——————————

Are saloons and cabins mosquito-screened ? ——————————

Are air-scoops always available ? ——————————

Number and type of rat-shields kept on board ——————————

Remarks. ——————————

——————————

——————————

——————————

(Signed) ——————————

Inspecting Health Officer.

Date ——————————— 19——

It would have been, further, very useful as a book of reference in conjunction with routine sanitary inspection reports.

I therefore devised a register in which to record this structural sanitary survey, of which the illustration (Fig. 6) is a sample page.

Owing to the outbreak of the European War, and the consequent depletion of effective staff, everything had to be abandoned except the most pressing requirements of the moment, but it is hoped eventually to obtain a really valuable series of observations.

The sample page will speak for itself. The idea is to get a survey of any and every possible ship. It will be seen that the inquiry has nothing to do with the present sanitary *condition* of a ship; that is another matter, dealt with in Chapter IX. This is merely a matter of *structural* detail, which holds good, once and for all, during the life of the ship.

Glossary of Structural Terms.

A certain number of terms have already been discussed. The list which here follows does not in any way pretend to be a complete glossary. No mention is made of any "rigging" terms, nor are everyday phrases, such as "hawser," "stateroom," etc., inserted.

Air-scoop.—A bent plate of tin or zinc used, by extrusion from a porthole, to deflect wind into a compartment.

After-peak.—The space behind the aftermost bulkhead of a ship. Often used as a water or ballast tank.

Becket.—A kind of strop, having an eye on one end and a toggle on the other. Used to suspend coiled gear clear of the deck.

Bilge.—By engineers this term is given to the inner surface of a vessel's bottom—*i.e.*, the space between the floors. The water accumulating there is called "bilge-water"; the apertures in the bottom plating for letting in water from the sea are styled "bilge-inlets."

Bulkhead.—Partitions by which compartments in a vessel are formed, or the hold of a ship divided. Cross bulkheads usually of $\frac{1}{4}$-inch or $\frac{1}{2}$-inch steel plates, extending from the

floor to the weather deck, usually stiffened on one side by vertical angle-irons 30 inches apart, and on the other by horizontal angle-irons 40 inches apart. Steamers always have four bulkheads—collision, stokehold, engine-room, and stuffing-box. Large steamers may have as many as twelve or more.

Bollard.—A post or pillar to which moorings are fastened.

Bunkers.—Compartments for storing coal for ship's use. According to their situation they are named as follows: (*a*) Hold bunker; (*b*) Pocket bunker; (*c*) Side bunker; (*d*) Cross bunker.

Cant-frames.—The frames at the fore- or after-end of a ship; set at a cant, and smaller in size than the body frames.

Carvel-built.—With side planks merely in apposition, making a smooth outside surface.

Caulking.—Driving oakum between planks, and closing with melted composition of pitch and rosin.

Chain-locker.—The compartment for storing the cable, just abaft the fore-peak—separated therefrom by the collision-bulkhead.

Clinker-built.—With side planks overlapping each other.

Cofferdam.—Usually a wooden construction in form of a large box, so designed as to fit closely round a vessel's bow or stern and when pumped out affording access to parts below the water-level, requiring repair.

Collision-bulkhead.—The cross-bulkhead just abaft the fore-peak of a ship.

Dead light.—Any cover or shutter fitted to protect the glass of a skylight, or a cabin port, etc., to prevent breakage of glass by the sea.

Decks.—In a ship there may be any two or more of the following: Bridge deck, boat deck, promenade deck, upper deck, main deck, 'tween or middle deck, lower deck, orlop deck, lower orlop deck.

Dunnage-mat.—Straw matting used for protecting perishable goods.

Fair-lead, Fair-leader, Warping-chock.—A metal guide through which a hawser or rope passes.

Fid.—Conical piece of hard wood used to open rope-strands in splicing.

Forecastle.—Sometimes called a "top-gallant fo'c'sle." One or more compartments built on the main or upper deck of a vessel, in the for'ard part of the ship, extending aft from the stem.

Fore-peak.—A compartment for'ard of the foremost (or collision) bulkhead. Frequently used as a ballast or water tank.

Frames.—Transverse ribs forming the skeleton of a vessel. Each frame is composed of several sets of timbers comprising the floor, first futtock, second futtock, etc.

Futtocks.—Some of the various pieces of timber of which a frame is composed.

Gasket.—A piece of line by which a sail is secured to a yard or boom when furled.

Garbord strakes.—The planks of the outer hull, which lie next to the keel proper.

Gimbal.—Double-swing bearings for compasses, lamps, etc.

Glory-hole.—The quarters allotted to the steward's department.

Gunny.—A bag made of sacking.

Hatch-combings (or *coamings*).—Raised sides of a deck opening which hold the hatch.

Hog.—A kind of scrubbing-brush used for cleaning a ship's bottom.

Holystone.—A brick of soft sandstone used for cleaning wooden decks.

Junk.—Old condemned rope.

Keelson.—An inner keel situated above a ship's floor in wooden vessels. Consists of various pieces of timber connected endwise, and bolted through floor and keel.

Kid.—A shallow tub or pan in which seamen's food is served.

Knight-head.—The plank next to the stem.

Ladders.—The following are the usual ladders used on a ship:

1. Accommodation ladder: Wooden ladder lowered outside the ship's side, for ordinary access of passengers, etc.
2. Companion stairway: Inside stairs from deck to deck, or to saloons, etc.
3. Deck ladder: Generally of iron, affording access from deck to deck in open air.
4. Jacob's ladder: Of rope, with wooden rungs, suspended from end of boat boom.
5. Rope ladder: Of rope, with wooden steps, hung from the bulwarks for the use of pilots.

Limber-board.—The plank which covers the opening of the limbers.

Limber-strake.—The plank of the inner skin alongside the keelson, abutting on the limber-board, and forming the outer side of the limbers.

Limbers.—The water-course on each side of the keelson.

Leech.—The side edges of a sail.

Oakum.—Unshredded rope-yarn, used for caulking decks.

Parcelling.—Strips of tarred canvas wound spirally round a length of rope.

Pawl.—The ratchet of a capstan.

Pintle-straps.—The rudder braces.

Pintles.—The pivots on which the rudder is hung.

Plummer-block.—Socket-blocks on which the propeller shaft rests.

Scarf.—The connection of two pieces of timber by the overlapping of their shaped ends.

Scran-bag.—A receptacle used in the Navy for impounding clothing, etc., left about.

Scuppers.—Round or oval apertures, from 1 inch to 3 inches in diameter, serving to lead off small quantities of water and preventing it from accumulating on a vessel's deck. In steel vessels the weather-deck scuppers are side drains emptying by holes cut in gunwale and sheerstrake. Scupper-pipes of 'tween and lower decks may empty outboard, or may lead between the frames to the bilge.

Scuttle.—(*a*) An aperture, smaller than a hatch, in a ship's deck; (*b*) A round (or square) opening in the side plating or in

a bulkhead to admit light and air (*i.e.*, synonymous with a porthole).

Seppings.—A wood filling sometimes introduced between the lower frames of a ship to give greater strength to the bottom structure.

Shakings.—Old ropes, canvas, and other rubbish.

Sheerstrake.—The uppermost side plank of a ship, immediately below the plank-sheer and bulwarks.

Shelf-pieces.—Heavy strakes of timber fitted immediately under a tier of beams for the beam-ends to rest on.

Side-stringer.—Horizontal scantling to strengthen the frames of a ship.

Soil-pipe.—The discharge pipe from a w.c. or latrine.

Sound-pipe.—A pipe about 1 inch in diameter extending from the upper deck into the well, or bilge, or double-bottom of a ship, into which a sounding-rod is lowered to ascertain the depth of water in the space.

Spirketting.—The first strake of inside planking immediately above a waterway.

Sponsons.—Triangular decks abutting on paddle-boxes.

Squillager.—A rubber squeegee broom used for drying wooden decks after washing.

Stem.—The piece of heavy straight (or curved) iron (or timber) which terminates the fore end of a ship's hull. Its lower end is joined to the fore end of the keel.

Sternpipe.—A round or oval aperture in the upper part of a vessel's stern or poop-deck, for passing mooring cables and hawsers through (*vide* " Fairlead ").

Sternpost.—The piece of timber or steel extending from the after end of the keel to the uppermost deck, and terminating the after end of the hull. On the sternpost the rudder-braces are fixed to receive the pintles by which the rudder is hung.

Strake.—A continuous range of plating or planking, extending all fore and aft of a compartment, or from end to end of a vessel.

Stringer.—Longitudinal girders of different forms for strengthening the hull.

Tanks.—Deep tanks may be built abaft or for'ard of the

engine-room bulkheads. Sections of the double-bottom, both under the holds and under the engine-room, may be used as tanks. The fore peak and after peak are both frequently put to the same purpose. Independent iron tanks are also sometimes carried in the holds or 'tween-decks.

Thimble.—An iron ring grooved all round its outside, in which a cringle of a sail or a rope is laid.

Thrust-block.—A heavy piece of metal, fitted with various grooves, in which the collars of the thrust-shaft gear and revolve, transmitting the thrust to the body of the ship.

Timbers.—Pieces of wood entering into the construction of the futtocks, or frames.

Toggle.—A wooden pin, usually tapered at both ends, and its middle part spliced into a becket—serving as a key when passed through the eye of a rope, or in the bung-hole of a cask, etc.

Topgallant-fo'c'sle.—See Forecastle.

Transom.—The cross planking fixed to the sternpost of a boat, just below the stern frames. There is sometimes a transom compartment or recess used as a storeroom.

Ventilator.—An arrangement by which fresh air is introduced to, and foul air expelled from, any part of a vessel. They are of various constructions, such as cowl, mushroom, elbow-bend, etc.

Waterway-piece.—Pieces of timber in a wooden ship fitted fore and aft, on the beam ends, against the frames.

Windsail.—(*a*) A ventilating cowl and shaft made of canvas; (*b*) an air-scoop.

Wing-house.—A small compartment on the upper deck, fitted against the bulwark, and serving various purposes, such as paint-locker, lamp-room, latrine, etc.

CHAPTER III

THE VENTILATION OF SHIPS

" . . . the air
Nimbly and sweetly recommends itself
Unto our gentle senses." *Macbeth*, I. vi. 1.

The problem of ship ventilation began in Roman times, when ships were first "decked" for war purposes; and the first attempt at its solution was outlined about the year 1500, when a shipbuilder of Brest, named *Descharges*, invented port-holes, which were soon after fitted in the poops and fo'c'sles of two of our men-of-war—the *Regent* and the *Sovereign*.

It can be quite understood that, with the modern subdivision of the ship by decks, bulkheads, engine-rooms, etc., the proper ventilation of the spaces occupied by human beings, cargo, coal, etc., has become a matter of increasing difficulty.

There are four factors which have to be considered in this connection:

(*a*) The air outside the ship.
(*b*) Available cubic space per head on board.
(*c*) The contamination of the air spaces.
(*d*) The purification of the air-spaces.

The Air Outside the Ship.

Considering water-vapour at sea-level to average about 1·4 per cent., the following will represent the usual volume composition of air at sea:

Nitrogen (including argon, helium, neon, krypton, and xenon)	77·90600
Oxygen	20·65940
Ozone	0·00015
Water vapour	1·40000
Carbon dioxide	0·03360
Ammonia	0·00080
Nitric acid	0·00005
	100·00000

This is a sufficiently constant analysis to represent the usual everyday conditions.

At sea, the CO_2 may occasionally fall as low as 0·02 per cent.; while in stagnant tropical harbours it may rise to 0·04 per cent. in association with other gases, such as marsh gas (CH_4) and sulphuretted hydrogen (H_2S).

The concentration, however, will scarcely ever be sufficiently marked or prolonged to have a serious effect on the occupants of a ship; and, for practical purposes, it may be taken that an inexhaustible supply of pure air is always available outside the ship—though perhaps from stress of weather not always obtainable.

Cubic Space per Head on Board.

It is obvious that the greater the crowding of ship spaces the greater will be the need for proper ventilation; and, as proper ventilation is much more difficult to secure on a ship than on land, it becomes highly important that a minimum cubic space should be legally insisted on—especially in the case of deck or steerage passengers and crew, who are less likely to be as well catered for in this respect as are cabin passengers.

Let us, however, for a moment recall the old shore standards —the dicta of our sanitary education.

The ideal aimed at for a healthy person is 800 cubic feet, and for a sick person, 1,000 cubic feet. To keep the air sweet, 3,000 cubic feet of fresh air must be supplied hourly per head.

If this amount is supplied in more than three or four instalments per hour, an uncomfortable draught is caused.

Thus, if we take a tiny room or cabin of 10 feet × 10 feet × 10 feet (=1,000 cubic feet), the proper amount of fresh air could be supplied by three changes an hour, which would not be uncomfortable.

Alas! these Utopian ideals have to be neglected in practice. The highest amount authorised by official sanction is the 600 cubic feet allowed by the War Office for a soldier. Then we come to the Local Government Board by-laws, which allow 300 cubic feet per head in common lodging-houses and poor-house dormitories. A further drop is seen in the Navy. There are no Admiralty regulations on the subject, but the

space per head works out at 200 to 150 cubic feet, according to the size and structure of the ship. Then we come to the Education Department of the Privy Council, who require 125 cubic feet per child in their schools (80 cubic feet for infant schools). Worst of all are the Board of Trade (Merchant Shipping Act), who require only 120 cubic feet per seaman, which figure is liable to certain deductions which may reduce it to 72 cubic feet. Lascars are normally supposed to have only the 72 cubic feet.

We thus see how badly off our ships are when compared with conditions ashore, and how important the subject of ventilation is.

With regard to the Mercantile Marine, the following are the legal provisions dealing with crew spaces:

MERCHANT SHIPPING ACT, 1894, SECTION 210:

Accommodation for Seamen.—(1) Every place in any British ship occupied by seamen or apprentices, and appropriated to their use, shall have for each of those seamen or apprentices a space of not less than 72 **cubic feet,** and of not less than 12 **superficial feet,** measured on the deck or floor of that place, and shall be subject to the regulations in the Sixth Schedule to this Act, and those regulations shall have effect as part of this section, and if any of the foregoing requirements of this section are not complied with in the case of any ship, the owner of the ship shall for each offence be liable to a fine not exceeding twenty pounds.

(2) Every place so occupied and appropriated shall be kept free from goods and stores of any kind not being the personal property of the crew in use during the voyage, and if any such place is not so kept free, the Master shall forfeit and pay to each seaman or apprentice lodged in that place the sum of one shilling for each day during which, after complaint has been made to him by any two or more of the seamen so lodged, it is not so kept free.

SIXTH SCHEDULE.

Regulations to be Observed with respect to Accommodation on board Ships.

(1) Every place in a ship occupied by seamen or apprentices, and appropriated to their use, shall be such as to make the space which it is required by the Second Part of this Act to contain, available for the proper accommodation of the men who are to occupy it, and shall be securely constructed, properly lighted and ventilated, properly protected from weather and sea, and as far as practicable properly shut off and protected from effluvium which may be caused by cargo or bilge-water.

(2) A place so occupied and appropriated as aforesaid shall not authorise a deduction from registered tonnage under the tonnage regulations of this Act unless there be in the ship properly constructed privies for the use of the crew, of such number and of such construction as may be approved by the Surveyor of Ships.

(3) Every place so occupied and appropriated as aforesaid shall, whenever the ship is registered or re-registered, be inspected by one of the Surveyors of Ships under this Act, who shall, if satisfied that the same is in all respects such as is required by this Act, give to the Collector of Customs a certificate to that effect, and if the certificate is obtained, but not otherwise, the space shall be deducted from the register tonnage.

(4) No deduction from tonnage as aforesaid shall be authorised unless there is permanently cut in a beam, and cut in or painted on or over the doorway or hatchway of every place so occupied and appropriated, the number of men which it is constructed to accommodate, with the words " Certified to accommodate . . . seamen."

This somewhat limited accommodation laid down by the Act of 1894 was, however (in certain instances), extended by the provisions of the later *Merchant Shipping Act of* 1906 passed while Mr. Lloyd George was at the Board of Trade, as will be seen by the following section:

Section 64.—(1) Subsection (1) of Section 210 of the principal Act shall be construed as if a space of not less than 120 **cubic feet** and of not less than 15 **superficial feet** measured on the deck or floor of that place were substituted for a space of not less than 72 cubic feet and of not less than 12 superficial feet measured on the deck or floor of that place.

(2) In estimating the space available for the proper accommodation of seamen and apprentices, there may be taken into account the space occupied by any messrooms, bath-rooms, or washing places appropriated exclusively to the use of those seamen and apprentices, so, however, that the space in any place appropriated to the use of seamen or apprentices in which they sleep is not less than 72 cubic feet and 12 superficial feet for each seamen or apprentice.

(3) *Nothing in this section shall affect*—

(*a*) Any ship registered before the passing of this Act or which was in course of construction on the first day of January, 1907; or

(*b*) Any ship of not more than 300 tons burden; or

(*c*) Any fishing boat within the meaning of Part IV. of the principal Act;

or require any additional space to be given in the case of places occupied solely by lascars and appropriated to their use.

There can be no doubt that this 120 cubic feet of space is quite insufficient if messrooms, wash-houses, etc., are to be deducted.

It is only too obvious that shipowners have scarcely made any effort to improve the sanitary conditions of their seamen in the past, however much it would have been to their interest to do so. As Dr. Collinridge, once Port Health Officer of London, and later M.O.H. to the City, said: "The more comfortable and cleanly forecastles can be kept the more contented and happy men are, the longer they will remain in the ship, and the more work can be got out of them."

It is satisfactory, however, to note that conditions are now improving somewhat. In the new "standard ships," built under the direction of the Controller of Auxiliary Shipping, the crews are berthed in the poop instead of in the forecastle, with special arrangements for steam-heating. The floor and cubic space now provided are considerably in excess of the Board of Trade requirements. The messing arrangements for firemen and seamen are separate from the sleeping accommodation, and a smoke-room is being provided for the general use of the men. Separate cubicles or rooms are provided, each fitted with two berths and a folding table, and situated along the side of the vessel. The firemen's and seamen's wash-places are fitted with lockers for dirty clothes, one for each man. Three spare cabins, with a separate bath and w.c., situated under the after end of the bridge, can be used for isolation purposes if necessary.

These improvements are largely due to the efforts of the "National Seamen's and Firemen's Union," who are to be congratulated on the results of their action.

Unions, alas ! do not always make for progress, as in the case of the Captain who tried to get his men to air their bedding in Navy fashion, but was met with a refusal; and their Union advised them to be men, and resist this demand on them for overwork !

An interesting letter on crew accommodation appeared in the *Lancet* of August 11, 1917, written by Fleet-Surgeon W. E. Home, who has done so much for many years to improve the hygiene of the Navy.

With regard to **Emigrants,** the Board of Trade lays down that passengers berthed in open steerages, who have the use

of public rooms elsewhere, may not be allowed more than 3 square feet on account of the use of such public rooms; and that at least 12 square feet (or 15 square feet, as the case may be) must be provided for each passenger in such open steerages.

With regard to the **Navy,** the Admiralty do not lay down a specific amount of requisite cubic space, nor do they require any one type of artificial ventilation, but one or two regulations may perhaps be quoted before closing this chapter.

By *King's Regulation* 554, the Captain is required to make sure that his ship is clean, dry, and well ventilated; that the drains are properly flushed; and that the ventilating fittings are efficient. He is also to take every means to ensure a natural circulation of air throughout the ship at all times. If the weather should prevent the opening of ports, fires should be lighted in the stoves, and wind-sails freely used.

King's Regulation 962 lays down that the bunket temperature must be noted every four hours (or every twenty-four hours if not under steam). In vessels with fixed coal-shoots the bunker-lids must be removed for three hours daily for the six days after coaling, and subsequently for three hours once a week.

The *Admiralty Transport Regulation* No. 58 requires a ship, prior to embarkation of passengers, to be thoroughly cleaned; if necessary dried by airing stoves; and to be well ventilated by wind-sails or other available means. No. 59 puts the onus on the Master of seeing that cleanliness, dryness, and proper ventilation are maintained; that the holds are clean, and free from noxious smells; that the 'tween decks are dry and well ventilated; that the instructions are carefully followed if Edmond's or other artificial ventilating system is installed; and that airing-stoves are issued when required for drying the mess decks after washing.

The Contamination of the Air Spaces.

Saloon cabins will seldom give any cause for anxiety, owing to their situation, their commodiousness, and the care bestowed on their construction.

It is otherwise, however, with regard to the other living spaces of a ship—such as crew's quarters, steerage, 'tween decks, etc., which form a serious and difficult problem.

The air below deck is often very undesirable. This may be due to many different causes, of which the chief will be:

(i.) Excessive humidity.
(ii.) Excessive heat.
(iii.) Excessive CO_2.
(iv.) Excessive organic matter.
(v.) Diminution of oxygen.
(vi.) Gaseous emanations from: (*a*) Bilges; (*b*) latrines; (*c*) fore peak; (*d*) bunkers.
(vii.) Effluvia from stores or cargo—*e.g.*: (*a*) Oil; (*b*) paint; (*c*) cattle; (*d*) sugar; (*e*) copra; (*f*) guano; (*g*) bone manure; (*h*) dried fish; (*i*) leeks, onions, or garlic; (*j*) fermenting fruit; (*k*) ferro-silicon.

The *relative humidity* is of great importance as expressing the drying power of the air. A hot moist air checks radiation of heat from surface perspiration. A cold moist air deprives the body too quickly of its heat by convection.

The moisture may have a fourfold origin:

(*a*) Atmospheric content.
(*b*) Respiratory dermal contributions.
(*c*) Deck-washing evaporations.
(*d*) Entry of storm water.

The atmospheric content we put at an average of 1·4 per cent.

The human contributions are said to average in twenty-four hours as much as 10 fluid ounces of water by the lungs, and 20 fluid ounces by the skin. This would amount to sufficient moisture to saturate 90 cubic feet of air (at 60° F.) each hour.

With wooden decks and a relative humidity already high, deck washing adds largely to the difficulty of securing a reasonable dryness.

To estimate the relative humidity in compartments, a swinging psychrometer is the most convenient instrument.

Fig. 7 will give a good idea of this form of hygrometer. In use, the wet-bulb cover is immersed in a cup of distilled water at the temperature of the compartment until saturated.

It is then whirled at arm's length some fifteen or twenty times, when a wet-bulb reading is taken. The process is repeated until the reading is about the same for two successive readings.

A special "humidity table" is supplied for the instrument, as the rapidity of evaporation will cause a different reading from that of the ordinary stationary hygrometer, and the tables for the latter would not give a correct humidity reading for the former instrument.

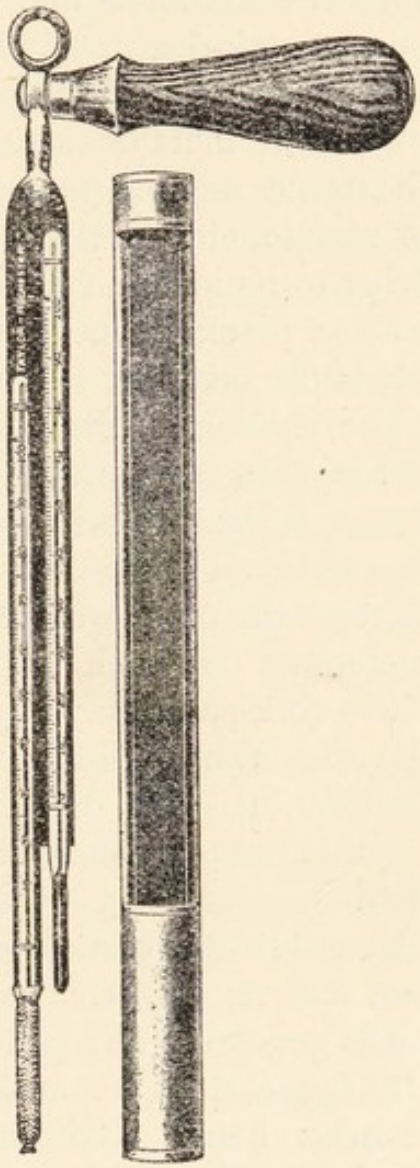


FIG. 7.—A SLING PSYCHROMETER OR WHIRLING HYGROMETER.
(After Gatewood.)

Excessive *heat* of below-deck compartments is another important matter. The heating may be due to several factors:

(i.) Human occupation.
(ii.) Warmth of entering air.
(iii.) Conduction through metal plates from outside atmosphere, and direct sun-rays.
(iv.) Lack of efficient ventilation.
(v.) "Wild heat."

Gatewood points out that, during the Spanish-American War, there were U.S.A men-of-war (in the tropics) whose sleeping quarters were never below 93° F., and whose stokehold temperature ranged to 170° F. In at least one of their ships the sick-bay temperature was rarely below 96°, and frequently above 100° F. He therefore concludes very soundly "that the ventilation of a modern ship is necessary for the removal of overheated air, even if it were not urgently required for other reasons."

The modern ship has its side plates of highly conducting steel which is powerfully influenced both from within and without by changes of temperature.

With a lowered temperature outside, the chilling of the adjacent internal air frequently goes below the dewpoint, causing a deposit of moisture on the metal surfaces known as "sweating." To obviate this it is usual either to sheathe with wooden matchboarding, or to coat the metal surface with painted cork-dust. The latter method diminishes or counteracts the sweating, but does not sufficiently do away with the result of the metallic conductivity on the temperature of the air. The former method (matchboarding) is likely to give a foothold for vermin, etc., and, moreover, cannot be used in men-of-war owing to its inflammable nature. Matchboarding is generally made of planks $2\frac{1}{4}$ inches wide and $1\frac{1}{4}$ inches thick. Between cabins the boarding is double, with an air space between.

The chilling effects of the metal on the adjacent air are said to vary inversely as the square of the distance from the plate. If the ship is in cold weather, and there is much difference between the inside and outside air temperatures, the effect on the occupants of outboard hammocks may be very deleterious. In such cases the outer row should not be slung. Where cork-paint only is used officers' bunks should be placed inboard. The condition in the sick-bay will also need careful attention.

"Wild heat" is the other great problem of temperature on board.

A considerable section of the ship is taken up by the engine-room and its appurtenances, where a very large amount of heat is generated day and night by the combustion of coal.

By funnel draught much of this heat is dissipated; but, on the other hand, a considerable amount is liberated within the ship. This is known as "*wild heat.*" Modern ships are mostly built of metal, which has a high conductivity, and are filled with air, which possesses the property of convection. Everything, therefore, is favourable for the invasion of ship spaces by the liberated "wild heat." If, in addition, we have tropical surroundings and imperfect internal ventilation, the internal temperature may become very prejudicial to health.

To obviate this condition, it is not only necessary to have a good ventilating system, but a proper non-conducting

installation should be a constructional feature. This is too often overlooked by marine architects.

Undoubtedly, however, one of the worst features of ship life is the excessive presence of *carbon dioxide* gas.

In rare instances some of this may be derived from bunker coal or special cargoes; and in olden days the combustion of lamp oil produced an appreciable amount. But the main source is human respiration.

Expired air contains about 5 per cent. less oxygen, and more than 100 per cent. excess of CO_2, in comparison with inspired air; in fact, the CO_2 excreted daily by an ordinary man averages 15 cubic feet!

CO_2 is not a poisonous gas, as is well known, but is rather an asphyxiating gas. In a given atmosphere suffocation may result from an excess of CO_2, or air starvation may result from a dangerous diminution of oxygen. The case of the s.s. *Londonderry* may be recalled. On a stormy night, over 150 steerage passengers were shut in a cabin $18 \times 11 \times 7$ feet, and 80 of them were found dead in the morning. The ship left Sligo for Liverpool on December 2, 1848.

The permissible CO_2 impurity is 0·02 per cent.—making (with the atmospheric CO_2) a total of 0·06 per cent. When the percentage reaches 0·1 the condition is incompatible with continued bodily health. When it gets as high as 0·5 per cent. physical results, such as lassitude, headache, and anorexia, become marked.

But it is not only from its intrinsic properties that a CO_2 excess is dangerous. Still more objectionable are the *organic impurities* which accompany it, and the CO_2 content forms a fair index towards the amount of these. Such organic impurities are usually associated with a disagreeable odour. Roughly speaking, they consist of:

(i.) Dust: Epithelial, clothing, food, coal, etc.; or produced by the desiccation of dirty harbour water used in washing decks.
(ii.) Micro-organisms of many kinds.
(iii.) Traces of expired organic matter.
(iv.) Gases from decayed teeth, etc.
(v.) Sweat products.

The dust and micro-organisms are the most dangerous features, and the sweat products the most obnoxious.

Gatewood shows that a crew of 800 men would excrete about 1,609 lb. (nearly three-quarters of a ton!) daily, of which 1,600 lb. would be water and 9 lb. solid matter. Of this 9 lb., 3 lb. would be NaCl and 6 lb. would be composed of organic acids, fats, cholestrin, extractives, epithelium, etc. Most of the water would vaporise. The solids would chiefly remain on the body or in the clothing; but small amounts will be found in the air, sufficient to precipitate silver nitrate, decolorise potassium permanganate, blacken on platinum, and yield ammonia.

The need for ventilation on this account is therefore obvious, as well as the necessity for cleanliness of person and clothing.

A most interesting series of CO_2 estimations were carried out by *Cope*, on a British man-of-war, to test the ship's air under the following conditions:

(*a*) Optimum condition, with all scuttles and hatches open and fans running.
(*b*) With only natural ventilation.
(*c*) With only artificial ventilation.
(*d*) With scuttles shut, hatches open, no fans running—in fact, the bluejackets' normal.

As far as possible, there were approximately the same numbers of men present under each condition of ventilation. The results may be classified as follows:

(*a*) Under optimum conditions, in practically all the living spaces, CO_2 was present to the extent of 0·6655 per 1,000 cubic feet.
(*b*) With only natural ventilation: CO_2 present equals 0·9095 per 1,000 cubic feet.
(*c*) With only artificial ventilation: CO_2 present to the extent of 0·8499 per 1,000 cubic feet.
(*d*) With no intentional supply of fresh air—in fact, with nothing but really natural ventilation: CO_2 present in proportion of 1·3046 per 1,000 cubic feet.

The above figures represent the average of 100 estimations under each of the stated conditions, and probably err in overestimating the CO_2 present.

Occasionally, in addition to excess of CO_2 and organic matter, there may be a *diminution of oxygen.*

Substitution of the former for the latter is, of course, a result of respiration; and, unless the air is changed by ventilation, the condition is a dangerous one.

There is another cause for a deficiency of oxygen *in closed spaces* which is frequently overlooked, and that is the absorptive power of certain oils, paints, or anticorrosive compositions. This is most marked in the case of red-lead (oxide + peroxide) paint, made, of course, with boiled linseed oil. *Belli* has shown, by experiments in the Italian navy, that the oxygen content in a ship's double bottom may be actually reduced as low as 3 per cent. by the use of this red-lead paint. The possibility of such a condition in an ill-ventilated paint-locker should not be lost sight of.

The **bacterial content** of air below decks has not received very much attention.

Some experiments of Dr. Candiotti, staff-surgeon in the French navy, were given in the *Archives de Médecine et de Pharmacie Navales* for April and May, 1917, investigating the bacterial content of the air of a French ironclad. He drew a large volume of air, 100 or 200 litres, through a tube of sugared water, and, plating that out, counted the colonies which developed. He does not mention the culture medium nor the temperature of incubation, but he gives the number and character of aerobes and moulds found in a cubic metre of air from different parts of the ship. His experiments were mostly made towards evening or at night, when the air was still, sometimes with the artificial ventilation stopped. His numbers from the engine-room and stokehold are low; those from the mess-decks are higher. In one of the latter he took two samples, the first about noon, which gave 1,200 aerobes, 800 moulds; the second from 8 p.m. to midnight, when the temperature was the same, but the ventilation was obviously poor. It was still weather, many hammocks were around and a disagreeable smell prevailed. This experiment gave 3,600 aerobes, but only 800 moulds, the same figure as by day, while the aerobe figure was trebled. In the wireless room Dr.

Candiotti found 3,800 aerobes, but in the galley on the main deck 8,100 aerobes, 900 moulds; in the vegetable store, two decks lower, 6,900 aerobes and 12,800 moulds. In these two latter sections only did he find colonies of the *Bacillus coli*, and he suggests that this may have accounted for the diarrhœa which he noted, his observations being made in summer. The aerobes found were mostly staphylococci, and Dr. Candiotti associates with this fact the prevalence among the men of boils and small abscesses, and the tendency of abrasions to inflame. He endeavoured by guinea-pig inoculation to prove the presence of the tubercle bacillus, but was unsuccessful. Other observers have found smaller numbers of bacilli in the air of a United States battleship, but exact comparison is impossible in the absence of information regarding the culture media used and other details of method. The results would gain in interest if the carbonic acid content of the air at the time of examination had been given as a guide to the efficiency of ventilation, and a statement made of the number of men in the compartment and the cubic space per head.

With regard to *gaseous emanations* from the various ship compartments, very little comment is necessary. From the bilges and peaks, H_2S and NH_4HS are the chief emigrants; from the latrines, the same gases and various ammoniacal products.

The *effluvia from cargo*, etc., will consist of various volatile oils, organic matter, sulphides, acrolein, PH_3, traces of AsH_3, etc., according to the nature of the cargo.

In many cases there is not much evidence to show that some of these mephitic gases are insalubrious.

In decomposing animal matter, such as manure, dried fish, etc., too great a concentration of evolved gas will often give rise to intense headache, vomiting, and diarrhœa.

An excess of H_2S will interfere with the proper aeration of the blood, and cause headache, malaise, anorexia, etc. PH_3 may cause acute intestinal inflammation and death. Remarks on cargo emanations will be found at greater length in Chapter IX.

Purification of Air Spaces.

The purification of the air spaces on a ship will be necessary either on account of pathogenic infection or of atmospheric vitiation.

In the former case, the object will be attained by the use of some gaseous disinfectant (*vide* Chapter X.).

In the latter case, there are rare instances where a gaseous disinfectant or chemical deodorant may be indicated; but as a general rule the only way of treating atmospheric vitiation is by securing the proper *ventilation* of the space in question.

In the ventilating of ships we have many factors to contend against. Amongst these will be: the great internal subdivision of ships; the small height of the compartments; the small available cubic space per head, leading to a concentration of deleterious air; the smallness of the available side scuttles; the fewness of the openings through the deck above; the absence of such diffusion through the walls as is obtainable in houses ashore; the dislike by the sailor man, generally, of "having things open"; and, in case of most artificial systems, the great length required for the ventilating trunks, leading to a loss of efficiency.

The two *methods of ventilation* are "natural" and "artificial."

Natural Ventilation.—By "natural ventilation" we mean the replenishment of the air in spaces through the agency of the wind, air temperature, or natural draught; and *not* by means of forcible extraction, propulsion, or movement.

Diffusion is too feeble to have an appreciable result, and may be neglected in this connection.

This natural ventilation will, of course, be chiefly attained by utilising the structural openings, intended for the purpose, such as skylights, scuttles, ports, cowl ventilators, mushroom ventilators, hollow iron-masts, etc.; or those openings intended for the reception of cargo, such as hatchways, cargo ports, etc. To a lesser extent the natural effect of these structural openings can be augmented by simple mechanical devices, such as wind-sails, air-scoops, etc.

In such a system the skylights, hatchways, mushroom venti-

lators, and hollow masts, will act as uptakes for the outlet of heated air; while the ports, cowl ventilators, or cargo ports would act as inlets. If wind-sails are rigged, a hatch can also be converted into an inlet.

Cope has shown the ventilating power of a 15½-inch circular port to be about 13,000 cubic feet per hour (allowing for loss by friction), thus giving enough ventilation for four men. This is supposing the port to be at the usual height of 5 feet above the deck, with a neighbouring hatchway (3 feet above the deck) as uptake, and a difference of temperature between internal and external air of 20° F.

With a wind blowing the air delivery would be increased; and still more so if an air-scoop were fitted to the porthole. But with a large crew such as that on a man-of-war, living in a comparatively confined space, it is impossible to secure proper ventilation by these natural methods, even under the best conditions; whilst under stress of weather the system will perforce cease altogether.

In most ships of the Mercantile Marine, methods of natural ventilation are amply sufficient for the needs of the cabin passengers and crew; although in the latter case they are often stultified by too close an approximation of inlet and uptake.

It is obvious, therefore, that for naval purposes, or for steerage 'tween decks, etc., some kind of artificial ventilation is of paramount necessity.

Most of the openings by which natural ventilation is secured are so well known that illustration or comment is needless.

Round portholes vary in size considerably. All sizes may be found in the Mercantile Marine; the largest I have met with being 16 inches (with 1⅛-inch plate glass), and the smallest 6 inches in diameter. The usual size is 13 inch diameter with 1-inch plate glass; a well-known maker being J. Roby, of Rainhill, Liverpool.

With regard to cowl ventilators (invented by *Boyle*), there is practically only one pattern in general use. The pity is that they only act as an inlet or outlet. The accompanying illustration (Fig. 8) will show how I have devised a double function, with practically no structural alteration.

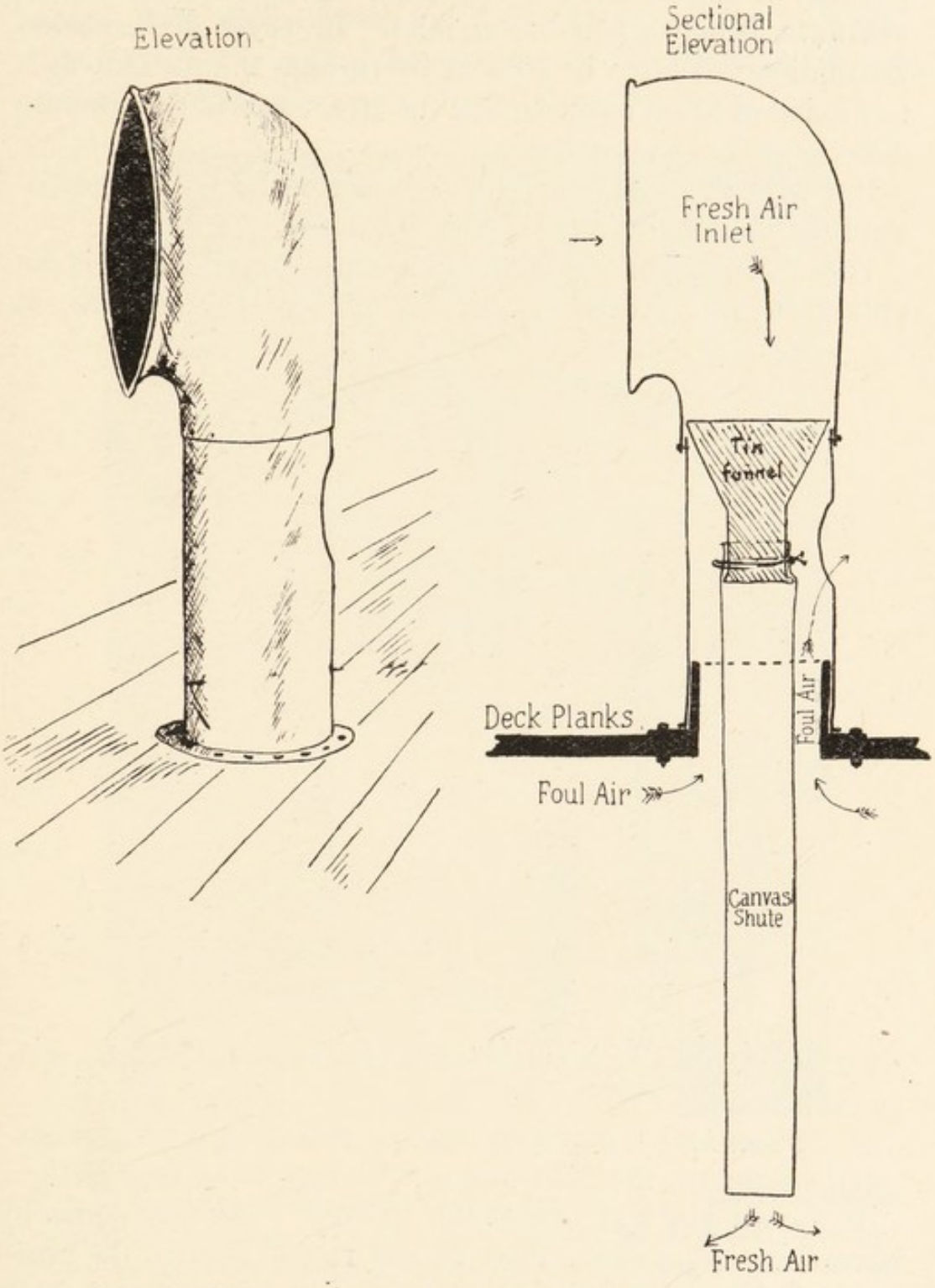


FIG. 8.—DOUBLE-ACTION ADAPTATION (BROOKE'S) OF AN ORDINARY SINGLE-ACTION COWL VENTILATOR.

In engine-rooms, where the furnaces form a hungry draught, there is, of course, no difficulty about an uptake, and a cowl ventilator is only wanted as an inlet. In 'tween decks a good ventilation can often be secured by turning the for'ard cowls to windward to act as inlets, and the after cowls in the opposite direction to act as uptakes.

But with the double-function adaptation I have suggested, a still better supply of fresh air is obtained.

The "*Mushroom*" *Ventilator*, on the other hand, is an uptake, with a protected cover to prevent the entrance of

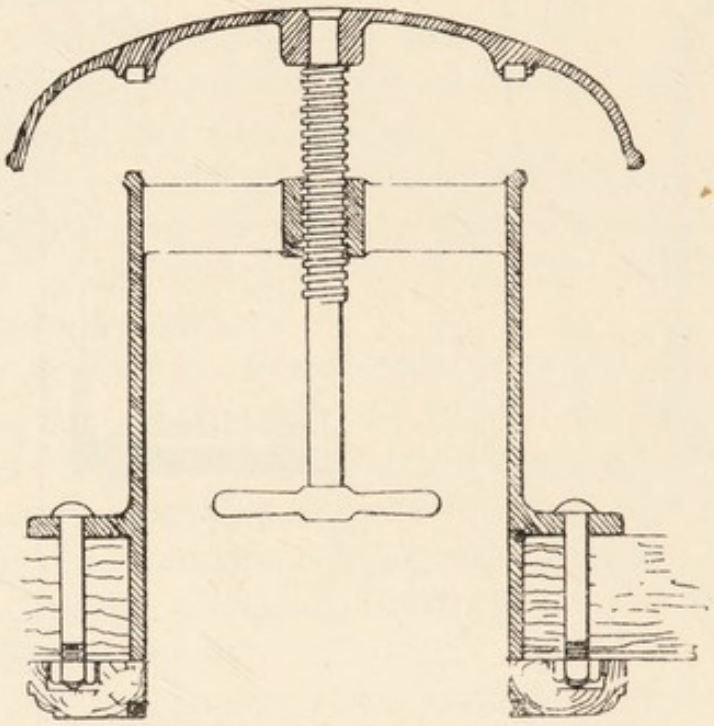


FIG. 9.—MUSHROOM VENTILATOR.

water (Fig. 9). It is suitable for small compartments, such as cabins, etc.

A "*Swan-neck*" pipe is sometimes substituted for a mushroom ventilator, the difference in efficiency being negligible.

In recent years an *Automatic Exhaust Ventilator* seems to have become popular. Figs. 10 and 11 will explain the principle. I have tested these many times, and have found that, under ordinary circumstances, there is generally a slight in-draught instead of exit!

In addition to the legal requirements of the Merchant

Shipping Acts with regard to the cubic space necessary for the crew quoted at the beginning of the chapter, the *Board of Trade* have laid down in their Survey "Instructions" (1913) the details which they require for the *ventilation of crew spaces*, chiefly dealing with "natural ventilation."

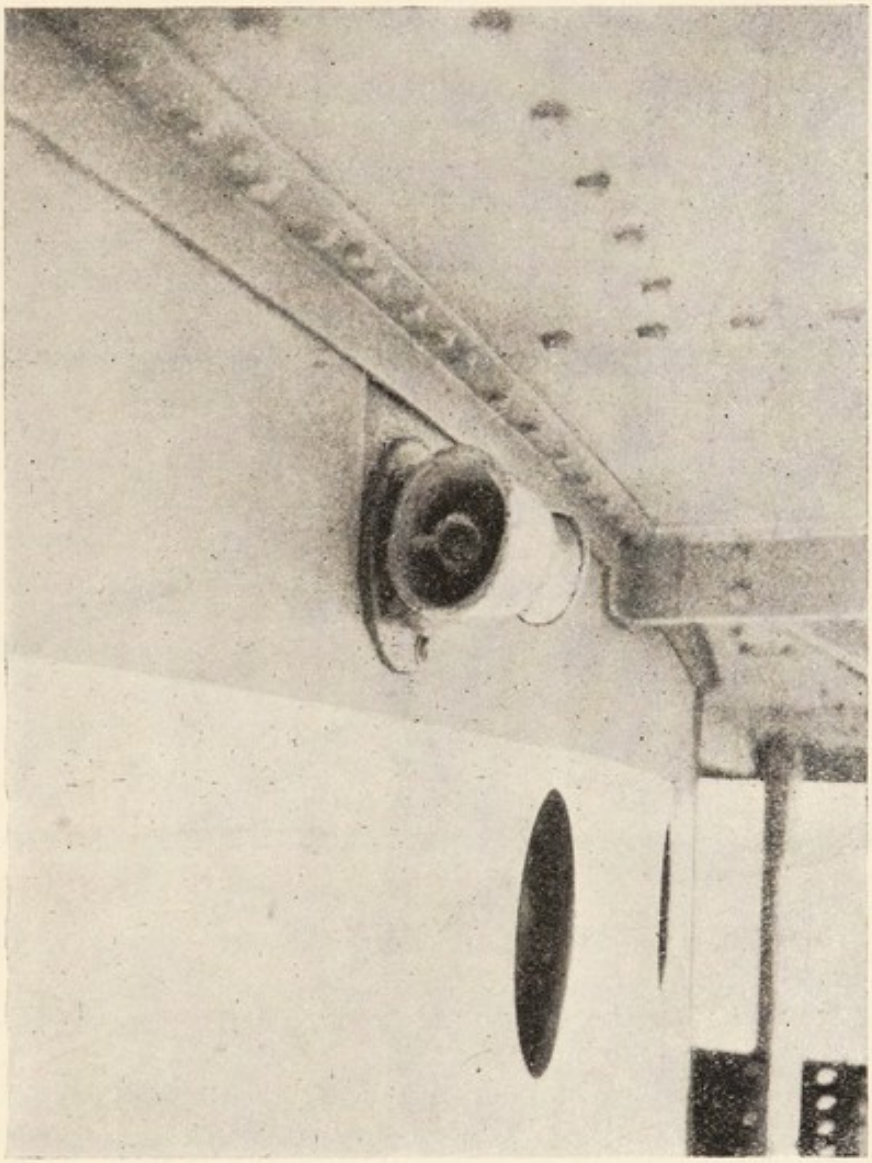


FIG. 10.—AUTOMATIC EXHAUST VENTILATOR.

Reg. 17. *Ventilation.*—The proper ventilation of every space appropriated to the officers or crew is one of the most important points the Surveyor has to consider and decide upon in connection with crew space inspection. No hard-and-fast rule can be laid down as to the system of ventilation to be adopted; but, whether the accommodation consists of a forecastle, poop, round house, side house, or cabins, there should not be less than two ventilators, one serving as an inlet for the admission of fresh air, and the other as an outlet for the escape of impure air.

Whenever practicable, ventilators must be fitted clear of the bunks in such positions as to cause no discomfort to the occupants. Should this, however, be found impracticable in any case, a substantial and permanent trunk must be fitted to convey the air clear of the bunk.

The *minimum diameter of overhead ventilators to sleeping or messing accommodation is fixed at 5 inches.*

In ventilating forecastles, poops, and 'tween deck spaces, the simplest method is to have an iron pipe with a movable cowl, fitted at each end of the space, so that while impure air escapes at one, pure and fresh air will enter at the other, and a constant circulation be kept up. When this method is adopted one of the ventilators should pass through the deck to at least the lower edge of the beams. The cowls may be fitted to unship, and caps may be fitted over the pipes when the anchor deck

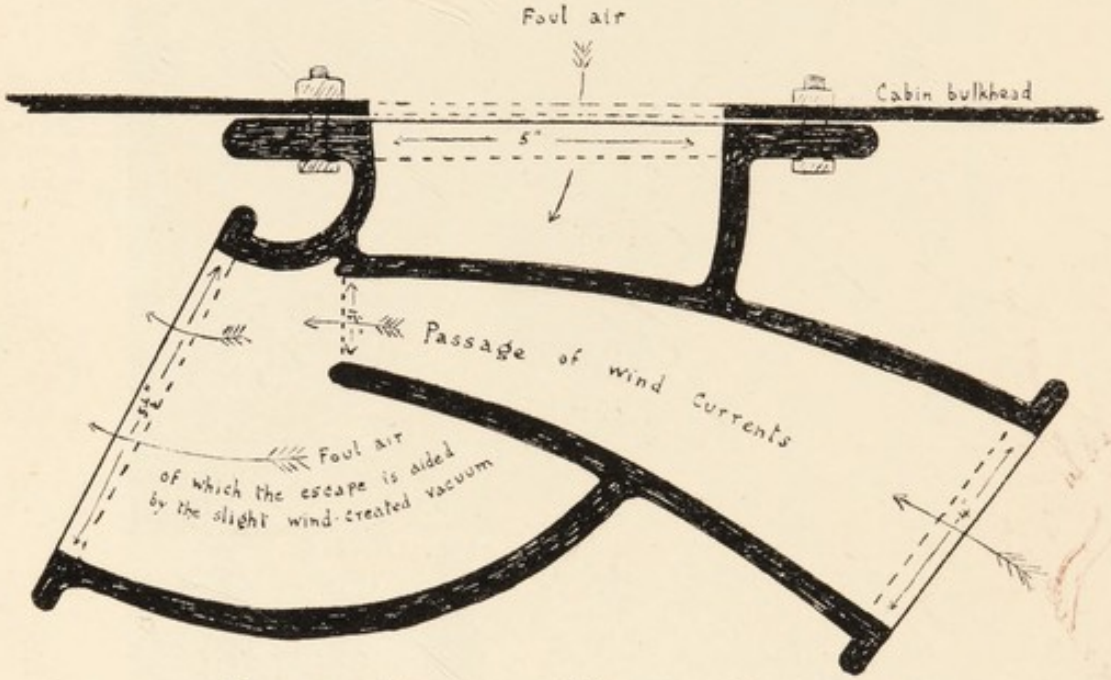


FIG. 11.—AUTOMATIC EXHAUST VENTILATOR.

is being worked. In the case of lower forecastles the cowls should be at least as high as the bulwarks.

Mushroom ventilators may be fitted for ventilating deck houses, but they may not be fitted to forecastles unless they are at least 30 inches high in the case of top-gallant forecastles; if they are fitted to lower forecastles they should be at least as high as the bulwarks.

Whenever practicable all cabins should have an efficient ventilator of cowl, mushroom, or swan-neck pattern fitted in the deck above them.

Mushrooms should be discouraged in every case except for deck-houses.

Scuttles, companions, doors, and skylights only, are not to be considered as efficient means of ventilating crew spaces.

Where a forecastle or deck-house is divided by a fore and aft bulk-

head or close partition, care must be taken that the ventilation of each space is complete in itself.

Skylights made to open, although useful on occasion as a supplementary means of ventilating the spaces over which they are fitted, cannot be relied upon as efficient ventilators available under all conditions of weather; and they should not be accepted in place of the ventilators ordinarily required.

In all vessels likely to be employed in *tropical climates* there should be some *suitable aperture* in the deck over each space appropriated to seamen and firemen, *to admit of a wind-sail not less than* 18 *inches in diameter* being introduced.

This may be effected by means of a skylight properly protected, or by a hatch, or by an opening in the deck, means being provided for effectually closing it at sea; any other equally efficient arrangement for introducing a wind-sail may be adopted.

Surveyors should point out to owners and builders that if the vessel is employed in the tropics the above arrangement for the introduction of wind-sails may be insisted on abroad if not found to be already provided.

Privies should be ventilated in a suitable manner direct to the open air, but it will not always be necessary to fit cowls or mushrooms for this purpose.

In all cases separate flanges or coamings must be fitted in the deck over forecastles or other crew-spaces for the funnels of bogies or fire-stoves placed therein. Cowl or other ventilators must not be utilised for this purpose, but are to be kept exclusively for ventilating the spaces.

Whenever it is proposed to ventilate crew spaces by the thermo-tank or any other system of mechanical ventilation, full plans to scale showing the spaces and all the arrangements for ventilating them should be forwarded by the Surveyor for the Board's consideration.

Further *Board of Trade* requirements for the ventilation of "*Emigrant Ships*" do not prescribe any special type of ventilation; but as they also chiefly refer to "natural ventilation," I quote the three pertinent rules (1911) here:

35. *Ventilation; General Rules.*—The statutory rule is that every emigrant ship shall be supplied with such provision for affording air to the passenger decks as the circumstances of the case and the conditions of the service intended may, in the judgment of the Emigration Officer at the port of clearance, require. No particular kind of ventilating apparatus is prescribed, but the detailed rules contained in the following clause apply to a system of ventilation by means of cowls which heretofore has been most generally adopted.

The cowls should be placed in such positions that the ventilating shafts can be kept open in any ordinary weather, and they should be arranged as far as possible to give a down-draught at one end of each compartment and an up-draught at the other.

Each passenger deck must be ventilated independently of any passenger deck above it, and the hold must be ventilated in such a manner as not to open into, or affect in any way, the passenger compartments.

If the owner or builder of an emigrant steamer proposes to adopt any new system of ventilation, full details of the arrangements, with drawings, should be submitted to the Board of Trade.

36. *Ventilation by Cowls.*—The ventilation of steerage compartments, hospitals, etc., should be in accordance with the following rules: In these rules the word " Compartment " means any space occupied by a steerage passenger.

(i.) Each compartment must be provided with ordinary cowl ventilators, or their equivalent, having an aggregate area of not less than 5 square inches for each adult accommodated in the compartment, that is, $2\frac{1}{2}$ square inches as inlet and an equal amount as outlet, measured at the narrowest part of the air passages. These ventilators must be exclusive of ordinary side scuttles, doors, hatchways, skylights, and other apertures not built solely for ventilation.

(ii.) If the compartment is in the wing between the ship's side and the boilers or engine-room, the area of the ventilators must be increased 33 per cent.

(iii.) All cowl ventilators must be carried to a convenient height above the deck and be clear of obstruction. In these ventilators the *area of the cowl should be at least* 50 *per cent. greater than that of the pipe.*

(iv.) When the pipes of cowl ventilators have curved bends or knees, and the angles do not exceed 30°, no additional area need be provided; but for curved bends or knees where the angle exceeds 30° the following additions to the area must be made:

(*a*) Curved Bends.
Angles from 30°-60° add 5 per cent. for each bend.
Angles from 60°-90° add 10 per cent. for each bend.

(*b*) Knees.
Angles from 30°-60° add 16 per cent. for each knee.
Angles from 60°-90° add 36 per cent. for each knee.

If the radius of the inner side of a bend is less than the diameter of the pipe, the bend should be regarded as a knee.

(v.) Each cowl ventilator should project 3 inches below the roof of the compartment to be ventilated, and be *provided with a canvas pipe*, or its equivalent, *extending* from its lower end *to about* 12 *inches from the floor of the compartment*; or, if the projection of the ventilator be objected to, battens, or other means of attachment for the canvas pipe should be fitted.

When the ventilators are acting as upcasts the canvas pipe should be removed.

(vi.) Compartments accommodating 75 adults or under should have not less than two cowl ventilators, and those berthing from 76 to 125 adults should have not less than three ventilators. When the number of adults exceeds 125 the number of ventilators must not be less than four.

(vii.) Ventilators *must not exceed* 314 square inches in area (20 *inches in diameter*), unless they communicate with two or more

compartments, in which case the area of the passage or pipe leading to any one of the compartments so ventilated must not exceed 314 square inches.

When an odd number of ventilators is adopted the required inlet and outlet area must be maintained.

The *minimum diameter of cowl ventilators is* 10 *inches.* This provision applies only to the ventilators of passenger compartments and not to those of hospitals and sanitary arrangements.

(viii.) The velocity of the air through cowl ventilators is assumed to be 800 feet per minute, and, where this velocity is maintained, the volume of air delivered per adult by a ventilator of the minimum area required is fully 830 cubic feet per hour.

(ix.) Trunkways built solely for ventilation, and carried to such a height above the weather deck that it will not be necessary to close them under any circumstances, may be accepted as either air inlets or outlets, but not as both, to compartments otherwise ventilated artificially or by cowls; but when a trunkway is thus used in combination with cowl ventilators, its area should be at least double that of a cowl ventilator doing similar duty.

(x.) All hospitals should be ventilated independently and to the open air; the ventilators should have at least 5 square inches of inlet and 5 square inches of outlet area per adult, with means for controlling the size of these openings.

(xi.) All sanitary arrangements should be suitable and efficiently ventilated to the open air.

(xii.) No ventilator may be carried through any transverse water-tight bulkhead without the consent of the Board of Trade.

(xiii.) Plans of special forms of cowl ventilators may be submitted to the Board of Trade for consideration. If the ventilator is found satisfactory it will have an area value assigned to it.

Ventilating side-scuttles, if made according to plans approved by the Board of Trade, may be accepted as equivalent to a cowl pipe having an area equal to the aggregate area of the orifices or valves, the area being measured at the most contracted part.

(xiv.) The Board of Trade will be prepared to consider the application of these rules in any particular case where exceptional difficulties may arise in giving effect to them.

37. *Ventilation by Mechanical Systems.*—When steerage compartments are ventilated by mechanical means the arrangements for the delivery and distribution of fresh air, and the exhaust of vitiated air, must be not less efficient than described above for the cowl system.

At least 830 cubic feet of air per hour for each adult must be delivered under normal conditions which would prevail at sea, with an increase of 33 per cent. in the case of compartments, between the machinery casings and the ship's side. The delivery of air in the hospitals should be at least 1,660 cubic feet of air per hour for each adult. Care should be taken that the vitiated air from the hospitals and the sanitary compartments does not exhaust into other compartments but into the open air.

If the Emigration Officer is doubtful whether the delivery of air into any compartment is equal to the above requirements, he should cause the actual delivery to be ascertained by anemometer, care being taken to close all openings that could not be left open at sea.

Before leaving the subject of natural ventilation, it may be as well to point out that mosquito-screening—often necessary in yellow-fever areas—will considerably alter the air conditions of a cabin. A ship on a tropical run which will require much mosquito-screening should, therefore, have her cabins fitted with some kind of artificial ventilation.

The subject of mosquito-screening is a most interesting one, and has been carefully worked out by *Melville-Davison*. After many experiments with different kinds of metal gauze, he found that the one which stood sea-air best (next to nickel, the cost of which is prohibitive) is that made of *oxidised phosphor-bronze*, which is both cheap, lasting, and strong. The mesh should be 16 × 16 per inch, made of 26 S.W.G. wire, crinkled in the warp and in the weft.

Fixing to ports, air-shafts, ventilators, etc., offers little difficulty. The chief problem arises in door screening. Melville-Davison's system is to remove the panels of existing doors, fit in gauze wire, and then replace panels, which can be secured by buttons as shown in the accompanying sketch (Fig. 12).

This is both cheaper and better than having double doors, or a special door, as is often fitted.

We now come to the next division of our subject:

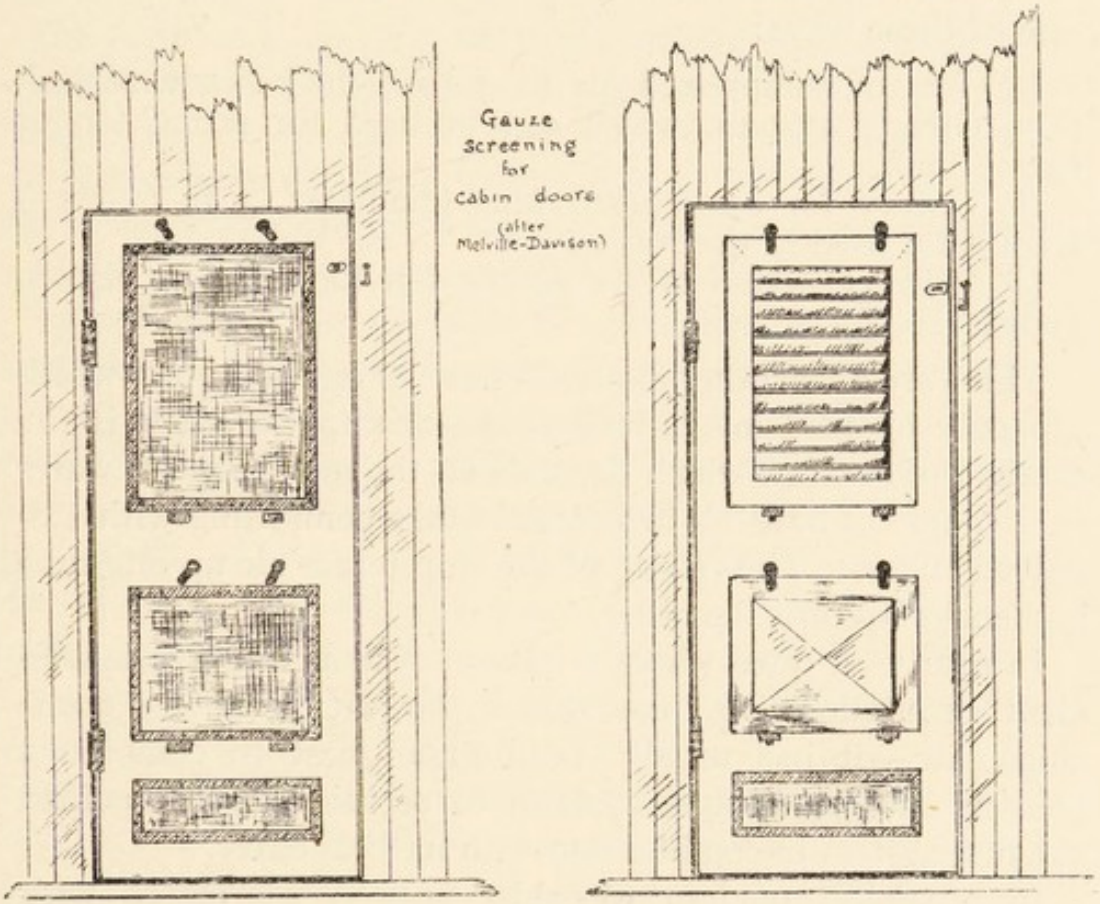
Artificial Ventilation.—By the term "artificial ventilation" we mean the replenishment of the air in any space by means of forcible movement, extraction, or propulsion.

Forcible movement, *per se*, is not necessarily a very patent factor in ventilation. We have, for instance, the action of punkahs or of electric fans in cabins, saloons, etc. The chief result of these is to cause increased evaporation from the skin, with a feeling of coolness. By mixing the air they also prevent to some extent unhealthy concentration of deleterious products; and they are also possibly of some slight assistance in aiding the effect of any natural ventilation which may exist. Otherwise, they are useless.

We see, therefore, that (to secure artificial ventilation) the forcible movement should not be of a passive nature, but rather of an active kind, in the direction of extraction or propulsion.

These two methods we know as (*a*) the *Exhaust method* (vacuum), and (*b*) the *Plenum method* (pressure).

But little thought will, I think, be necessary to convince anyone that an exhaust system, used by itself, or used in conjunction with any natural system the volume of whose air entry it is able to overtake, must necessarily do more harm than good. This, because sufficient vacuum will be estab-



GAUZE PANELS IN POSITION. ORDINARY PANELS SUPERIMPOSED.
FIG. 12.

lished to withdraw undesirable air from many parts of the ship, such as bilges, peaks, holds, etc. It will also, of course add greatly to the wild heat, so that the air will be hotter as well as of doubtful quality.

If, therefore, an exhaust method is used, it must be either of less capacity than that of the natural ventilation present, or else it must be used in conjunction with some form of plenum artificial system.

Exhaust System.—The exhaust is usually obtained in one of three different ways:

(*a*) Use of furnace draught by connecting with fires or funnel casing.
(*b*) Produced by steam jets (*e.g.*, Edmond's system).
(*c*) Exhaust action of an electric fan (ordinary or sirocco type).

Plenum System.—The forced air delivery is usually secured in one of three ways:

(*a*) Jets of compressed air at 3 to 4 lb. per square inch (*e.g.*, Green's system, which can be used for propulsion or extraction).
(*b*) Rotary (or centrifugal) fans (diameter, 3 to 6 feet—frequently used in the Navy).
(*c*) Delivery action of an electric fan (ordinary or sirocco type).

There are a few other methods, more or less eccentric, which are only of academic interest. An example of such is the method of *Perkins*, which depends on the movement of water in a couple of half-full cylindrical tanks connecting with two valved tubes. The rolling of the ship forces air up one tube and sucks it down the other.

In nearly all cases where a natural system will give insufficient ventilation—*e.g.*, men-of-war, large emigrant or coolie ships, etc.—it has usually been found best to combine a plenum and an exhaust system; or occasionally a modified exhaust system in combination with natural entry.

In a typical modern war-ship, entirely ventilated with *Davidson's* sirocco or similar fans, about 12 per cent. of the total fans would work as exhaust agents. These exhaust fans are used for engine-room compartments in order to prevent the dissipation of wild heat throughout the ship. They are usually of 40 inches diameter with a capacity of 40,500 cubic feet per minute each.

The remaining 88 per cent. of the fans would act as intakes, those for the engine-room being of 35-inch and 25-inch diameters with a capacity of 31,000 cubic feet and 15,500 cubic feet per minute each, respectively. The rest of these intake fans would be of 12½ inches diameter, with a capacity

of 4,000 cubic feet of air per minute each. Each "supply-fan" pumps the air into a main discharge pipe with branches (louvred at intervals) which terminate in the different spaces —the outlet being provided by hatches, etc., as in natural ventilation.

It is best to employ round rather than square pipes, since they give the least frictional resistance for the largest delivery area.

The pressure is about 5 lb. to the square foot, and the air velocity at the outlet is about 2,000 feet a minute. This velocity will be steadily curtailed by the branches, and it will therefore be necessary to fit reducing sections in order to obtain the original outlet velocity. Such contractions should be not more than 1½ inches to the foot run.

Experiments by *Taylor*, of the Construction Department U.S. Navy, showed that the friction varies as the square of the velocity of air through the pipe, and the coefficient of friction may be as low as 0·00008, but is increased by comparatively small internal roughness or faulty alignment to 0·0001 or more. Generally speaking the delivery volume varies with the speed, the pressure with the square of the number of revolutions, and the driving power as the cube of the speed. That is to say, doubling the speed doubles delivery, increases pressure four times, and requires eight times the power.

There are certain compartments which are specially ventilated. The *sick-bay* should have a considerably greater supply of air than the other compartments, and the openings for natural ventilation should also be on the generous side.

Coal-bunkers are not connected up with a ventilating system; they are ventilated only by natural inlets and outlets.

Water-closets should be specially ventilated, each with its own exhaust.

Other artificial systems will comprise: the "centrifugal fan"—generally 3 to 6 feet in diameter—which is fitted on some men-of-war. Or, *Dr. Edmond's System*, which also has a naval application, and is recommended for Admiralty transports. The principle of this latter system is that of

an artificial exhaust; but if a good breeze is blowing it can also be used as a natural inlet.

The accompanying illustration (Fig. 13) will give a good idea of the principle. A 16-inch main ventilator will exhaust over 60,000 cubic feet per hour. Several of such cowled ventilators may be fixed, each communicating with an air-shaft

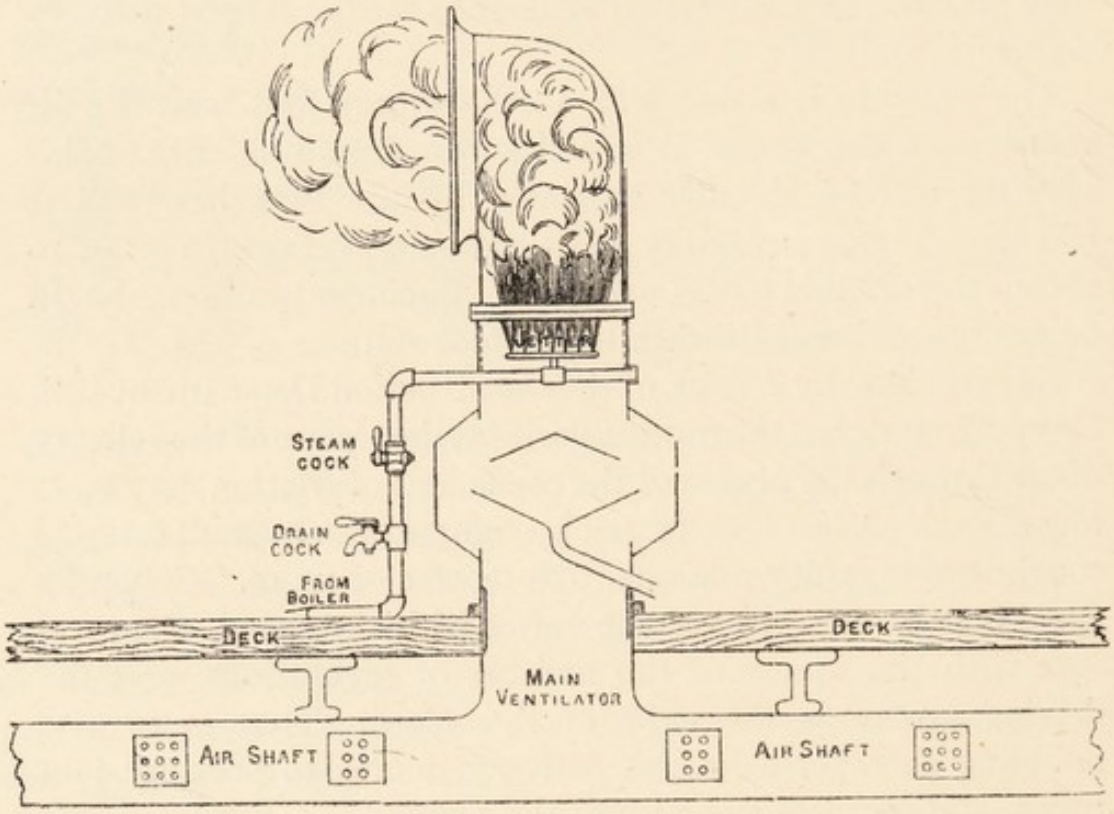


FIG. 13.—DR. EDMOND'S VENTILATOR.

fixed laterally or amidships. The shafts have perforations every 5 or 6 feet.

Steam is kept at 40 lb.

To exhaust Foul Air.—Turn the cowl *from* the wind, open the drain cock (*see plan*), and keep it open till nothing but steam comes from it; then close it, and open the steam cock (*see plan*); this forces the steam through the steam jetter (*see plan*), and creates a vacuum in the air-shaft which causes the foul air to be sucked in through the perforations in the 'tween decks, and carried up the main ventilators, fresh air being supplied down the hatchways, etc.

To diffuse Cool Air.—Steam is shut off, and the cowl is turned to the wind.

CHAPTER IV

THE WATER-SUPPLY OF SHIPS

" Unless the vessel whence we drink is pure,
Whate'er is poured therein turns foul, be sure."

HORACE: *Epis.* I.

ALTHOUGH a supply of good water is just as important for a ship as is a supply of good air, yet there is no comparison between the relative difficulties in the two problems.

It is often a most difficult matter to ventilate a ship; but since the introduction of steam it is comparatively easy to obtain and distribute a fairly pure and potable water.

In the old days the conditions were very different. Some idea of those which obtained as lately as 1756 may be gleaned from contemporary correspondence.

A naval officer—Edward Thompson—writing in that year from Antigua to a friend who was about to enter the Navy, says:

" Fluxes and fevers are the reigning distemper, and both I attribute to the water drunk by the seamen, which is taken out of tanks or cisterns, built by Admiral Knowles. It is all rain water, and covered close up, which for want of air breeds poisonous animalculæ, and becomes foul and putrid. The melancholy effects it produces might be in a great manner prevented by boiling the water before it is issued, or ordering the people to do it. This would destroy the vermin and correct the putrefaction. I am convinced by long observation that most of the distempers in southern climates arise from the water drunk, as ship sicknesses do from the bilge-water; which is evidently proved in leaky ships being always healthful."

Troubles connected with the water-supply only began to

show signs of amelioration in 1772, when the Admiralty directed all men-of-war to be fitted with a still—the invention of a Dr. Lynn—although only small quantities could be thus prepared.

After 1815, 2-ton iron tanks were substituted for some of the casks in which the drinking water had always been carried previously. The introduction of soap rations also became a naval feature at about the same time.

At the present day it must be admitted that the water-supply of ships is, on the whole, remarkably satisfactory; and little more than a brief outline of modern conditions need be given in this chapter.

Amount of Water Required.

It will be recalled that the needs for people ashore, per head per day, are usually calculated in gallons, as follows:

Drinking and cooking	1
Washing—house and person	9
Laundry, w.c., and waste	10
Trade purposes	5
Streets, sewers, fires, etc.	5
	30

And the amount of storage required is usually calculated by *Hawksley's* formula:

$$D = \frac{1000}{\sqrt{F}} F$$

where D is the number of days' storage required to be found; and F is the mean annual rainfall, in inches, of three consecutive dry years.

At sea the conditions are somewhat different. The storage is limited only by tank-capacity, and is independent of rainfall. Moreover, unlimited sea water can be substituted for fresh water for many of the cleansing and scouring purposes which would require fresh water if carried out ashore.

Sea Water.—In the Atlantic, Pacific, and Indian Oceans, the specific gravity is about 1·027, and the water has the following average composition:

Sodium chloride	28·032	
Magnesium chloride	3·341	
Magnesium sulphate	2·191	
Calcium sulphate	1·412	
Potassium chloride	0·791	
Magnesium bromide	0·075	
Calcium carbonate	0·050	
Ferrous carbonate	0·005	
Magnesium nitrate	0·002	
Ammonium chloride ..		
Magnesium carbonate ..	0·001	
Lithium chloride		
Silica		35·900
Water		964·100
	Total	1,000·000

This *saline content* of 3·59 per cent. varies in different regions. In the Black Sea it is only 1·76 per cent. In the Mediterranean it is as high as 3·92; and in the Red Sea, 4·1 per cent.

The *temperature* of the water is of considerable importance as affecting the internal condition of iron ships. Round Great Britain's shores the sea temperature varies, as a rule, from 45° F. to 65° F., according to the season. The Mediterranean is from 60° to 70° F.; near Hong-Kong it ranges from 60° to 75°; at the Cape from 68° to 78°; the Bay of Bengal from 78° to 86°; the Red Sea from 78° to 90° or more; while at a place like Singapore, which is close to the Equator and protected by the Archipelago, the range is only about five degrees (82° F. to 87° F.) all the year round.

The *germicidal value* is nil; but it is occasionally stated to have an *antiseptic value* owing to its content of sodium chloride. This is probably incorrect, for decomposition of foodstuffs (such as rice, etc.) in sea water is very rapid, and the stench when the material is salved is often unbearable.

It might here be mentioned that I was able, in 1918, to breed out the swamp mosquito—*Culex sitiens*—quite readily in pure sea water. *Anopheles ludlowii* breeds in very brackish water, and could probably adapt itself to sea water.

Attempts have frequently been made to obtain free chlorine from sea water, ever since *Charles Watt* (in 1859) discovered that a bleaching liquid was formed by electrolysing a solution of an alkaline chloride.

The idea was first applied to sanitation by *M. Hermite*, of Nice, and is generally called the "*Hermite*" *process*. Sea water is electrolysed in a special apparatus (Patent No. 22,279, 1893) by a current of 300 ampères, at a pressure of 6 volts. By this means two grammes of free chlorine are obtained per litre, and the liquid is diluted six or eight times for use. It is conveyed by pipes for sewer-flushing, etc. The chemical reaction shows that the resulting fluid is a dilute solution of hypochlorous acid.

$Mg(OCl)_2 + 2H_2O = Mg(OH)_2 + 2HOCl$. Magnesia and chlorine are

first liberated from the magnesium chloride of the sea water, and they subsequently combine to form magnesium hypochlorite ($Mg(OCl)_2$) and magnesium chloride. The former dissociates into magnesia, which deposits in the electrolyser, and hypochlorous acid, which remains in solution.

As a practical disinfectant it is expensive to manufacture, corrosive to pipes, and rapidly loses its available chlorine. It is superior to mercuric chloride, but it shows no advantage over the product obtained by treating chloride of lime, in solution, with carbonic acid.

The disadvantages of using sea water on ship-board are several. Owing to the presence of the hygroscopic chlorides the water does not evaporate like fresh water, and wooden decks will thus retain moisture for some time.

On iron decks, evaporation leaves a deposit composed of mineral salts—some of them deliquescent—which favours the rusting of iron. Then, of course, it will not permit a lather with ordinary soap, and thus has a limited application in personal ablution or the washing of clothing. It is, however, of enormous and economical value in the sanitation of ships, and is always ready on occasion as a source of fresh water for boilers and drinking purposes, by distillation.

The amount of fresh water which will be needed to supplement the sea water for ship purposes will vary very much according to the size and type of ship, the nature of the voyage, the type of passengers, etc.

The Naval Regulations lay down no definite amount of water for *men-of-war*, the average consumption in the various navies varying from 4 to 8 gallons per head per day, including all fresh-water purposes.

For *transports* the Admiralty specify the following:

(Appendix XV. Transport Regulations.)

'When there is a distilling apparatus on board, water is to be issued on the most liberal scale possible. The minimum daily allowance of water is to be, for each individual embarked, including the crew of the ship, 6 pints when out of the tropics, and 1 gallon when within the tropics; which quantities are to suffice for all purposes."

It is hard to see what "all purposes" means here. Presumably—all requirements for cooking and drinking. It cannot, of course, include either ablution or general purpose

supply, both of which should be reckoned in calculation of a water-supply.

For *emigrant ships* the Board of Trade require ample water for all on board, sufficient to secure "the issues required by the dietary scale throughout the length of the voyage as determined by the voyage scale." The quantity is then specified:

> 48. *Water; quantity.*—The quantity of water placed on board must be sufficient to secure the issue of 4 quarts per day to each statute adult of the steerage passengers, to provide an ample amount for the cabin passengers and crew, and to allow for cooking purposes 10 gallons a day for every 100 statute adults on board. The total amount necessary to meet all these requirements is the normal quantity to be placed on board an emigrant ship before the commencement of the voyage, and that quantity may only be reduced if an engagement is made to take in water at an intermediate port, or if an approved distilling apparatus is carried. . . .
>
> When a distilling apparatus is carried only half the normal quantity need be placed on board at the commencement of the voyage if the following conditions are complied with, viz.:
>
> (i.) that the apparatus is efficient and of a pattern approved by the Board of Trade:
> (ii.) that before the commencement of every voyage the apparatus is examined by an Engineer Surveyor, and the Surveyor certifies that it is of an approved pattern and in good working condition, and states in his certificate the number of gallons of pure fresh water which it is capable of producing in every 24 hours.
> (iii.) that the Emigration Official at the port of clearance is satisfied that the apparatus is capable of producing one gallon of pure fresh water in every 24 hours for every person carried in the ship;
> (iv.) that there is on board the ship and rated on the articles some person competent to manage and repair the apparatus. (Order in Council of 25 January, 1908.)

In considering these regulations, it becomes obvious that a gallon a day is considered sufficient for storage and use on board ship. Now, while on emergency one gallon, or even half a gallon—perhaps even a quarter of a gallon—of fresh water per head can rightly be said to be *enough*, it, nevertheless, is not right that a bare minimum should alone be insisted on. Not only should double or treble the minimum be required, but all the other fresh-water needs of a ship—such as ablution purposes, laundry needs, and general service supply—should

be included in the *per capita* calculations; for, even if not essential to life, such additional supply is essential to the sanitary welfare of a ship.

Now, as I have already said, there are ships and ships. Each will have its special needs, according to its size, voyage, and occupants.

I propose, therefore, to divide all ships (for purposes of water-supply) into five classes:

Class A : Atlantic Liners of the largest classes.—Such ships carry a very large complement of passengers and crew. The large numbers of first and second class passengers are, generally speaking, used to an unlimited supply of fresh water. Much laundry work is undertaken. There is also likely to be much waste of water.

Class B : Men-of-War.—Such ships are the permanent home of large numbers of men, whose physical and sanitary well-being is a matter of the highest importance. All the personal laundry is done on board. Considerable fresh water is needed for general purposes on board.

Class C : Ordinary Ocean-going Ships.—Such ships comprise ordinary passenger steamers, as well as cargo-boats. The laundry will vary according to the ship, but is never very large. A fair amount will be used in personal ablution and general service.

Class D : Emigrant, Coolie, or Pilgrim Ships.—On such ships a certain reasonable amount must always be allowed for personal ablution, although sea water will be largely used where possible. The general service supply will also need to be attended to if sanitary conditions are to be maintained. The laundry can be neglected.

Class E : Local Trade, Coasting Trade, and Short-voyage Ships.—Laundry can be neglected. Ablution and general service needs are reduced to a minimum. Fresh supplies can be obtained at frequent and short intervals.

Now it is obvious that each of these five classes will need a different amount of water per head, and I would suggest the following scale as being approximately satisfactory:

Class.	*A.*	*B.*	*C.*	*D.*	*E.*
Cooking and drinking	*Gallons.* 1	*Gallons.* 1	*Gallons.* 1	*Gallons.* 1	*Gallons.* 1
Personal ablution ..	2·5	2	2	1·5	0·5
Laundry: personal and ship's	2	2	0·5	—	—
General service: Pantry, mess-rooms, cabins, saloons, etc.; cleaning and washing ..	3	2·5	2	1·5	0·5
Waste	1·5	0·5	0·5	—	—
Total (gallons) per head, per day ..	10	8	6	4	2

Even if these totals represent the needs of a ship, it will be necessary to carry some reserve; and, in order to calculate how much will be needed for each ship, I propose the following formula for adoption:

$$\text{No. of tons of fresh water needed (1 ton = 224 gals.)} = \frac{C \times V}{f\sqrt{V}}$$

Where:

C = maximum complement of passengers and crew.

V = maximum number of days between any two ports on a voyage.

f = a factor depending on the class of ship, according to following table:

Class of Ship.	*A.*	*B.*	*C.*	*D.*	*E.*
Factor	4	5	7	11	20

Only half the above amounts need be taken when an approved distilling plant is instilled.

Deficiencies on the estimated amount required should be made good at each satisfactory port of call.

Sources of Ship's Water-Supply.

The water-supply will be obtained, as a rule, only from three sources:

(i.) Town-mains in a port.
(ii.) Distillation of sea water on board.
(iii.) River water.

(i.) *Port Supply.*—The very large majority of ships obtain their water-supply at ports of call as needed. Most modern ports of any size have a satisfactory and filtered municipal water system, which is safe and good to drink. Others, again, have an unfiltered supply, often of a doubtful quality. It is seldom, however, that a voyage of any considerable duration will have to occur nowadays between two ports possessing a good water-supply.

The method of getting the water on board will depend on the berthing of the ship. If berthed at a wharf, arrangements are usually made for town water-mains to be laid on at each section, and these mains have only to be connected with the ship's filling-pipes by a short length of hose. If, on the other hand, the ship is lying in a roadstead, or mid-stream in a river, then the town water will have to be conveyed to the ship in some form of water-boat. It is here that the danger will come in, due to:

(*a*) Leakiness of boat, letting in dirty sea or river water;
(*b*) Dirtiness of boat;
(*c*) Contamination by the boatmen living on, or working, the boat;
(*d*) Use of water other than the town water supposed to be supplied.

Any of these sources will be a likely cause of water-infection, and Port Health Authorities should make a point of keeping these craft under constant supervision.

I remember a few years ago cases of cholera occurred amongst the crews of several ships after lying in the river at an Eastern port. For the protection of health, I consequently issued a warning notice to all ships leaving Singapore for the port in question, recommending them to take their water and fresh vegetables at Singapore rather than at the other port.

My action was received with a storm of indignation by the Water Company of the port, who pointed out that their supply was from artesian sources, with the highest certificates of purity. They apparently overlooked the fact that their guaranteed water had to be conveyed in questionable boats across a dirty river to the ships they supplied!

(ii.) *Distillation Supply.*—Distillation of sea water is the usual source of the water-supply in most navies. A certain number of tramp steamers also distil all the fresh water they need.

A good many of the larger liners and passenger or cargo steamers are fitted with a distilling apparatus, but this is only used intermittently, or else as subsidiary to a tank supply.

The great majority of steamers plying the ocean have no distilling plant at all, except for boiler-feed purposes.

It is sometimes thought that distilled water, although bacteriologically pure, is undesirable, and tastes frequently of oil. This would be most likely to be the case if recondensed boiler steam were used; but this is never done in any of the modern plants. Boiler steam merely passes through coils in the evaporators and then returns to the boiler-feed tanks. It is the coils, thus heated, that evaporate sea water surrounding them, the steam thus secondarily produced being condensed for use.

A frequent system is that in which the water, after distillation, is pumped into what are called "ripening tanks" for'ard to be cooled and aerated. The water is then sent to gravity tanks on the upper deck, whence it is distributed by 3-inch mains to all parts of the ship, with numerous reliefs, cut-out valves, and by-passes.

Very often there is a by-pass to the boiler-feed tank pipes. This is unsound in principle, for the fresh-water system should be entirely independent.

The Admiralty regulations for the *distilling apparatus* of *transports* are:

Appendix XIII. (3):

"One or more distils of approved description, capable of *making in* 24 *hours* 1½ *gallons of pure* **cold** *water for each person carried, ship's crew included,* and 10 gallons daily for each horse or mule.

"The apparatus will be carefully surveyed and tested, and a certificate must be produced from the maker or a properly qualified engineer that it is in thoroughly good condition."

Any ship having a plant which complies with this Admiralty requirement might reasonably be expected to take only half the tank supply required by the formula —

$$W = \frac{V}{f\sqrt{V}}$$

Distillation renders a ship independent of ports, and certainly excludes water-borne diseases; but it is somewhat expensive, and, under the good modern conditions which obtain in most ports, it is in most cases scarcely necessary or justifiable.

(iii.) *River Supply.*—It is strange when we consider the number of ocean ports situated up-river. To mention only a few: London, Calcutta, Rangoon, Bangkok, Saigon, Canton, Nankin, Hankow, Manaos, New Orleans, etc. In many of such-like places it is possible to get a town supply; but the temptation in any case for water-boats to use the river water for supplying the smaller craft is obvious, while, on the larger rivers (in themselves, of course, less dangerous) steamers have frequently to make use of the surrounding water. In all the latter cases the water should be steam-boiled and then passed through a pre-filter before being admitted to the ship's tanks.

Section 1293 of the K.R. and Admiralty Instructions deals with such water-supplies when found necessary to use them in the Navy. It lays down that the Medical Officer should analyse (Form M191) all water-supplies from shore or rivers (intended for drinking or cooking purposes) as far as is possible with the chemical tests supplied; and he is to inform the Captain if there is any doubt as to the purity of the sample.

It is a great pity that the Board of Trade do not furnish the Ships' Surgeons of the Mercantile Marine with a similar analytical outfit, and make them responsible for all water-supplies taken on board.

Storage of Ship's Water-Supply.

In olden days, ship's water was always stored in casks (wooden). At the present day casks are still used in many sailing ships, junks, dhows, and other native craft, but never in steamers. For purposes of ordinary marine work we may, therefore, practically neglect them, though specific details are still retained in the Merchant Shipping Act, 1894, Sect. 296 (1), which may be quoted if only as an example of what is required of a water-cask.

"The water to be placed on board emigrant ships, as hereinbefore provided, should 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 not be made of fir, pine, or soft-wood, and each cask shall be capable of containing *more than* 300 *gallons*."

On the modern ship, fresh water is stored in three ways:

(i.) In permanent compartments of the ship;
(ii.) In iron tanks;
(iii.) In ultimate delivery receptacles.

(i.) *Compartment Storage.*—The structure of ships varies greatly, but there may be as many as nine permanent structural compartments capable of use or actually used for the storage of fresh water. Some of these compartments are usually kept solely as ballast or boiler-feed tanks. Occasionally the latter may be used intermittently for drinking water.

Reference to the sectional sketch of a ship (*vide* Fig. 3) will show the location of these compartments, which are as follows:

(*a*) Fore peak.
(*b*) Fore ballast tank (in double bottom).
( ) No. 2 ballast tank (in double bottom).
(*d*) For'ard deep tank.
(*e*) No. 3, or engine-room, ballast tank (in double bottom).
(*f*) After deep tank.
(*g*) No. 4 ballast tank (in double bottom).
(*h*) After ballast tank (in double bottom).
(*i*) After peak.

These need but little comment.

A large number of steamers use their fore peak or after peak as fresh-water tanks.

Many steamers have no "deep tanks" at all; fewer have one; and only a small proportion have two.

The ballast tanks of the double bottom will also vary in number. There may be one, two, three, four, or five. If only one, it is usually under the engine-room. If two, one will be for'ard and one aft.

The commonest arrangement in the steamer of two to four thousand tons (net) is to have several ballast tanks for boiler feed, and to keep her fresh water in the fore or after peak and in three or four independent tanks in the 'tween decks or lower hold.

The Board of Trade have laid down that, if drinking-water is carried in the double bottom (ballast tanks), the following conditions must be complied with:

(*a*) The Emigration Officer must be fully satisfied as to the structural condition of the tanks and as to their cleanliness. The water must also be tested after it is shipped to see that it is good and wholesome.

(*b*) The water should be distributed throughout four separate divisions of the double bottom, and the distilling apparatus on board must be capable of producing daily the total quantity of water required for all persons on board.

(*c*) The inlet and outlet connections of each tank must be so arranged that while at sea they are entirely under the control of the Master and Chief Engineer jointly, by means of an efficient locking system, and that no tank can be dealt with in any way without the full knowledge of the Master.

(ii.) *Tank Storage.*—Water-tanks are usually made of galvanised wrought iron, subdivided internally by "swash-plates" to steady the water.

The process of galvanising consists in coating the iron with zinc. Commercially the zinc is obtained from calamine ($ZnCO_3$), red-ore (ZnO), or more often from blende (ZnS).

This "blende" is generally associated with lead sulphide (PbS), and, in distilling the zinc, about 1·5 per cent. of the lead comes over with it; it is possible therefore that a dangerous amount of lead ($\frac{1}{25}$ gr. per gallon) might be thus communicated to the water, though quite unlikely.

The zinc itself is also insoluble except in dilute acid, when its salts are very soluble and poisonous ($\frac{1}{5}$ gr. per gallon, dangerous).

The tanks should be tested to a pressure of 15 lb. per square inch before use.

It is usual to paint the outside of the tanks, with ordinary paint, and to coat the inside either with paraffin-paint or with cement wash. The latter is the best method: The surface is first cleaned and then coated with three layers of a thick wash made with cement and powdered fire-clay. The bottom of the tank is not cement-washed, but should be filled in with concrete (cement, 1; fine sand, 2) sufficiently deep to cover the rivet-heads and tap-flanges.

Manholes are on the top, to facilitate access and inspection. It has been suggested that less chance of contamination would occur if the manholes were situated high up on one side. It is doubtful, however, if there would be any special advantage in such a situation.

The size of tanks will vary from 1 ton upwards, generally holding 600 gallons or more.

It is important that they be cleaned at least every six months.

(iii). *Delivery Storage.*—Occasionally water which has been pumped from the tanks is kept in some form of receptacle ready for use. For instance, buckets are often used for stokers' use, etc. Generally speaking, it is a bad plan. Occasionally a general drinking-vessel is provided for bluejackets. This is known as a "*scuttle-butt,*" which in olden days consisted of a butt (or barrel) from which the sailors helped themselves to water through a scuttle (or hole) cut in the top. Nowadays such a container, when provided, takes the form of a closed cylindrical iron tank, with a capacity of 75 to 100 gallons. A refrigerating coil is fixed inside; and round its base outside are a drip-pan, and faucets, from which the men can drink when thirsty. The principle is rather insanitary. *Gates* of the U.S. navy devised a "bubbling spring" attachment for their scuttle-butts, which consists of a series of drinking-funnels in which a cone of water rises on turning a tap. It

is hygienically sound, but very unsatisfactory for the men, who have to protrude their lips uncomfortably, and find it hard to get a good drink.

In these cases, where many people have to drink from a common source or utensil, the cup or cups should be kept in a formalin solution when not actually in use.

Purification of Ship's Water-Supply.

To talk of purification implies an actual or potential impurity of the water. Such impurity is most unlikely to occur in the case of ships whose water-supply is obtained by distillation, provided that the supply tanks are regularly cleaned.

There will be several ways by which the ship supply may get contaminated:

(i.) questionable water-supply;
(ii.) during the transport to the ship;
(iii.) via the ship's filling pipes;
(iv.) through a by-pass from boiler-feed supply;
(v.) via the tank manholes.

We have already seen that *river water* is the most likely to be contaminated, and that *town water* is, on the whole, fairly safe.

We have also seen how likely it may be that a supply will get infected during *transport in water-boats* to the ship.

Moreover, owing to *connections in the pipe systems* of the boiler-feed supply and the drinking-water supply, it becomes possible for the one supply to be accidentally or purposely used in the place of the other.

Another source of contamination frequently overlooked is the one via the *filling pipes*. The sounding and filling pipes of a tank terminate on the ship's deck. Generally, for purposes of convenience, the opening consists of a brass flange and screw plug—all flush with the deck surface. The danger is obvious. Dirt and filth from the deck may easily gain entry through a faulty plug. The filling pipe should always have a raised coaming at least a foot or 18 inches high. It can easily be placed in such a position that inconvenience is not caused; and it should be fitted with a locking device to prevent any tampering on the part of unauthorised persons.

The tank *manholes* are usually fitted with covers, fixed with screw bolts or with a bayonet-jointed flange. They are generally in a most inaccessible position, and there is but little likelihood of contamination by this source in the ordinary course of things. The doubtful factor will arise when the tanks are cleaned; and it may be quite possible that this worthy object will defeat itself unless due care is taken to prevent the introduction of contamination by the persons who enter such tanks.

Enough has been said to show the possibilities of contamination. The question then arises, What will be the nature of this contamination ?

The most common will be: vegetable and mineral débris in the form of mud; rust from pipes and tanks; to a lesser extent traces of animal débris; etc., etc. All this will, in a short time, separate out and fall to the bottom of the tank as a sediment. With it, of course, will be countless living organisms—mostly bacterial.

The whole safety or danger of the water will depend on the absence or presence of pathogenic species amongst its living inhabitants.

If any one tank is definitely incriminated—as evidenced by the occurrence of a considerable number of cases simultaneously amongst those using that supply—then it is no use to attempt to purify the water; the only possible course is to empty the tank as promptly as possible, and then get the Chief Engineer to steam it thoroughly for half an hour. This applies chiefly to cholera. If there is anything to point to a possible enteric or bacillary dysenteric infection, the same course should be pursued.

The two latter diseases are, however, more likely to exhibit themselves sporadically than epidemically as a result of an infected supply, and they are therefore harder to trace.

Similarly, amœbic dysentery, irritative colitis, diarrhœas, etc., may also occur sporadically amongst crew or passengers drinking from contaminated sources.

It should, however, be distinctly understood that such

infection of water on a modern steamer is of the rarest occurrence; but the possibility should always be borne in mind.

It is a comparatively easy matter to secure the purification of the fresh water on board. *Melville-Davison,* the Medical Superintendent of the Booth Line, has devoted a considerable amount of careful attention to this subject, and very valuable remarks thereon appear in his small volume on "Ships' Hygiene."

The principle he advocates is as follows: Water from the tanks, etc., is first pumped up to a "service" or "supply" tank on the highest available deck in order to give it the neces-

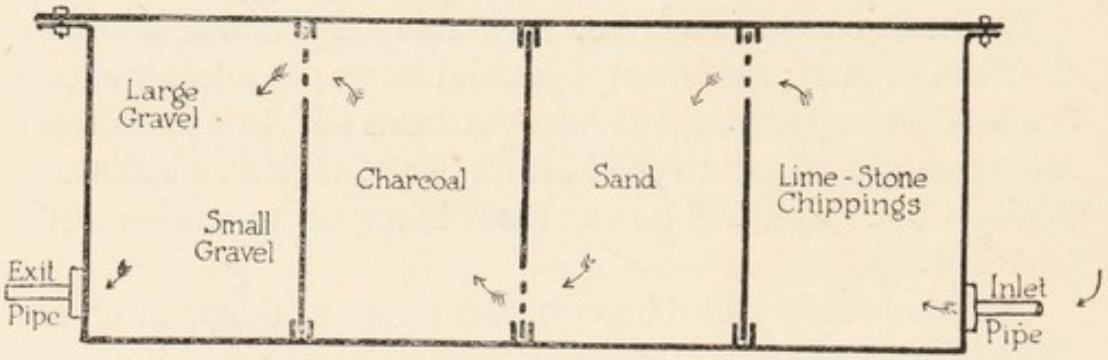


FIG. 14.—SECTIONAL ELEVATION OF FILTER-TANK.
(After Melville-Davison.)

sary "head" for filtering needs, and to facilitate general distribution throughout the ship by service mains.

From this service tank the water passes through a "*pre-filter,*" in the four compartments of which suspended matters are removed and impurities oxidised to some extent (*vide* Fig. 14).

The further treatment of this water, from which the gross impurities have been removed, is designed to render it sterile. It consists of treatment on one of two different lines:

(*a*) central installation; or,
(*b*) terminal installation.

Dr. Melville-Davison suggests that the former should be fitted in all new ships, and the latter only adopted in existing ships which have a service tank to give the necessary pressure.

The idea of the *central installation* is to pass the water, after

leaving the pre-filter, through porcelain candles of the Pasteur or Doulton type. This cannot be done rapidly without further mechanical effort, which is provided either by (*a*) a *pressure method*, to force the water through the central installation of tube filters by a force pump, or else by (*b*) a *vacuum method*, to suck it through by a suction-pump. The latter has not proved satisfactory owing to the difficulty of securing satisfactory and permanent filter fittings.

In the case of a *terminal installation*, the idea is that the water, after leaving the pre-filter, is distributed throughout the ship by service mains, at the various exits of which some form of filter is affixed. The arrangement of the idea will be seen in Fig. 3.

Two types of terminal filter are suggested—(*a*) a *porcelain-candle type*, as in the central installation; and (*b*) an *electrical type*.

He suggests as the best material for the structure of the filter, a white brass (copper, 50; tin, 25; nickel, 25), which is strong, takes a good polish, and is unacted on by the water within it. He also points out that the porcelain candles should be boiled once a month, or oftener.

The electrical type of terminal filter is dependent on the production of ozone by an electrical brush discharge. This is secured automatically when the water-tap is turned on, and the ozone produced is intimately mixed with sprayed water before the latter issues from the exit tap. Such an installation was fitted in s.s. *Vincent*, and worked fairly satisfactorily. The water, however, has a certain taste and smell after being so treated.

In reviewing these excellent methods, we are first of all confronted with the fact that the majority of steamers on the seas of the world are not fitted with a high-level service tank. To install a filter and delivery system, therefore, in an existing ship would be a matter of some difficulty and of questionable justification, however advisable it might be in a new ship.

The whole principle of these schemes is twofold—firstly, to rid the water of its gross impurities; and, secondly, to destroy its organisms.

Possibly a simple and economical method of attaining these two objects would be to abstract the water from its tank, and pass it through a tank (in the engine-room) in which steam coils were fixed. The water would thus be automatically sterilised, and it could then be pumped to a high-level service tank to cool, and subsequently pass to the delivery mains, via a pre-filter—where it would be deprived of its gross impurities.

CHAPTER V

THE VICTUALLING OF SHIPS

AND THE DIETETIC DISEASES SCURVY AND BERI-BERI

" da, si grave non est,
quæ prima iratum ventrem placaverit esca."

HORACE: *Serm. II., VIII.*

THIS chapter does not deal with the victualling of cabin passengers—who can look after themselves—but solely with the food of crew and emigrants, who are legislated for, as being less able to control their environment.

The subject was almost entirely neglected for several hundred years, important as it was, and is.

During the sixteenth and seventeenth centuries, when our sea-borne trade was expanding so largely, it is estimated that, on an average, over 5,000 deaths took place annually amongst our seamen from scurvy alone!

Experience has therefore been a hard task-mistress, and a slow one withal, for it was not until the last half of the nineteenth century (when steam power was becoming generally adopted) that commissariat conditions in the Mercantile Marine became universally satisfactory. The climax may be said to have been reached when, in 1906 (incredible as it may seem), the Board of Trade for the first time laid down a definite schedule of seamen's diet.

It is from naval records, however, that we get the earliest glimpses into the feeding of seamen.

I propose in this chapter to briefly review the relations of foodstuffs to energy according to modern ideas; and then, in the light thereof, to set forth and analyse several ancient and modern scales, and to add a few remarks on the so-called dietetic ship diseases *scurvy* and *beri-beri*.

The defects of the diets at sea in the past were, chiefly:

1. Deficiency of vegetables and antiscorbutics.
2. Indifferent, or bad, quality of all the food.
3. Monotony.
4. Excessive ratio of protein.
5. Bad storage.

The gradual amelioration of these conditions was empirical rather than scientific. Later advances in physiology and in the chemistry of foodstuffs put such matters on a new basis. Proximate food-products were shown to consist of carbon, hydrogen, oxygen, nitrogen, with traces of several other elements.

These were found to be combined as complex or simple bodies, which we classify as:

1. Proteins ($C_{54}O_{22}N_{16}H_7S_1$), as general percentage composition.
2. Hydrocarbons (fats: approximately $C_{10}H_{18}O$).
3. Carbohydrates (sugars $C_{12}H_{22}O_{11}$, and starches $C_6H_{10}O_5$).
4. Vegetable acids.
5. Mineral salts.
6. Water.

It has been shown that the average man discharges daily 4,700 grs. of *carbon* and 307 grs. of *nitrogen*.

This wastage has to be made up by an intake of these elements in the shape of food, and this food is the source of the heat and energy (*i.e.*, the capacity for producing physical change) displayed by the body.

The work of Joule and Mayer has shown that the energy evolved by a given weight of matter is proportional to the heat given out during its combustion.

This heat is measured in terms of a heat-unit known as the Calorie,* which is the amount of heat required to raise, by 1° C., the temperature of 1 kilogram of water (or 1 lb. by 4° F.),

Expressed in terms of work, one Calorie = 1·54 foot-tons.

Now the various food-products, when ingested and digested, have a definite heat value.

* The word *Calorie* should be spelt with a capital letter. If spelt with a small letter it signifies a smaller unit, referring to 1 gramme of water.

Thus, for instance:

Proteins have a heat value of 4 Calories for each gramme (or 113 Calories per ounce) made use of by the body. Fats have an equivalent of 9 Calories per gramme, or 255 Calories per ounce; carbohydrates, of 4 Calories per gramme, or 113 Calories per ounce; absolute Alcohol,* of 0·75 Calories per gramme, or 21 Calories per ounce.

A well-balanced daily diet for a man of average weight, doing moderate work, would be:

Protein	.. .. ..	100 grammes.
Fat	.. .. ..	60 ,,
Carbohydrate	.. ..	540 ,,

If we express this diet in the above heat values we find it to yield energy to the extent of 3,100 Calories.

This is a suitable standard number of Calories to supply daily to a seaman.

Sedentary work will need less Calories; whereas hard muscular work, such as that of a navvy, will require more.

It can thus be seen that, if we know the percentage composition of foodstuffs in terms of protein, fat, and carbohydrate, we can easily deduce the Calorie value of a mixed diet. Analytical tables by different authorities vary enormously, but I think the table on pp. 102-103 will be found to give an average *available* percentage for some of the more ordinary articles of diet.

To calculate the value of a diet from the table, we proceed:

$$\frac{\text{Ration-item (in ounces)} \times \text{Percentage of contained protein} \times 113}{100} = \text{Heat value of Protein in Calories.}$$

The same procedure is carried out for the other constituents of the same food-item, and the total Calories added together.

The process is then repeated for all the other items constituting the daily diet—at the total value of which we thus arrive.

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* 1 oz. (Av.) weight of water occupies a volume of 1 fluid ounce. Therefore fluid-ounce measures of liquids which contain light alcohol, heavy solids, and water may be considered as ounce *weights* for ordinary calculations.

28·34 grammes = 1 ounce.
160 fluid ounces = 8 pints = 1 gallon = 4·5 litres.

Article.	*Approximate Available* Percentage Composition.*			
	Protein.	*Fat.*	*Carbo-hydrate.*	*Alcohol.*
Almonds	15	40	5	—
Bacon	5	50	—	—
Beef (corned)	20	6	—	—
,, (fresh lean)	15	14	—	—
,, (salt)	11	15	—	—
Beer and stout	0·5	—	1	5
Beer (lager)	0·5	—	2	5
Biscuit (hard tack)	8	1	50	—
Bread	6	0·5	40	—
Butter (fresh)	2	70	—	—
,, (salt)	—	72	—	—
Cereals, etc.:				
Arrowroot	0·8	—	70	—
Barley	9	1	60	—
Macaroni	7	0·4	65	—
Maize	6	5	60	—
Oatmeal	10	4	55	—
Rice	4	0·5	75	—
Cheese (average)	20	18	0·3	—
Chocolate	5	10	50	—
Cocoa (British)	8	5	10	—
,, (Dutch)	6	7	14	—
Coffee (as extracted)	0·5	3	2·5	—
Cream	3	25	3	—
Eggs (average weight = 2 ozs.)	12	7	—	—
Fish:				
Cod (salt)	12	0·5	—	—
Fresh (average)	10	0·5	—	—
Herring	9	8	—	—
Mackerel	8	8·5	—	—
Salmon	13	7	—	—
Flour (wheat) or atta ..	10	1	65	—
Fowls	12	4	—	—
Fruit:				
Apples	0·3	0·1	9	—
Bananas	0·7	0·2	12	—
Dates	4	0·2	30	—
Figs	4	0·5	28	—
Grapes	0·8	1	12	—
Melons	0·2	0·1	2	—
Oranges	0·6	0·1	8	—
Rhubarb	1	1	—	—

* It should be remembered that only a certain proportion of constituents are made use of by the body—*e.g.*, only 85 per cent. of sugar and 70 per cent. of butter are available, although they are entirely carbohydrate and fat respectively. This point is often overlooked in calculating diets.

Article.	Approximate Available Percentage Composition.			
	Protein.	Fat.	Carbo-hydrate.	Alcohol.
Ham (smoked)	15	30	—	—
Lard, or Ghee	—	80	—	—
Liver	16	2·5	2	—
Milk (fresh)	4	3	4	—
,, (condensed)	10	9	45	—
Mutton	17	5	—	—
Pemmican	30	50	—	—
Pickles	0·5	0·1	2	—
Pork (salt)	2	35	—	—
Raisins	2	1·5	20	—
Sausage (pork)	9	20	4	—
,, (ham)	12	15	5	—
,, (beef)	15	12	6	—
Spirits:				
Brandy	—	—	0·2	50
Gin	—	—	0·1	40
Rum	—	—	0·3	50
Whisky	—	—	0·2	40
Suet	—	75	—	—
Sugar	—	—	85	—
Tea (as extracted)	1	0·2	1	—
Treacle (molasses)	1·5	—	60	—
Vegetables:				
Artichokes	2	0·1	15	—
Beans (haricot)	15	2	55	—
,, (soya)	30	15	20	—
Beetroot	1	0·1	12	—
Brussels-sprouts	5	0·5	5	—
Carrots	1	0·2	8	—
Celery	1	—	2	—
Lettuce	0·5	0·1	0·5	—
Parsnips	1	0·5	14	—
*Peas (dried) or Dhal (*Phaseolus radiatus*)	18	1	40	—
Potatoes (Irish)	1·5	0·1	18	—
,, (sweet)	1·5	0·1	20	—
Pumpkin	2	0·1	5	—
Turnips	1	0·1	5	—
Walnuts	10	20	8	—
Wines:				
Champagne	0·5	—	3	—
Claret	0·5	—	0·2	10
Hock	0·5	—	0·3	10
Port	0·5	—	4·5	20
Sherry	0·5	—	2	20

* Fresh peas have only ½ the value.

Naval Victualling.

From the earliest times of which we have record the staple food of British seamen was salt fish, bread, and wine.

During the last half of the sixteenth century a more varied and extended scale had come into force. This was composed as follows:

	Per Man.
Daily :	
Biscuit	1 lb.
Beer	1 gal.
Twice weekly :	
Salt beef	2 lb.
Bacon or pork	1 lb.
Peas	1 pint.
Thrice weekly :	
Fish, fresh or salt	½ lb.
Butter	2 oz.
Cheese	¼ lb.

At first sight the beer seems excessive, but it should be remembered that it replaced the wine ration and other food-stuffs—even water, which was generally undrinkable.

The Calorie value of the above ration works out at more than the requisite standard (provided the food was all eatable!) and it is interesting to note that the contract rate for the ration was, at that time, only 4½d. in harbour and 5d. at sea!

In 1622 the ration was the same, but the price had gone up to 7½d. and 8d.; about this time, however, a report describes the provisions as "bad and scanty," and the ships as "floating pesthouses."

A more extended diet was apparently provided for the five ships sent to the East Indies by the East India Company in 1600. In the minutes of the Company the following items were sanctioned: "Bread, meale, beare, syder, wine, beef, porke, peace, beanes, ffyshe, otemeale, steale wheate, cheese, butter, oyle, vinegar, aqua vite, honny, suger, spices, cloves, musterd seede, and rice."

In 1690 the naval beef ration was reduced by one quarter, which was made good in flour and raisins. The beer had got so bad about this time that the Government started brewing

it themselves, and only ceased about the year 1833. Brandy, wine, and rum had been in alternative use for some time. The rum was at first served undiluted, but in 1740 Admiral Vernon adopted the practice of watering it before issue, and the diluted spirit ration was thenceforward known as "grog," owing to the Admiral's predilection for wearing coats made of grogram—a coarse material made of silk and mohair.

In 1795 lime-juice first became an article of regular issue.

Lemon-juice (*Citrus limonum*) has a specific gravity of 1039 and contains 32·5 grains of citric acid to the ounce.

Lime-juice (*Citrus limetta*) has a specific gravity of 1037, and content of 32·22 grains of citric acid to the ounce.

The Board of Trade regulations standardise both, however, to a specific gravity of 1030, and a citric acid content of 30 grains.

As found in the Navy, or Mercantile Marine, the juice is chiefly prepared in Sicily or in the West Indies. It is usually put up in 4-pint bottles, one ounce of brandy being added to each ten ounces of juice. If thus fortified, and a thin layer of olive oil be floated on the top, the juice will keep fresh for at least three years.

Sugar is added to it when issued, in the proportion of half its weight.

About this time the usual breakfast ration was known as "*Scotch coffee.*" It consisted of burnt biscuit, boiled in water, and sweetened with molasses.

After the peace of 1802 the old contracts for supplying brandy to the fleet by French merchants mostly terminated, and brandy became almost entirely replaced by rum, which was then obtained from the British West Indies.

"Scotch coffee" gave place to "*burgoo*" as a breakfast ration. This was no great improvement, for "burgoo" was merely hot oatmeal-water, sweetened also with molasses.

In 1824 the spirit ration was reduced from $\frac{1}{2}$ pint to 1 gill, and tea issues were first started.

The following year cocoa was introduced as a breakfast ration, for the first time.

This brings us down to the more modern period, and I will close this brief messing review with the present-day naval ration as laid down in Appendix XVI. to the King's Regulations and Admiralty Instructions:

DAILY RATION.

Bread, 1 lb., *or* { Bread, ¾ lb. and Flour, ¼ lb. } If no bread available, then { Biscuit, ½ lb., *or* Flour, 1 lb. }

* { Fresh meat, ½ lb. / Fresh vegetables, 1 lb. }

Spirit, ⅛ pint { 1 part mixed with 3 parts water at time of issue—Art. 1697 / Grog money can be received in lieu of this—Art. 1695. }

Sugar, 4 oz.

Tea, ½ oz. (*or* coffee, 1 oz.).

Chocolate, ½ oz. (*or* coffee, 1 oz.).

Condensed milk, ¾ oz. (*or* ¼ pint of fresh milk when ashore).

Jam, marmalade, or pickles, 1 oz.

Twice weekly, Preserved meat, 4 oz. (once weekly in harbour, and not at all when stationed ashore).

The average daily Calorie value of this ration is little over 2,000—that is to say, is short, by $\frac{3}{10}$, of the requisite standard; and, though certainly of a very different quality, it is not nearly as good as the naval rations of Queen Elizabeth's day. Petty Officers, Seamen, and Marines, however, receive a "messing allowance" of 4d. per diem in addition to the above ration, and this will easily make good the deficit of required Calories. Provision is also made for generous allowance of *Extra Issues* (Art. 1690).

A. *Lime-Juice :*
Lime-juice, ½ oz. } may be issued daily to every person on
Sugar, ½ oz. } board on the Surgeon's requisition.

B. *Engine-room hands—when ship is under way :*
Oatmeal, 2 oz. }
Sugar, 1 oz. } is allowed daily.
Lime-juice, ½ oz. }

C. *Night, or extra heavy work :*
Bread or biscuit, ½ lb.
Preserved meat, 6 oz.
Sugar, ¼ oz.
Coffee, ½ oz. (*or* tea, ⅛ oz.; *or* chocolate, ½ oz.).

---

* When not available, the following two rations may be given, on alternate days.

A. Salt pork, ½ lb.
Split peas, ¼ lb.
Celery seed, $\frac{1}{28}$ oz.
Potatoes, ½ lb. (*or* 2 oz. of haricot beans or peas).

B. Preserved meat, 6 oz.
Flour, 8 oz. }
Suet, ¾ oz. } *or* rice, 4 oz.
Raisins or jam, 2 oz. }
Potatoes, ½ lb. (*or* 2 oz. haricot beans or peas).

NOTE.—Ships must carry at least 30 (but not more than 90) days' supply of rations, at above scale, for their whole complement.

D. *War service, or specially arduous conditions :*
Fresh or salt meat—allowance may be increased from ½ lb. to ¾ lb.
Preserved meat—allowance may be increased from 6 oz. to 9 oz.

It will thus be seen that seamen in the Navy are very well off as regards their victualling arrangements.

The only other naval scale which need here be given is that laid down by the Admiralty for use in transports—under form No. T. 113, as given in Appendix XV. to their Transport Regulations, 1908. (See table, pp. 108-109.)

Victualling of the Mercantile Marine.

Very little is known of the early commissariat conditions of the Mercantile Marine beyond such glimpses of stray voyages, already quoted, like those of the East India Company's ships, which were sufficiently organised to partake more of naval than mercantile conditions.

Until a century ago the victualling of the Navy itself was sufficiently indifferent; what it must have been like in the Mercantile Marine, where no official control was exercised, makes one shudder to think!

As time went on, as steam was introduced and began to oust the sailing ship, so the Merchant Shipping Acts began to lay down that the Master must provide his crew with proper food. But what standard was considered proper seemed to be beneath official notice; and a scale was actually only laid down for the first time in the Merchant Shipping Act of 1906!

The Merchant Shipping Act of 1854 (Section 181) laid down that the seaman's right to provisions began when he commenced work; and Sections 221-223 of the same Act provided for a complaint by three or more of the crew if the provisions or water were bad in quality or deficient in quantity; and a money compensation in certain cases for short or bad rations, though no schedule of scales was given.

The forerunner of official control was the **Passengers Act,** 1855 (18-19 Vic., Cap. 119).

In Section 35 of that Act a scale of provisions for *emigrants* and *deck passengers* was set forth—nothing being said about the crew.

Transports.

SCALES OF RATIONS, WATER, AND MEDICAL COMFORTS FOR TROOPS, SEAMEN, AND OTHER THIRD-CLASS PASSENGERS CARRIED IN TRANSPORTS

SCALES OF RATIONS FOR MEN, WOMEN, AND CHILDREN.

Number of Days each Week to be issued.	*Articles.*	*Men.*	*Women.*	*Children.* 5 *and under* 10 *Years of Age.*	*Children.* 1 *and under* 5 *Years of Age.*
6	Meat, fresh .. oz.	12	8	6	
2	,, ,, (for soup) ,,	—	—	4	DAILY SCALE.
1	Compressed corned beef and mutton ,,	12	8	6	Milk, fresh .. 2 pts. Bread .. .. 4 oz.
Daily	Bread, fresh ,,	16	12	8	Rusks or tinned farinaceous food ½ ,,
Daily	Vegetables, fresh ,,	2	2	1	Sugar .. .. 2 ,,
Daily	Potatoes .. ,,	10	10	5	Rice .. .. 2 ,,
Daily	Butter .. ,,	1½	1½	¾	Oatmeal .. 2 ,,
2	Rice .. .. ,,	2	2	—	Soup and bouilli, essence of beef, or mutton broth ½ pt.
3	,, ... ,,	—	—	2	
4	Oatmeal .. ,,	2	2	1	
2	Flour .. ,,	6	6	3	
2	Suet .. ,	1	1	½	
2	Raisins	2	2	1	
Daily	Tea .. .. ,,	½	½	¼	
Daily	Sugar .. ,,	2	2	2	
2	,, (extra for puddings) ,,	2	2	1	*Each infant* under 1 year to be provided with—
2	,, (extra for rice) ,,	1½	1½	—	Milk, fresh Sugar
4	Jam .. .. ,,	2	2	1	Patent farinaceous food
Weekly	Salt .. .. ,,	2	2	1	Cornflower or arrow root
Weekly	Pepper .. ,,	1/6	1/6	1/12	entirely at the discretion of the Medical Officer.
Weekly	Mustard .. ,,	1/12	1/12	¼	
Weekly	Vinegar .. pt.	1/6	1/6	½	
Weekly	Pickles .. oz.	6	6	3	
Weekly	Milk, condensed unsweetened, lb.-tins	1	1	—	
Daily	Milk, fresh .. pt.	—	—	½	

Boys of 10 and under 14 years of age, and *girls* of 10 years of age and upwards, are to receive a *woman's* ration.

Boys of 14 years and upwards are to receive a *man's* ration.

NOTES.—The scale is to be strictly adhered to whenever practicable, but to meet cases in which *fresh* provisions may not be procurable,

or it may be necessary to vary the tea ration, the following list of equivalents is appended:

Fresh meat = equal weight compressed corned meat.
Fresh bread = equal weight of biscuit, or flour, or rice.
1 lb. fresh vegetables or potatoes = 2 oz. preserved mixed vegetables.
1 lb. tin of condensed milk = 1⅔ pints.
½ oz. coffee with ⅝ oz. of chocolate or ¼ oz. of tea, together may be taken as equivalent to ½ oz. of tea, and the issue may be made accordingly.

Any article in the foregoing scales of rations may be stopped or changed, but only in individual cases, upon the special requisition of the Medical Officer.

Spirit Ration for Petty Officers and Seamen of the Royal Navy and Royal Marines.

When petty officers, seamen, and marines are embarked for passage they are to receive (in addition to the above) ⅛ pint of spirits daily.

No spirit is to be issued to men under 20 years of age. For them and for abstainers a suitable substitute is to be provided if desired.

Water.

When there is a distilling apparatus on board, water is to be issued on the most liberal scale possible. The *minimum daily allowance* for everyone on board (including crew) is 6 *pints*. This amount must be increased to 1 *gallon in the tropics;* and these amounts are to suffice for all purposes.

Medical Comforts.

Daily scale for 1,000 persons, in addition to ordinary rations:

Brandy, 1 bot.
Whisky, 2 bots.
Port-wine, 8 bots.
Fresh eggs, 24.
Prepared soup, 12 pints.
Bovril or Liebig—to make 60 pints.
Sago, 2 lb.
Arrowroot, 4 lb.
Rice, 8 lb.
Fresh milk, 20 pints.
Lime-juice, 500 oz. } at discretion of Medical
Sugar, 500 oz. } Officer.
Sugar, 15 lb.
Tea, 2 lb.
Pearl barley, 3 lb.
Ale or porter, 25 pints.
Soap, 2 lb.

Note.—The Medical Officer in charge may requisition mutton- or chicken-essence, calf's-foot jelly, etc.

Ration Scale for Remounts on Government Transports.

Per head daily :

	Horses or Mules.	*Cobs or Small Mules.*
Oats	3 to 4 lb.	2 to 3 lb.
Bran	5 to 6 ,,	3 to 4 ,,
Hay	12 ,,	10 to 12 ,,
Carrots (or other roots)	¾ ,,	¾ ,,
Water	10 gals.	10 gals.

Also, in addition,

For each 100 *horses :*

Oatmeal	1 lb.
Linseed	2 ,,
Rock salt	6 ,,

Amount to be carried for estimated duration of voyage, plus a reserve of 25 per cent.

PASSENGERS ACT, 1855.

SCALE FOR STEERAGE PASSENGERS.

(*Weekly, per Statute Adult.*)

	Voyages of 84 Days' Sail, or 50 Days' Steam.	
	When not Exceeding.	*If Exceeding.*
	lb. *oz.*	*lb.* *oz.*
Bread or biscuit	3 8	3 8
Wheaten flour	1 0	2 0
Oatmeal	1 8	1 0
Rice	1 8	0 8
Peas	1 8	1 8
Beef	1 4	1 4
Pork	1 0	1 0
Butter	—	0 4
Potatoes	2 0	2 0
Sugar	1 0	1 0
Tea	0 2	0 2
Salt	0 2	0 2
Mustard	0 ½	0 ½
Pepper	0 ¼	0 ¼
Vinegar	1 gill.	1 gill.
Preserved meat	—	1 lb.
Suet	—	6 oz.
Raisins	—	8 oz.
Lime-juice	—	6 oz.
Water	42 pints.	42 pints.

Substitutions were allowed at the discretion of the Master:

(*a*) 1 lb. preserved meat *for* 1 lb. salt beef or pork.

(*b*) { 1 lb. of flour, bread or biscuit, *or* / ½ lb. of beef or pork } *for* { 1¼ lb. oatmeal, *or* / 1 lb. rice, *or* / 1 lb. peas.

(*c*) 1 lb. rice *for* 1¼ lb. oatmeal (or *vice versa*).

(*d*) ¼ lb. preserved potatoes *for* 1 lb. of potatoes.

(*e*) 10 oz. currants *for* 8 oz. of raisins.

(*f*) 3½ oz. of cocoa or roasted coffee *for* 2 oz. of tea.

(*g*) ¾ lb. treacle *for* ½ lb. sugar.

(*h*) 1 gill mixed pickles *for* 1 gill of vinegar.

The above ration has a Calorie value of about 2,064 per cap. per diem.

It speaks well for the individual who framed this diet scale, when we see that the accumulated modern experience of sixty years has scarcely altered it.

It was reproduced, almost as it stands above, in the *Merchant, Shipping Act*, 1894, where it appears as the Twelfth Schedule under the provisions of Section 298 of that Act.

The only difference of any importance was the addition of one extra substitution—*i.e.*:

1¼ lb. freshly baked bread *for* { 1 lb. flour, *or* / 1 lb. biscuit, *or* / 1¼ lb. oatmeal, *or* / 1 lb. rice, *or* / 1 lb. peas.

The issue of lime-juice also was made discretionary, unless the ship were in the tropics.

This scale for steerage passengers was yet again substantively reproduced under the provisions of Section 17 of the **Merchant Shipping Act,** 1906. As, however, the scale contains additional children's diets and an altered list of substitutes, and is, moreover, the scale in current use, I give it here in full. It was promulgated by the Board of Trade in January, 1908.

FOOD SCALE FOR EMIGRANTS AND STEERAGE PASSENGERS

(*Under Merchant Shipping Act*, 1906).

WATER.

Four quarts daily to each statute adult, exclusive of the quantity necessary for cooking any article issued under this scale in a cooked state.

PROVISIONS.

Weekly, per statute adult.

	lb.	*oz.*
Beef or pork, or partly one and partly the other	2	4
Preserved meat	1	0
Suet	0	6
Butter	0	4
Bread or biscuit not inferior in quality to Navy biscuit	2	8
Wheaten flour not inferior to best seconds	3	8
Oatmeal, rice, and peas, or any two of them	2	0
Potatoes	2	0
Raisins	0	6
Tea	0	2
Sugar	1	0
Salt	0	2
Mustard	0	$0\frac{1}{2}$
Pepper, black or white, ground	0	$0\frac{1}{4}$
Dried or compressed vegetables	0	8
Vinegar or mixed pickles	1 gill.	

For children between one and four years of age, in addition to half-ration of the above-named articles:

	Per Week.
Preserved milk	3 gills.
Condensed egg	1 oz.
or fresh eggs	3 ,,

For children between four and twelve months of age:

	Per Week.
Water	21 pints.
Preserved milk	7 gills.
,, soup	9 oz.
Condensed egg	1 ,,
or fresh eggs	3 ,,
Biscuit	12 ,,
Oatmeal	4 ,,
Flour	8 ,,
Rice	4 ,,
Sugar	10 ,,

REGULATIONS RELATING TO PROVISIONS AND WATER.

1. The first issue of provisions shall be made within two hours after the steerage passengers have embarked.

2. Provisions requiring to be cooked shall be issued in a properly cooked state.

3. In vessels which have two distinct refrigerating machines, fresh meat may be substituted for the total quantity of salt meat required.

4. In vessels which have one refrigerating machine, and are not intended to call at an intermediate port, fresh meat may be substituted for half the quantity of salt meat required.

5. In vessels which have one refrigerating machine, and are intended to call at intermediate ports, salt meat need only be provided for the time occupied in the longest distance between ports, as shown by th

official log-book of the ship on previous voyages, or as determined by the Emigration Officer at the port of clearance.

6. Ten per cent. of the total quantity of meat provided for the voyage shall be tinned meat, but not more than 2,000 lbs. of tinned meat need be carried if the balance of the 10 per cent. is made up with salt beef or salt pork.

7. Where the supply of fresh meat for the use of the passengers and crew is carried in a refrigerator, only half the quantity of suet required under the scale need be provided separately.

8. Two pounds of biscuit shall be provided for each steerage passenger and member of the crew carried in the ship, but the total quantity of biscuit provided need not in any case exceed 1,600 pounds.

9. Fresh vegetables, preserved in tins, may be substituted for dried or compressed vegetables in the proportion of half a pound of fresh vegetables, or vegetables preserved in tins, to one ounce of dried or compressed vegetables.

SUBSTITUTES AND EQUIVALENTS.

Fresh meat	1½ lb.	To be considered equal.
Salt meat	1 ,,	
Preserved meat	¾ ,,	
Coffee	½ oz.	To be considered equal.
Cocoa	½ ,,	
Tea	¼ ,,	
Flour	1 lb.	To be considered equal.
Biscuit	1 ,,	
Rice	1 ,,	
Split peas	½ pt.	To be considered equal when issued with meat rations.
Flour	¾ lb.	
Calavances or haricot beans	½ pt.	
Rice	¾ lb.	
Marmalade	1 lb.	To be considered equal.
Jam	1 ,,	
Butter	½ ,,	
Mustard	—	To be considered equal.
Curry powder	—	

As a comparison I give the following scale, which is laid down for *Chinese* deck passengers (emigrants) by Rule 7 of the Ninth Schedule, Hong-Kong Chinese Emigration Ordinances. This scale is in current use, and applies to the enormous numbers of coolies leaving China for other ports of the East—of whom over a quarter of a million annually enter Singapore alone.

7. The following conditions as to provisions shall be observed to the satisfaction of the Emigration Officer:

(1) Provisions, fuel, and water shall be placed on board of good quality, packed, and sufficient for the use and consumption of the

passengers, over and above the victualling of the crew, during the intended voyage, according to the following scale: For every passenger *per diem not less than :*

Rice or bread stuffs	1⅓ lb.
and	
Dried—salt fish	⅓ lb.
or	
Chinese condiments and curry stuffs	1 oz.
Fresh vegetables which will keep for short voyages, such as sweet potatoes, turnips, carrots, and pumpkins	1⅓ lb.
Firewood	2 lb.
Water (to be carried in tanks or sweet casks)	1 gall.

(2) The last preceding condition as to provisions shall be deemed to have been complied with, in any case where, by the special authority of the Emigration Officer, any other articles of food have been substituted for the articles enumerated in the foregoing scale, as being equivalent thereto; and,

(3) The passengers may supply their own provisions for the voyage, and proper accommodation for the stowage and sufficient cabooses for the cooking of such provisions must be allowed.

This scale, short and simple as it seems, has, nevertheless, a Calorie value of well over 2,000.

We are now brought to the Act (Merchant Shipping Act, 1906) in which, as I said, a food scale for the *crew* was laid down for the first time. It is laid down under the provisions of Section 25 of that Act, and is inserted as the First Schedule. (See table p. 115.)

CONDITIONS AND EXCEPTIONS IN APPLYING SCALE.

1. The issue of provisions for which a total weekly, and no daily, amount is given in the above scale shall be reasonably distributed throughout the week.

2. The issue of soft bread under the scale shall not be required—

(*a*) in a ship of less than one thousand tons gross registered tonnage; or
(*b*) if rough weather renders the making of the bread impracticable; or
(*c*) in any ship until the date of the first agreement with the crew entered into after the first day of January nineteen hundred and eight;

but where soft bread is not issued, an equivalent amount of biscuit shall be issued instead.

3. An equal quantity of fish, up to an amount not exceeding three-quarters of a pound in any one week, may be substituted for preserved meat under the above scale.

FIRST SCHEDULE TO THE MERCHANT SHIPPING ACT, 1906.

Scale of Provisions for the Crew of Merchant Ships.

	Water.	*Soft Bread.*	*Biscuit.*	*Salt Beef.*	*Salt Pork.*	*Preserved Meat.*	*Fish.*	*Potatoes.*	*Dried or Compressed Vegetables.*	*Peas, Split.*	*Peas, Green.*	*Calavances or Haricot Beans.*	*Flour.*	*Rice.*	*Oatmeal.*	*Tea.*	*Coffee.*	*Sugar.*	*Milk, Condensed.*	*Butter.*	*Marmalade or Jam.*	*Syrup or Molasses.*	*Suet.*	*Pickles.*	*Dried Fruits.*	*Fine Salt.*	*Mustard.*	*Pepper.*	*Curry Powder.*	*Onions.*
	qt	lb.	lb.	lb.	lb.	lb	lb.	lb.	lb	pt.	pt.	pt.	lb.	lb.	oz.	oz.	oz.	lb.	lb.	lb.	lb	lb.	oz.	pt.	oz.	oz.	oz.	oz.	oz.	oz.
Sunday	4	1	–	$\frac{1}{2}$	–	$\frac{3}{4}$	–	–	–	–	–	–	$\frac{1}{2}$	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Monday	4	–	1	–	1	–	–	–	–	–	–	–	–	$\frac{1}{4}$	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3
Tuesday	4	1	–	$1\frac{1}{4}$	–	–	–	–	–	–	–	–	$\frac{1}{2}$	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Wednesday	4	–	1	–	–	$\frac{3}{4}$	–	–	–	–	–	–	$\frac{1}{2}$	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Thursday	4	1	–	–	1	–	–	–	–	–	–	–	–	$\frac{1}{4}$	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Friday	4	–	1	–	–	$\frac{3}{4}$	$\frac{3}{4}$	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Saturday..	4	–	1	$1\frac{1}{4}$	–	–	–	–	–	–	–	–	$\frac{1}{2}$	–	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Weekly	28	3	4	3	2	$2\frac{1}{4}$	$\frac{3}{4}$	6	$\frac{1}{2}$	$\frac{2}{3}$	$\frac{1}{3}$	$\frac{1}{3}$	2	$\frac{1}{2}$	8	$1\frac{3}{4}$	4	$1\frac{1}{4}$	$\frac{1}{3}$	$\frac{1}{2}$	1	$\frac{1}{2}$	4	$\frac{1}{2}$	5	2	$\frac{1}{4}$	$\frac{1}{4}$	$\frac{1}{4}$	3

The fish issued, whether under the scale or as a substitute, must be fresh fish, dried fish, or canned salmon or canned herrings.

4. Within the tropics, a pound and a half of preserved meat or three pounds of fresh meat may be substituted for two pounds of salt pork.

5. Fresh potatoes must be issued for at least the first eight weeks of the voyage in the case of every ship leaving a port within the home-trade limits at any time between the last day of September and the first day of May, and at any other time when they can be procured at a reasonable cost.

When fresh potatoes are not so issued, an equal amount of yams, or vegetables preserved in tins, or an equivalent amount of dried or compressed potatoes or dried or compressed vegetables in the proportion of one pound to six pounds of fresh potatoes, must be issued in their place.

6. Fresh vegetables, or vegetables preserved in tins, may at any time be substituted for dried or compressed vegetables in the proportion of half a pound of fresh vegetables, or vegetables preserved in tins, to one ounce of dried or compressed vegetables.

7. A mixture of coffee and chicory containing not less than seventy-five per cent. of coffee may at any time be substituted for coffee in the proportion of five ounces of the mixture to four ounces of coffee.

8. The dried fruit issued under the above scale must be raisins, sultanas, currants, figs, or prunes.

9. The onions to be issued under the above scale must be fresh onions when in season; and when fresh onions are not in season, an equal amount of onions or vegetables preserved in tins, or an equivalent amount of dried or compressed onions or vegetables in the proportion of one ounce to half a pound of fresh onions must be issued.

10. In port—

(*a*) soft bread shall be issued in lieu of biscuit; and

(*b*) when procurable at a reasonable cost, a pound and a half of fresh meat and half a pound of fresh vegetables shall be issued daily, and when fresh meat and fresh vegetables are so issued, salt and preserved meat, and dried or compressed vegetables, need not be issued.

11. The stokehold hands are to receive sufficient oatmeal and one quart of water extra, daily, while under steam.

SUBSTITUTES AND EQUIVALENTS—NOT TO BE USED WITHOUT REASONABLE CAUSE.

Fresh meat	1½ lb.	To be considered equal.
Salt meat	1 ,,	
Preserved meat	¾ ,,	
Coffee	1 oz.	To be considered equal.
Cocoa	½ ,,	
Tea	¼ ,,	
Flour	1 lb.	To be considered equal
Biscuit	1 ,,	
Rice	1 ,,	

Split peas	⅓ pt.	To be considered equal when issued with meat rations.
Flour	¾ lb.	
Calavances or haricot beans	½ pt.	
Rice	¾ lb.	
Marmalade	1 lb.	To be considered equal.
Jam	1 ,,	
Butter	½ ,,	
Mustard	—	To be considered equal.
Curry powder	—	

This scale is now in current use by all British ships registered in and trading from the United Kingdom. It is a fairly good scale, with a mean daily Calorie value per man of over 3,600.

Any three or more of the crew have still the right to complain of the quality or quantity of the food served out, as they had under the 1854 Act.

Many British Colonies have separate scales, made under local ordinances, for the crews of vessels trading or registered locally. Such scales deal, of course, with native crews, and are inserted in the Ship's Articles, just as is done in the United Kingdom.

The following is an example of such local scales, being the one in force under the Merchant Shipping Ordinance of the Straits Settlements. It will be seen that it is more or less a skeleton scale, for native crews, especially Chinese, generally prefer to feed themselves from their wages.

DIET SCALE—NATIVE CREWS: STRAITS SETTLEMENTS.

Per Head, per Day.	*Chinese.*	*Malay and Indian.*	*Remarks.*
Rice	2 lb.	2 lb.	
Fresh pork or beef	1 lb.	—	
Salt fish	—	4 oz.†	†*Or*, ¼ lb. vegetables and ¾ lb. fresh fish or ½ lb. fresh beef when in harbour.
Tea	¼ oz.	*⅛ ,,	
Dhall	—	4 ,,	
Coffee	½ ,,	—	
Ghee	—	1 ,,	
Sugar	2 oz.	*2 ,,	*Omitted in case of "local-trade ships."
Biscuits	—	*6 ,,	
Salt	—	¼ ,,	
Vinegar	—	*2 ,,	
Curry meat	—	*‡3½ oz.	‡Only given when vessel leaves the tropics.
Curry stuff:			
Chillies	—	6 drs.	
Pepper	—	6 ,,	
Turmeric	—	4 ,,	
Coriander	—	2 ,,	
Cummin	—	2 ,,	
Water	4 quarts.	4 quarts.	

There is only one other remark I should like to make before leaving the subject of diets, and that is with regard to the subject of *storage of provisions on ship-board.* In the old days this was a matter but little thought of; while at the other extreme we have the splendid arrangements of a modern passenger liner. There is a mean—an indifferent mean—which is found on most ships that sail the sea, and much improvement might often be effected.

The essential points to notice on ships not specially constructed for the purpose are:

1. *Situation.*—The store-locker should be accessible and able to be got at without damage to the food in any weather. It should be specially fitted for the purpose.

2. *Cleanliness.*—The compartment should be scrupulously clean. It should be painted, when empty, at conclusion of the voyage. On tropical voyages plentiful whitewash should be applied. It should be cleaned once a week.

3. *Coolness.*—It should be as far from the heat of the engine-room as possible, and should be thoroughly well ventilated.

4. *Dryness.*—All bags, boxes, etc., should be kept perfectly dry. Moulds spread very rapidly unless this is done. All sacks should be raised off the ground on planks, which themselves should rest on bricks. All bins and boxes should also be on bricks, to allow a free current of air below as well as above.

5. *Freedom from Vermin.*—Rats and cockroaches are too often the usual inhabitants of food stores. When the latter are in abundance it means that the place is not being kept clean. The former should be caught when possible.

SCURVY

"And sometimes it leads to the Northland, and the scurvy softens your bones,
And your flesh dints in like putty, and you spit out your teeth like stones."

The Lone Trail.

For at least three hundred years scurvy was the veritable curse of the sea. It began its long career (soon after the discovery of America, in 1492) with the inauguration of venture-

some and extended voyages at the end of the fifteenth and beginning of the sixteenth century, and continued until its final discomfiture between 1796 and 1800.

The horrible conditions make one shudder to think of; and for a century or two the mortality rate was far in excess of the worst engagements in the Great European War.

As far as I know the earliest detailed report of scurvy at sea is to be found in Hakluyt, where he deals with the second voyage of Jacques Cartier, "by the Grand Bay, up the river of Canada to Hochelaga," in the year **1535**. This reference is sufficiently good to quote:

"In the moneth of December, wee understood that the pestilence was come . . . the said unknowen sicknes began to spread itselfe amongst us after the strangest sort that ever was eyther heard of or seene, insomuch as some did lose all their strength, and could not stand on their feete, then did their legges swel, their sinnowes shrinke as blacke as any cole. Others also had all their skins spotted with spots of blood of a purple coulour: then did it ascend up to their ankels, knees, thighes, shoulders, arms and necke: their mouth became stincking, their gummes so rotten, that all the flesh did fall off, even to the rootes of the teeth, which did also almost all fall out. With such infection did this sicknesse spread it selfe in our three ships, that . . . of a hundreth and tenne persons that we were, there were not ten whole, so that one could not helpe the other, a most horrible and pitifull case."

A few other scattered references may be of some interest here.

In 1578, one of the ships of Drake's fleet—the *Elizabeth*, Captain Wynter—was detached, and stayed for some three weeks in the Strait of Magellan. The crew were suffering frightfully from scurvy, relieved to some extent by collection of food ashore. Amongst other things, they secured some aromatic bark from an evergreen tree (? *Drimys winteri*, Foster), and this was used on the voyage home as a remedy for the disease—an early contribution to its therapeutics!

A little later, the *Desire*, Captain Davis, discovered the Falkland Islands (August 14, 1592). This expedition was also eventful from the fact that only sixteen of the crew survived the ravages of scurvy on the homeward voyage!

The long sea route to India, rendered necessary by the Moslem closure of Egypt and the Red Sea, had been first

discovered by Vasco da Gama, who rounded the Cape and reached Calicut in 1498—thus starting the Portuguese influence in the East. But it was not until nearly a century later, when Dutch influence had to a large extent replaced that of the Portuguese, that the ships of England turned eastwards. The original *East India Company* was founded and given a Charter by Queen Elizabeth in the year 1600, establishing their first factory at Herat in 1608. The fleet which conveyed this first British expedition consisted of four ships —the *Dragon* (the former name of which was the *Scourge of Malice*), the *Great Susan*, the *Hector*, and the *Assention*.

The *Dragon* was the flagship of the Commodore of this mercantile squadron—Captain, afterwards Sir James, Lancaster, who had already made a previous voyage to India. His surgeon was one Raphe Salter. The fleet sailed from Woolwich on the 13th (!) of February, 1600. On reaching the equatorial calms the usual scurvy broke out. Lancaster and Salter apparently took the matter in hand, saw to the sanitation of the *Dragon*, and insisted on each member of the crew having three spoonfuls of lemon-juice every morning, fasting. The other three ships were not so skilful; and when Table Bay was reached, on the 9th of September, 105 men had died, and the *Dragon* was the only ship whose crew had strength left to anchor!

The same monotonous drama of death sailed the seas, decade after decade, until—a century and a half later—we come to the time of the great explorer, Captain Cook.

The first long voyage of that great sailor was in a 370-ton barque named the *Endeavour*, which sailed from Plymouth on the 26th of July, 1768, having a complement of 94 (officers and scientific staff, including a surgeon and a surgeon's mate, 27, and crew 67). The outward journey was as follows: Rounded the Horn and reached Tahiti, 13.4.1769; New Zealand, 7.10.1769; Botany Bay, 29.4.1770; and via New Guinea to Batavia, which was reached on the 11th of October, 1770. Up to that time, therefore, the ship had been absent from home over two years; but the most astounding thing was that Cook had kept the whole of his crew free from scurvy

all that time—not a single case had occurred. Such a thing had never been known before. It was magnificent. He ascribed it as due to constant vigilance, daily personal inspection of the ship, cleanliness, and dryness of men and ship, green food whenever possible, and exhibition of the following routine articles of diet: Sauer-kraut, inspissated lemon-juice, molasses, portable soup, and malt to be made into wort. Alas! two months in the "sickly climate of Batavia" introduced dysentery. He lost two Lieutenants, the Master, the Surgeon, two snotties, the boatswain, the carpenter, the astronomer, and others; and, when they reached home, on the 12th of June, 1771, forty of the crew were no more.

His second voyage was in the *Resolution*, in which he returned to England in 1775, after an absence of three years and eighteen days. During the whole of that time Cook only lost one man from sickness, although his consort—the *Adventure*—(which had the same victualling) lost many of her crew from scurvy. Cook read a paper before the Royal Society on the "Prevention of Scurvy," and was given an F.R.S.

We now come to the purely medical aspects of this disease, which, in its clinical features, has some resemblances to the disease known as "sprue"; but which, etiologically, has something in common with the other great ship disease—beri-beri—in that both affections seem undoubtedly to be related to foodstuffs, but how caused being even yet a mystery.

Definition.—Scurvy is a constitutional disease, associated with an unknown dietetic origin, and characterised by debility, spongy gums, and muco-cutaneous hæmorrhages, and leading (if untreated) to impaired nutrition, profound exhaustion, and death.

Symptoms.—The onset is usually very gradual. The first thing noticeable is a failure of strength when making a physical effort. This is soon followed by mental depression. A darkish swelling appears round the eyes, and the face becomes podgy and apathetic. The gums are swollen and spongy, and bleed frequently. The breath becomes offensive, though the appetite is often good and the tongue clean. Rheumatoid muscular pains are a marked feature at this stage.

After some weeks all the above symptoms become aggravated. The urine often shows albumin and abundance of phosphates. The breath is now fœtid, the teeth get loose and drop out. Blood extravasations appear—either in the form of purpuric spots, extensive cutaneous ecchymoses, hæmatomata in muscle tissues, epistaxis, etc.

Skin ulcerations are frequent and extensive. The exhaustion becomes more profound. Insomnia may alternate with delirium, and in a short time death will ensue—usually from diarrhœa, pneumonia, or nephritis.

Treatment.—The main feature of the treatment is citric acid, given in the form of lime or lemon juice. (This became a routine prophylactic in the R.N. in 1795 and in the M.M. in 1865.)

The acid of oranges has a similar though less potent effect. Certain vegetables seem to possess marked anti-scorbutic value, especially potatoes, watercress, lettuce, and raw cabbage. Vinegar is also useful for exhibition.

In the early stages the above dietetic treatment will usually have an immediate effect, other food being regulated according to the digestion.

For the early spongy gums, tannic acid or 2 per cent. silver nitrate should be applied twice daily by a swab.

In the later stages treatment should be palliative, and is often of little avail.

Pathology.—The gross visible lesions will be demonstrated. The blood shows no leucocytosis. Post mortem, the heart, liver, and kidneys are often fatty, and show parenchymatous degeneration. The spleen is soft and enlarged. Sub-periosteal hæmorrhages are frequently found in the femora; and the epiphyses are congested or detached.

Etiology.—As in the case of beri-beri, little is known as to the cause of scurvy beyond that it has an obvious connection with the dietary.

The causes suggested are—

(*a*) A microbial origin.
(*b*) An acid intoxication (Almroth Wright, 1895).
(*c*) A toxæmia from damaged meat (Torup of Christiania).

Owing to the almost entire absence of scurvy at the present day, the question may perhaps be never satisfactorily settled.

BERI-BERI

Like scurvy, this disease is apparently connected with diet. The former disease, however, owing to its well-marked and disgusting characteristics, its connection with several centuries of sea-life and with various historical expeditions, loomed large in the public eye until the end of the eighteenth century. People talk glibly of the presence of beri-beri in the Roman army invading Arabia in 24 B.C., but it is extremely doubtful if the disease was at all common or widespread until recent times, and one can hardly say that it was recognised as a clinical entity much before the middle or perhaps the beginning of the eighteenth century; although perhaps the old-time

authors implied this disease when they talked of scorbutic hydræmia, marine asthma, white scurvy, etc.

There is no doubt that since that time the disease has had a very close connection with the sea, and has been responsible for a very large number of deaths amongst seamen.

It has been called in question whether beri-beri on ships is the same disease as that which occurs on shore. Careful consideration of European reports and investigation of Eastern examples lead me to suppose that the term beri-beri has been too loosely applied. The disease studied in Europe by Bullmore, Nocht, and by the Norwegian Commission is quite different in its features, course, and spread, to the true tropical beri-beri which often occurs widely on ships in the East. Unfortunately, the term "ship beri-beri" was given to the former type, which is almost certainly a disease of faulty nutrition allied to scurvy. This term should be thrown overboard. It is either beri-beri or not beri-beri; in neither case is there justification for calling it "*ship* beri-beri." I propose to call it **wet scurvy,** as opposed to the ordinary scurvy—analogous to our division of beri-beri into "wet" and "dry."

Reports of what was obviously our wet scurvy have come to light at intervals. *Shattuck* (1881) and *Roosevelt* (1887) note epidemics respectively on the *Nelly Swift* and on the *Henry S. Sanford.* Then, in 1900, *Bullmore,* the surgeon to Falmouth Hospital, reported his investigation of twenty ships, with a history of 91 cases and 18 deaths.

His conclusions were: that it was not the tropical beri-beri; and that it was an alkaloidal poisoning fanned into flame by the disturbance of sailors' digestion due to improper diet (*i.e.*, a ptomaine poisoning plus an auto-intoxication).

Then a *Norwegian Committee,* under the presidency of *Uckerman,* published in 1902 their report on an investigation of 104 ships, with 574 cases and 85 deaths.

They found that it chiefly occurred on long voyages, and nearly always in *sailing* ships. Over 75 per cent. of the infected ships were of Norwegian nationality. They considered (I should say without sufficient evidence) that the disease was due to an intoxication by tainted animal or vegetable food.

Later, *Nocht*, in 1903, detailed his work in connection with thirty-four infected sailing ships returning to Hamburg. There had been 282 cases on board, with 44 deaths. He considered that the course and nature of the disease were opposed to a beri-beri identity, and regretted the term "ship beri-beri," which had been misapplied by the ports Punta Delgada and Falmouth. In his opinion the disease was a kind of scurvy.

Wet Scurvy (synonym: "Ship beri-beri").

Symptoms.—Like scurvy, these are not acutely rapid. It begins with a feeling of malaise and general weakness, accompanied by loss of appetite, nausea, and usually constipation. The loss of power in the legs gradually increases, accompanied by some numbness and pricking sensations. Œdema of the ankles follows, and spreads up the limbs and trunk. The tongue is clean, but pale and swollen. The breath is offensive. The pulse-rate increases, and there is some breathlessness and palpitation. The urine shows no albumin. In bad cases the deep reflexes are lost.

One of the most remarkable points about the disease is the fact that the exhibition of fresh provisions, vegetables, etc., will clear up all except the moribund cases, in the short period of eight to fourteen days, leaving no trace of the disease at all.

Very little is known of the pathology. One post-mortem disclosed fluid in the thoracic serous cavities. The heart was hypertrophied and dilated; and the kidneys showed acute parenchymatous degeneration. There was no nerve degeneration.

It is generally recognised that the disease is not infectious, and one ship does not continue to have the disease recurring as happens in the case of beri-beri.

There are one or two points worth noticing. In the first place, the disease cannot be a ptomaine poisoning—for that is an acute condition characterised by vomiting, diarrhœa, and collapse. In the second place, why should Norwegian ships be so frequently affected? *Holst* explains as follows:

The disease was rare on Norwegian ships until 1894. Previous to that date the rations included rye-flour biscuits made with yeast; and salt meat and peas were served almost daily. But after that date, the biscuits were replaced by soft bread, made from wheat, or wheat-and-rye, flour—without yeast; and the meat rations were reduced. The disease has since been very prevalent.

All experiments so far made seem to make it clear that

scurvy is caused by a one-sided diet, or by a dietary deficiency; and, also, that "wet scurvy" has a similar origin.

We now come to **Beri-beri** proper. There is no doubt that this disease has played a large part in marine mortality, especially in the tropics.

One of the most interesting examples is that of the *Japanese Navy*. For six years prior to 1884 the average beri-beri admission rate was 324, 5 per 1,000 of the strength. Diet commutation was general, but there is no doubt that the food consumed was approximately in the ratio of: Protein, 109; fat, 16; carbohydrate, 622.

In February, 1884, new regulations abolished the commutation system, and introduced a diet: Protein, 140; fat, 62; carbohydrate, 674 (largely derived from other sources than rice). That year the admission rate sank to 127·4; in 1885, to 5·9; and, since then, the rate has been less than 1 per 1,000. It is therefore obvious some exciting or predisposing cause has been removed.

In recent years the most frequent marine occurrence of the disease has been in the Indian Ocean and Malay Archipelago, amongst Dutch men-of-war, cargo boats, and coasting vessels —almost entirely amongst native crews in the latter cases. English men-of-war and cargo boats in the Bay of Bengal have also come in for a good share, also French steamers carrying Indian coolies to West Africa or French America.

Outbreaks have also been reported amongst crews in the Torres Strait, Persian Gulf, and Red Sea; also on board Brazilian warships in the Atlantic, during the war with Paraguay.

Beri-beri.

Symptoms.—The disease generally begins gradually. There may be an ill-defined malaise and a little epigastric discomfort, but the first notable symptoms are weakness of the legs and tenderness of calf muscles.

By the third or fourth day pretibial œdema will be obvious, and the knee-jerks feeble or absent. In rare cases this condition may continue for months, constituting what is called the "rudimentary form."

More often the initial symptoms progress. The muscular weakness

becomes a paralysis. The skin is anæsthetic; muscular tenderness is extreme; the knee-jerks are lost; the tibial œdema increases and spreads.

At this stage the disease will progress on one of two lines.

(A) In the *atrophic form* (dry beri-beri), the paralysis becomes more marked, and may extend to trunk and arms, and occasionally even to face, tongue, pharynx, and larynx. The muscles of the affected limbs become atrophied. Progression is distinctive owing to the " drop foot "—paralysis of the extensors causing the toe to drop, and necessitating a high step and a flail-like slap on the ground in order to avoid scraping the toes. The disease advances until the patient is almost skin and bone. Beyond early palpitation, cardiac features are not prominent in this type of the disease, which usually ends in death from intercurrent disease, or else in months and years of slow convalescence resulting in permanent atrophy and paralysis.

(B) Instead of this atrophic form the disease may develop into an *œdematous type* (wet beri-beri). In such cases the early symptoms already mentioned develop less on the lines of a peripheral neuritis, and the œdema becomes a marked feature. It gradually spreads over the body, and the serous cavities are also inundated. The general anasarca may give the idea of advanced kidney disease, but examination of the urine will show an absence of albumin. The volume of urine is diminished, and an excess of oxalates are usually present. The paralysis is always noticeable, but is not so marked as in the dry form. Hyperæsthesia is a very prominent symptom. This horrible water-logged condition may persist for weeks. It is in this type of the disease that cardiac symptoms are most likely to occur. The dyspnœa becomes urgent. There is intense precordial pain. Auscultation shows the right ventricle much enlarged, and second pulmonary sound accentuated. The pulse is thready. The body gets cold, and the face cyanosed; and an agonising death (without loss of consciousness) will supervene.

Treatment.—Unless dying, the patient should at once be removed from the crew's quarters or cabin to a clean and airy place.

A good routine prescription is:

R.	Mag. sulph.	℥i.
	Ac. sulph. dil.	♏xx.
	Tinct. aurantii	℥i.
	Inf. calumb.	ad ℨi.
	M. Ft. mist.	
Sig.	ℨi. t. d. s.	

The symptoms may demand the exhibition of diuretics or cardiac stimulants.

The food should be light but nutritious, and will in itself form the rational treatment. White rice should be excluded from the diet, which should include plenty of vegetables, especially peas and beans. It is unlikely, on shipboard, that either under-milled rice or rice polishings will be procurable. These two substances have a markedly curative effect.

In fulminating cardiac cases, quick venesection may relieve the right heart.

Pathology.—The heart is usually enlarged, with a fatty myocardium. The blood, dark and fluid. The lungs are often œdematous. The kidneys and liver are often congested. The duodenum is often hyperdemic.

The most distinctive changes, however, are in the nervous system. The peripheral nerves show inflammatory degeneration, especially the muscular branches—the nerve trunks being more exempt. The myelin sheath breaks up into beads, and finally disappears, as do also the axis cylinders. Involvement of the vagus is found in the cardiac cases.

In chronic cases the perineurial and endoneurial nuclei are increased, and the nerve is finally replaced by connective-tissue.

The œdema is, of course, due to the implication of the vasomotor nerves.

The spinal cord is not primarily affected in beri-beri, though secondary changes may occur, such as degeneration of anterior horn cells, or of the posterior roots and columns. Occasionally complete sclerosis of the columns of Goll and Burdock have been observed.

We now come to the vexed question of the *Etiology* of the disease.

There have been an extraordinary number of hypotheses—the various fish theories of *Gelpke, Grimm,* and *Miura ; Ross's* idea of arsenical poisoning; *Takaki's* proposal of nitrogen starvation; *Laurent's* idea of fat starvation; *Manson's* place infection; *Trentlein's* suggestion of oxalate poisoning; *Grögner's* theory of a hæmamœbic origin; *Hose's* proposition of moulds in rice; *Pekelhäring* and *Winkler's* coccus; *Tsuzuki's* coccus; and *Hamilton Wright's* bacillus. These theories are now mostly of historical interest.

Wernick, in 1878, was, I think, the first person who came to a conclusion that beri-beri was due to a diet in which white rice bulked too largely. This conclusion was supported in 1880 by *Van Leent,* and in 1885-7 by *Takaki.*

In 1907 *Braddon,* as a result of observation and reading on these lines, published a work in which he stated: (1) that beri-beri attacks those who are rice eaters only; (2) that the incidence varies with the kind of rice eaten—those eating white rice being attacked, and those eating cured rice, exempt; and (3) that the disease was probably an intoxication due to a fungus growing on the decorticated rice. He thus

emphasised the results of *Takaki*, recorded twenty years previously, and in a masterly way brought them to the notice of the world.

Fraser and *Stanton*, in 1907-8, carried out a series of experiments with fowls, and with batches of P.W.D. coolies to test the truth of *Braddon's* hypothesis. They did not attempt to investigate *Braddon's* first postulate, which most people will admit is untenable; nor did they come to his conclusion (3); but in all their work on his postulate No. 2, their results were largely confirmatory. In one or two instances the experiments were inconclusive—as, for instance, on page 18 of Bulletin No. 10 of 1909, Dr. Fraser has to acknowledge that one of the experimental parties of P.W.D. coolies (fifty-first mile, Durian Tipus Road) was kept on white rice for 156 days with no beri-beri at all, and only developed the disease fourteen days after they were moved to the sixty-fourth mile.

There is no doubt that *Takaki* inadvertently stumbled on an important matter.

As a result of the campaign thus started, thousands of lives have probably been saved annually in the East; but, unfortunately, the tide of investigation has thereby been diverted into a backwater.

Braddon has put the word RICE like a great fog-bank across the horizon of the scientific world.

It may be granted that experiment has demonstrated a connection between white rice (*i.e.*, "polished" or "overmilled") and the peripheral neuritis which we know clinically as beri-beri. But this does not necessarily solve the etiology.

I am as convinced that the ingestion of polished rice is not the cause of beri-beri *per se* as I am that, in many instances, the eating of such rice will lead to an attack of the disease.

If, as is now held, the causative factor be a deficiency of some *vitamine** (or similar body) normally present in the peri-

* Investigated by Cooper, Funk, and Vedder.

Vitamine = Not an inorganic salt; not a proteid; not volatile; not an alkaloid; devoid of phosphorus; soluble in water; soluble in acid alcohol; dialysable; precipitated by phospho-tungstic acid.

Phosphorus, however, exists in the pericarp. A rice containing less than 0·4 per cent. of P_2O_5 will show that the pericarp has been polished off to a dangerous extent.

carp of a rice-grain, then how are the following facts explainable ?

1. The incidence rate of the disease, over wide areas of the East, shows a marked periodicity of curve; and, although the area is very large, the maxima tend to synchronise.

Is it conceivable that vast numbers of the rice-eating population will show a synchronous variation (four-yearly) in the amount of rice eaten over a large number of years ? The coincidence would be Brobdingnagian !

2. Bodies of men fed on a staple diet of white rice will for years be without beri-beri, which will then appear, reach a maximum, and then die down—all on the same diet. Examples can be found anywhere. The Singapore Gaol is an instance in question. Beri-beri died out in that institution in 1886 and was absent for twelve years, appearing again and increasing year by year to a maximum of over 400 cases in 1902.

There was just as much deficiency of vitamines in the dietary of all the years in question. Why does the deficiency produce no result for twelve years, and yet produce a result in the preceding and succeeding periods ? It is unthinkable.

3. Beri-beri will occur when no rice is included in the diet—e.g., *Lovelace's* report on Brazilian railway construction (1912).

This of course disposes at once of *Braddon* and *Fraser's* contention that white rice only is the cause of the disease. But it is not incompatible with the extension of their theory, which becomes possible since the isolation of vitamine. *Vedder* found that a diet replete with requisite alimentary principles may yet be deficient in the so-called beri-beri preventing vitamine.

4. Beri-beri will occasionally occur when an exclusive diet of parboiled rice is issued. For instance, such cases occurred in the Singapore Gaol in 1906. The Medical Officer at that institution, newly appointed in 1911, found and reported a series of mild cases of peripheral neuritis. The type produced on this diet is a modified one, but is characteristic except for the œdema. It is then apparently no longer called beri-beri.

These facts are generally passed over in silence by the white rice theorists.

5. Beri-beri (not "ship beri-beri"), when once introduced into a building or fo'c'sle amongst people on a staple white

rice diet, will frequently crop up at intervals, for a long time. As a rule, if the occupants are on parboiled or under-milled rice, the disease will tend to disappear spontaneously.

This is the point that led *Manson* to adopt his " place-germ " theory.

6. McCarrison has produced symptoms indistinguishable from polyneuritis gallinarum by organ cultures from pigeons suffering from that disease.* How then can we reconcile admissions of a rice connection with these apparently antagonistic statements of fact? The rice-theorists will *not* face them!

The situation seems to lead to the following conclusions:

I. *The cause of beri-beri must be bacterial.*

II. *The specific bacterium must largely be present in the air (chiefly in hot and moist air).*

III. *Decorticated or polished white rice must be a food of election for the specific organism.*

IV. *The pericarp of a rice grain must, as a rule, be prejudicial to the growth of the specific organism.*

I think, to an unprejudiced person, these four conclusions must be tentatively unanswerable.

What the germ may be will probably never be investigated while the vitamine-rice fog obscures the horizon.

Possibly *Kohlbrugge's* acid-forming rice bacillus, which quickly acidifies exposed rice in the damp heat of the tropics, will ultimately hold the field. If this idea is correct (and it seems the only possible one) it will in an astounding way harmonise all the existing theories of a white rice deficiency, of a rice toxin, of a dirty food, of a bacterial origin, of an intoxication, and of a place infection; and it will finally lay at rest the claims of those who hold that the mere removal of a few grains of pericarp from even the main article of a mixed diet, could cause such physiological default as would produce a grave disease in one staple rice eater and not in 499 others—a theory which, at many points, fails to explain the behaviour and spread of the disease.

In conclusion, I would ask that this theory be given a fair

* *Ind. Journ. Med. Research*, 1914, vol. ii., No. 1.

trial. Don't consider the unappetising parboiled, or untempting and expensive under-milled, rice.

Disinfect the room where your white rice is stored, the room where it is cooked, and the room where it is eaten. After cooking, keep the lid of the receptacle on until it is time to eat its contents. Then I think it will be found that the Oriental can eat his polished rice with impunity, exempt from that curse of the East—beri-beri.

CHAPTER VI

SHIP VERMIN: RATS, FLEAS, BUGS, AND COCK-ROACHES

"These also shall be unclean unto you among the creeping things that creep upon the earth; . . . the mouse" (*i.e.*, rat).

Lev. xi. 29.

RATS AND FLEAS

It is well recognised that rats are responsible for an enormous amount of material damage to cargo on ships, representing in value a very large sum of money.

But in the domain of disease the rat is still more formidable. He is the primary host of *Trichinella spiralis* (*Owen*) which is conveyed by him to the pig, and by the pig to man. He is also responsible, in veterinary practice, for the conveyance of a virulent form of equine influenza, and also "foot-and-mouth" disease.

But it is his connection with plague, combined with his predilection for sea-travel, that have proved him to be one of man's greatest enemies.

The first connection of the rat with the sea will probably have synchronised with the dawn of merchant shipping; and it is possible that the epidemic of plague in Rome in the second century B.C. may have been thus carried.

In the history of our own Navy and Mercantile Marine there is an extraordinary silence on the subject of rats, although we know from occasional remarks that they must have been a veritable plague in most ships.

One of these sidelights occurs in a rare little volume called "Nautical Economy," published in 1836 by Wm. Robinson of 9, Staining Lane, which gives an intimate account of a

seaman's life in H.M.S. *Revenge* during the period 1805-1811. The writer says: "After having been examined by the doctor and reported seaworthy, I was ordered down to the hold, where I remained all night (May 9, 1805) with my companions in wretchedness, and the rats running over us in numbers."

At the present day there is scarcely a ship that is free from rats; and it is undoubtedly by means of ship-borne rats that the present pandemic of plague has cast its net over the world.

In any ship a rat speedily makes itself at home, and makes free use of most parts of it. It is sometimes thought that the bulkheads keep rats to the one special hold in which they happen to be. This, however, is not the case. They wander freely in search of food: beneath floor-planking, behind side planking, through limber-holes and what not, their runs extend widely. If one family keep to one hold, it will be because other tribes or species of rats are on board, and the rat is very tribal—holding no intimate intercommunication. A flea census will often show this tribal aloofness: For instance, in the Sixth Report of Indian Plague Investigations, *Boycott* found that 94 per cent. of the fleas on rats in one locality were *C. fasciatus ;* while, on rats of similar species, only 100 yards away, 97 per cent. were *X. cheopis.*

The matter of a ship rat-census is one which has never been properly worked out.

The Indian Plague Commission I believe reported *Nesocia bengalensis* as furnishing 48 per cent. of Indian rats, and *Mus decumanus* as 37 per cent., *Mus rattus* presumably furnishing most of the remaining 15 per cent., but in what area I am uncertain.

On ships trading between Europe and the tropics many different species may be found, as:

Mus rattus.
Nesocia bengalensis.
Mus concolor.
Mus rattus (var. *alexandrinus*).
Mus decumanus (vel *norvegicus*).
Mus griseiventer.
Mus musculus.

What the percentages of any may be it is hard to say, but it seems certain that the majority of rats on the greater number of ships will be found to be *Mus rattus* or one of its tropical varieties. *Nesocia bengalensis* is probably pretty common; and *Mus decumanus* is occasionally found to predominate on a ship. The latter rat is not indigenous in India, but was obviously introduced by ships, for it is now found in all the chief Eastern ports, and up the banks of navigable rivers. From the point of view of ship-borne plague, I am inclined to think that *M. decumanus* may be the most dangerous of the rat travellers. (*Vide* later remarks on "Rats as a Plague Factor.") The little *Mus concolor*—an aberrant member of the rattus group—is sometimes found on ships trading with Rangoon. *Mus musculus*—the common mouse—I have now and then found on a ship; but "the rat is his fiercest enemy" (*Rucker*), and if there are many rats about he lies very low.

The following brief notes on these species I have mentioned may perhaps be of use, as well as the table, which may be a help towards an interim diagnosis.

Mus rattus (Linn.). The common Indian or black rat.

Synonyms: *M. alexandrinus ; M. indicus.*

This rat is of world-wide distribution, and at one time was the common rat of Europe until displaced by *M. decumanus*.

There are several varieties of the species. In Europe the rat is usually much blacker than its Eastern relations. In India there are three chief varieties: *M. rattus* (var. *alexandrinus*), a rather large variety, with a rather cold dorsal tint, and occasionally a whitish under-surface to the tail; *M. rattus* (var. *nitidus*), in which the fur is finer, and the tail about the same length as the head and body, and the soles of the feet often white; *M. rattus* (var. *rufescens*), a slender form, with spinous hair and a rufous tint dorsally. This is a variety frequently found in India, Ceylon, Burma, and the Malay Peninsula.

Measurements.—Head and body, 8 to $8\frac{1}{2}$ inches; tail, $6\frac{3}{4}$ to $7\frac{1}{4}$ inches; hind foot, $1\frac{1}{4}$ to $1\frac{1}{2}$ inches.

Colouring.—Dorsally a warmish grey, interspersed with blackish hairs. On casual inspection it somewhat resembles *M. decumanus*, but the belly is white and distinctly demarcated from the dorsum. The tail is uniform in colour. The feet are generally white; the incisors orange.

This rat is found on the outside ground, in houses, roofs, and in trees. It is a rather domesticated species, often living in the closest proximity to man. It is less carnivorous than *M. decumanus*. A litter of 7 to 9 in number is born several times a year. There are 10 to 12 mammæ. At birth, the young are pink, naked, with eyes and ears closed, and measure 5 cm., the tail being only 2 cm.

It is typically a climbing rat. It hides rather than burrows. In Java it frequently nests in the hollow bamboos of which beds, etc., are made. It is capable of jumping upwards at least 2 feet. On one occasion a *Mus rattus* confined within a smooth galvanised garbage tin, 24 inches deep, " by a series of jumps spiralled its way to the top of the can and escaped."

It has but a feeble sense of direction, for an *M. rattus* and an *M. rattus* (var. *alexandrinus*), when released at sea 1,500 feet from the shore, failed to reach it (*Creel*), although they kept afloat for forty-five and fifty-five minutes respectively.

Nesocia bengalensis (Blandf.). The Indian mole rat.

Synonyms: *Arvicola bengalensis* (Gray); *Mus providens* (Elliot); *Mus indicus* (Blyth); *Gunomys varius* (Thos); *Mus kok* (Gray).

Measurements.—Head and body, 6 to 9 inches; tail, 5·5 to 7·5 inches; ear, 0·75 inch; hind foot, 1·2 to 1·45 inches; zygomatic breadth, 1·1 inches.

Colouring.—Dark brown above, grizzled with yellow; greyish white below; feet flesh-coloured. Tail uniform dark brown, more slender than *M. decumanus*.

Mammæ 18. This rat is distributed throughout India, Assam, Burma, and Ceylon.

It has been reported from Penang, and probably occurs through the Malay Peninsula.

In Calcutta it constitutes only 37 per cent. of the rats found

in the European quarter, but at least 60 per cent. of the grain area rats.

The Indian Plague Commission considered it to contribute 21 per cent. to the total Burmese rat population, and 48 per cent. of all the Indian rats.

It is, therefore, a very common rat, and is probably the one most concerned in the spread of plague in Calcutta and India generally.

It has been much confused with *M. decumanus*, but the uniform colour of the tail, the smaller size of the hind foot, the light purplish coloured feet, with their small round foot-pads, the coarse and thin bristly fur, as well as the usual generic characteristics of *Nesocia*, should all point quickly to this bandicoot.

It grunts and erects its fur when irritated. It takes freely to water and swims well. It is a field and house burrower.

Mus concolor (Blyth). The little Burmese rat.

This is a very small rat, not much bigger than a mouse.

Measurements.—Head and body, $4\frac{1}{4}$ to $4\frac{1}{2}$ inches; tail, $4\frac{1}{4}$ to $4\frac{1}{2}$ inches; hind foot, $\frac{7}{8}$ inch.

Colouring.—The dorsum is a buffish brown, with a rufous tinge in some specimens. The fur merges gradually into a greyish-white venter. The tail is transversely banded with alternate light and dark stripes.

It is a diminutive form of *M. rattus*, with a rather spiny coat.

It is not mentioned much from India, but constitutes 50 per cent. of total Rangoon rats, and 75 per cent. of house rats in that place. It is common both in town and in country in Malaya, but not to the above extent.

Mus decumanus (Pallus). The brown or Norwegian rat.

Dimensions.—Head and body, 7 to 10 inches; tail, 6·25 to 7 inches; ear (from orifice), 0·77 inch; hind foot, 1·75 inches.

Colour.—Dorsally greyish brown, with darker hairs interspersed, merging ventrally insensibly into a yellowish white, through which grey hairs are seen throughout. The tail is dark on the dorsum and light underneath.

It is a heavy-bodied rat, with small eyes, and is often confused with *Nesocia bengalensis*. The latter, however, has

round foot-pads, while *M. decumanus* has cordiform median pads, like *M. rattus*.

The mammæ are 10 to 12. The gestation period is twenty days. There are four or five litters annually, and at each 4 to 10 blind and naked young are produced. These are able to breed at six months of age.

In a Calcutta rat census, it was found to constitute 51 per cent. of all rats in the European quarter, but only 26 per cent. of the rats in the grain areas.

The Indian Plague Commission reported it as forming 37 per cent. of the total Indian rats, but only 7 per cent. of the total Burmese rats.

When caged, it takes things philosophically.

Its flea population is nearly twice that of *M. rattus*.

It probably originated in Mongolia, but has now a world-wide distribution.

It is less a friend of man than is the black rat, being typically a burrowing animal, with remarkable powers for gnawing through hard material, such as brick, etc., and preferring sewers, drains, farmyards, and so forth, to the human propinquity of a house. *Kloss* states that it is the commonest of sea-going rats; but that does not seem to be the experience of most observers.

It is capable of jumping 17 inches upwards or outwards.

It has considerable power of direction, for *Creel* found that an individual released 1,300 feet from land swam a total of 1,500 feet, and reached shore in fifty-five minutes. Another individual swam a distance of 450 feet in only six minutes.

Mus griseiventer (Bonhote). The Malay house or roof rat.

This is the commonest house rat in the southern part of the Malay Peninsula.

It is an aberrant member of the *rattus* group.

Measurements.—Head and body, $5\frac{1}{2}$ to $7\frac{1}{2}$ inches; tail, usually $6\frac{1}{2}$ inches; hind foot, $1\frac{3}{8}$ inches.

Colouring.—It has a warmish speckled appearance, often not unlike *rattus*. Ventrally it merges into a uniform grey. The tail is uniform in colour throughout. The feet are brownish.

Synopsis of Species of Genera *Mus* and *Nesocia*.

Six pads on planta;
ears not covered with long hair;
third upper molar smaller than second
= **Rats and Mice.**

- Head and body, 4 to 15 in.; proximate plantar pad elongate and double length of next pad = **Rats.**
  - Tail light on under surface.
    - Tail shorter than head and body.
    - Tail much longer than head and body. Red brown, with white stomach = **M. vociferans.**
  - Tail of uniform colour.
    - Tail longer than head and body. Hair coarse and wiry. Belly yellowish-white. Head and body, 9 to 10½ in. Tail, 10⅝ to 10¾ in. Hind foot, 2 to 2¼ in. = **M. validus.** (Cf. *N. bandicota*.)
    - Tail generally shorter than head and body.
  - Tail banded in stripes, and same length as head and body = **M. concolor.**
- Head and body less than 4 in.; proximate plantar pad rounded, and not double length of next = **Mice.**
  - Tail not shorter than head and body; hind foot less than 0·7 in. = **M. musculus.**
  - Tail shorter than head and body; hind foot more than 0·7 in. = **M. buduga.**

Dorsum greyish; merges insensibly into yellow-white. Abdomen speckled with grey. Snout and feet flesh-coloured
= **M. decumanus.**

Bright red brown. Abdomen pure white; tip of tail all white
= **M. surifer.**

Skull elongate, slender. Anterior surface upper incisors smooth. Tr. laminæ of worn molars curved.

Dorsum greyish, with black markings. Abdomen whitish. Head and body, 8 to 8½ in. Tail, 6¾ to 7¼ in. Hind foot, 1¼ to 1½ in.
= **M. rattus.**

More warmly speckled. Abdomen uniformly grey. Head and body, 6½ to 7½ in. Tail, 6½ in. Hind feet, 1⅜ in.
= **M. griseiventer.**

Dark rufous. Abdomen yellowish-white. Head and body, 6 to 8 in. Tail, 5¾ to 6 in. Hind foot, 1¼ in.
= **M. neglectus.**

Skull broad and robust. Anterior surface upper incisors faintly grooved. Tr. laminæ of worn molars nearly or quite straight.

Fur coarse and bristly. Feet black or dark brown.

Head and body, 12 to 15 in. Ears, 1⅛ in. Tail, 11 to 13 in. Hind foot, 2 to 2½ in.
= **N. bandicota.**
(Cf. *M. validus*.)

Head and body, 9 in. Tail, 7·8 in. Hind foot, 1·9 in. Ears, 0·9 in.
= **N. nemorivaga.**

Fur coarse grey. Feet light purple coloured. Abdomen dirty grey white. Snout colour of feet. Head and body, 6 to 9 in. Tail, 5·5 to 7·25 in. Ear, 0·75 in. Hind foot, 1·2 to 1·45 in.
= **N. bengolensis.**
Cf. *M. decumanus*.)

Mus musculus (Linn.). The common mouse.

Measurements.—Head and body, 2·5 to 3 inches; tail, 2·5 to 3·5 inches; hind foot, 0·6 to 0·7 inch.

Colouring.—Dark to light brown, paler on belly, but never white. Tail uniform colouring.

The distribution is world-wide. It can spring and climb well. It is omnivorous, but prefers grain and human food. Mammæ, 10.

Three to five litters per annum of 4 to 8 each.

Rat-fleas.

The following interesting list of fleas found on rats was given by *Shipley* in the *Journal of Economic Biology*, 1908, vol. iii., pt. 3:

1. **Ceratophyllus fasciatus**, Bosc.

This is the flea most commonly found on *Mus rattus* and on *M. decumanus* in Great Britain, and indeed throughout Central and Northern Europe. It also occurs on the house mouse, *M. musculus*. Rats from Cape Town also harbour this species, and it is occasionally found on rats from India.

2. **Ceratophyllus londiniensis,** Rothschild.

Synonym: *Ceratophyllus italicus*, Tiraboschi.

Very common on both species of rats and allied forms. Apparently this species does not bite man.

3. **Ceratophyllus consimillis,** Wagner.
4. **Ceratophyllus lagomys,** Wagner.
5. **Ceratophyllus mustelæ,** Wagner.
6. **Ceratophyllus penicilliger,** Grube.

Numbers 3, 4, 5, and 6 are all very common fleas on *Mus decumanus*, though Tiraboschi has not found them in Italy. Systematically they are allied to *Ceratophyllus fasciatus*, Bosc.

Ceratophyllus silantieri is the common flea of the tarbagan.

7. **Ctenocephalus canis,** Curtis.

Occurs chiefly on the dog, but has been found on many carnivores, on hares and rabbits, monkeys and man, and the rat. In Italy some 25 to 30 per cent. of rat-fleas belong to this species. The members of it are unusually agile, and are great jumpers.

Probably concerned in the spread of a dog cestode (*Dipylidium caninum*); and of the dog filaria (*F. immitis*).

8. **Ctenocephalus felis,** Bouche.

Found on cats and also on rats. Like the preceding species, it is found widely distributed in the Old World.

Mr. Rothschild tells me there is no doubt that these two species are distinct.

9. **Ctenopsylla musculi,** Duges.

Is the commonest flea found on the domestic mouse in our country, and it sometimes makes its way to the rat. It has been taken from *M. rattus* in Pretoria, and in Italy is the commonest flea on that species. It seems to be cosmopolitan in its distribution.

10. **Dermatophilus cæcata,** Enderlein.

The genus *Dermatophilus* (Guerin), Rothschild, with the genera *Echidnophaga* and *Hectopsylla,* comprise the family Sarcopsyllidæ, which includes the Jiggers or Chigos, whose females burrow in the skin. *D. cæcata* is recorded from *Mus rattus* taken in San Paulo in Brazil.

11. **Echidnophaga rhynchopsylla** Tiraboschi.

Synonym: *Echidnophaga murina,* Rothschild.

This flea, which Dr. Tiraboschi found on *Mus rattus* in Italy, usually upon the head and snout, is interesting because it, with *E. gallinacea,* are the only two species of the family Sarcopsyllidæ so far recorded in Europe. It is nearly allied with *E. gallinacea.* The females all had their heads solidly embedded in the skin of the host.

12. **Echidnophaga gallinacea,** Westwood.

Synonyms: *Echidnophaga gallinacea,* Tiraboschi; *Argopsylla gallinacea,* Baker; *Echidnophaga gallinacea,* Rothschild.

Tiraboschi has taken this, which he considers a species distinct from *E. rhynchopsylla,* from *Mus rattus* in Italy.

13. **Neopsylla bidentatiformis,** Wagner.

Taken on *Mus decumanus* in the Crimea, and on *Spermophilus* sp. in Siberia and the Caucasus.

14. **Xenopsylla cheopis,** Rothschild, 1903.

Synonyms: *Pulex murinus,* Tiraboschi; *Pulex pallidus,* Tidswell; *Pulex philippinensis,* Herzog; *Pulex brasiliensis,* Baker; *Læmopsylla cheopis* (Rothschild).

This flea was described by Rothschild from specimens taken from numerous small rodents in Egypt. Tiraboschi found it common in Italy, and on 40 per cent. of the ship rats in Genoa. It occurs on from 80 per cent. to 90 per cent. of the rat population of Sydney and Brisbane, where it was described by Tidswell under the name of *Pulex pallidus,* and on 25 per cent. of the rats in Marseilles, where Gauthier Raybaud records that the numbers decrease as the distance from the water-front increases. Herzog took 42 fleas of this species from 153 rats of both species in Manila, and it also occurs commonly in South America. It has been found at Plymouth and at Pretoria. It is by far the commonest of the rat fleas of warmer countries, and the Plague Commission consider that it forms 99 per cent. of the fleas found on *Mus rattus* and *M. decumanus* in India.

This species readily passes on to monkeys, guinea-pigs, and man, and we have seen it live on many wild rodents. It is now recognised as the chief means by which the plague is conveyed from rats to man.

15. **Pulex irritans,** Linn.

This, the common human flea, has been found biting both *Mus rattus* and *M. decumanus,* as well as many other animals which come in contact with man.

With a view to **flea diagnosis** the following condensed synopsis of classification may be of use:

ORDER: *Siphonaptera* (Latreille).

FAMILIES:

I. *Sarcopsyllidæ* (Taschenberg, 1880). Thoracic segments together *shorter* than first abdominal segment. Labial palpi with two or three segments.

Synopsis of Sarcopsyllidæ.

1. Head divided by groove from antennal groove upwards.

(*a*) Rostrum with two segments. Genus: *Echidnophaga.* (Common in fowls and birds.)

2. Head no groove.

(*a*) Rostrum with two segments. Genus: *Dermatophilus*. (This is the jigger, or burrowing flea, of West Africa and West Indies.)

(*b*) Rostrum with three segments. Genus: *Hectopsylla*.

II. *Cetatopsyllidæ* (Baker, 1905). Thoracic segments together *equal* to first abdominal segment. Labial palpi with four or five segments.

(NOTE.—This family is confined to bats.)

III. *Pulicidæ* (Taschenberg, 1880). Thoracic segments together *longer* than first abdominal segment. Labial palpi with five or more segments.

Classification of the more important Genera of Pulicidæ.

TABLE A.

GENAL AND PRONOTAL COMBS PRESENT.

1. Anterior portion of head forming a kind of helmet which bears a vertical comb of many teeth. This comb quite separate from the genal comb. Genus: *Stephanocircus*.
   No helmet; only one comb on head - - - - 2
2. Eye well developed - - - - - - 3
   Eye vestigial - - - - - - - 4
3. Genal comb horizontal; club of antennæ short, distinctly segmented only on one side; proboscis consisting of four segments. Genus: *Ctenocephalus*.
   Genal comb subvertical, consisting of four or five spines; club of antenna elongate, segmented all round; proboscis of five segments. Genus: *Typhloceras*.
4. Abdomen with conspicuous combs - - - - 5
   Abdomen without conspicuous combs - - - - 6
5. Proboscis of many segments. Genus: *Macropsylla*.
   Proboscis of five segments. Genus: *Hystrichopsylla*.
6. Tibial bristles close-set, forming a comb. Genus: *Leptopsylla*.
   Tibial bristles not close-set - - - - - 7
7. Two genal spines, which cross one another almost **X** shape. Genus: *Chiastopsylla*.
   Genal spines not crossing one another - - - - 8
8. Fifth segment of hind tarsus, with a central pair of bristles in between the first lateral pair. Genus: *Ctenophtalmus*.
   Fifth segment of hind tarsus, with lateral bristles only. Genus: *Neopsylla*.

TABLE B.

GENAL COMB ABSENT, OR HEAD ANTERIORLY, WITH TWO FLAPS; PRONOTAL COMB PRESENT OR ABSENT.

1. Head anteriorly, with two flaps on each side before the mouth-parts Genus: *Ischnopsyllus*.
   Head without these flaps - - - - - 2
2. Genal margin, with a large recurved tooth-like process. Genus: *Lycopsylla*.
   Genal margin, without this process - - - - 3
3. Pronotal comb absent, or consisting of a small number of widely separated obtuse teeth - - - - - 4
   Pronotal comb, consisting of close-set teeth - - - 5

4. Antepygidial bristles absent. Genus: *Vermipsylla.*
   Antepygidial bristles present. Genus: *Malacopsylla.*
5. Hindcoxa, with a comb of teeth on the inside. Genus: *Hoplopsylla.*
   Hindcoxa, without comb on inner surface - - - 6
6. Antepygidial bristles absent. Genus: *Uropsylla.*
   Antepygidial bristles present - - - - - 7
7. Frons with a large tubercle in a groove. Genus: *Listropsylla.*
   Frontal tubercle small or absent - - - - - 8
8. Pygidium strongly convex; frons without tubercle. Genus: *Pygiopsylla.*
   Pygidium not convex; frons with small tubercle. Genus: *Ceratophyllus.*

TABLE C.

GENAL AND PRONOTAL COMBS BOTH ABSENT.

1. Club of antenna segmented all round - - - - 2
   Club of antenna distinctly segmented on one side only - - 4
2. Club of antenna asymmetrical, its first segment lanceolate. Genus: *Rhopalopsyllus.*
   Club of antenna symmetrical - - - - - 3
3. Genal process, with bristles below the eye. Genus: *Parapsyllus.*
   Genal process, without bristles below eye. Genus: *Coptopsylla.*
4. Frons with tubercle. Genus: *Moeopsylla.*
   Frons without tubercle - - - - - - 5
5. Pronotum longer than metanotum; genal edge produced into a triangular tooth. Genus: *Pariodontis.*
   Pronotum not longer than metanotum; mesopleura with internal vertical rod. Genus: *Xenopsylla.*
   Pronotum not longer than metanotum; mesopleura short, without internal vertical rod. Genus: *Pulex.*

Rats as a Plague Factor.

Most rats seem to be about equally susceptible to plague. The rise of the epizoötic in rats seems to depend on a temperature of 50° to 85° F., a sufficient number of susceptible rats, and a relatively high flea-rate.

The decline of the epizoötic, conversely, depends on a mean temperature of 85° F. or over, an increase in the number of immune rats, and a fall in the flea-rate.

In Bombay it was found that sporadic plague continued amongst *M. decumanus* during the off season. Late in the cool season an exacerbation occurred as an epizoötic amongst *decumanus*. After a mean interval of about ten days the disease spread to *rattus*, and an epizoötic started amongst the latter. This was followed in a few days by the first human cases.

This seems to be the very common sequence of events.

Some of the interesting conclusions of the Indian Plague Commission, 1908, may be here given:

(i.) Contagion occurs in less than 3 per cent. of the cases.

(ii.) Bubonic plague in man is entirely dependent on disease in the rat.

(iii.) Infection is conveyed from rat to rat and from rat to man only by a rat-flea.

(NOTE.—In naturally infected plague rats, no mesenteric bubo was seen in 5,000 post mortems—showing that infection is not carried by eating of their dead comrades.)

(iv.) A case (bubonic) in man is not by itself infectious.

(v.) A large majority of cases occur singly in houses; when more than one case occurs in a house, the attacks are nearly simultaneous.

(vi.) *Plague is usually conveyed by imported rat-fleas, on persons or in baggage ;* the human agent may escape infection.

(vii.) Insanitary conditions have no influence, except as favouring rat-infestation.

(viii.) The non-epidemic season is bridged over by acute plague in rats, with a few cases in man.

Thus the tangled epidemiological skein is gradually being opened up. But old ideas die hard, and there are many who still fail to realise that a case of bubonic plague, *per se*, is of very little danger to a community unless accompanied by infected fleas in clothing or baggage, which can then infect the rat population.

For a long time the actual method of transference of the bacillus by the flea was unknown. The feces of the flea were found to be infected, and it was thought that the bacilli might in some way obtain access to the human or rat skin in that way. Bacilli were never found in the flea's salivary glands, so that infection could hardly take place by the act of biting.

At last, however, light has been thrown in these dark places.

Bacot and *Martin*, in a most interesting paper (*Journal of Hygiene*, 1914, 401), show that two species of rat fleas can transmit plague in the act of sucking blood under conditions precluding the possibility of infection by dejecta. "In a

certain proportion of infected fleas the bacilli multiply to such an extent as to occlude the alimentary canal at the entrance to the stomach, and extend into the œsophagus. When such a flea attempts to suck blood it distends the infected œsophagus and some of the contents is forced back into the wound. In this condition fleas cannot stand drying up in a hot atmosphere, which may explain the limitation of epidemic plague In India."

Recent experiments have been made by *Strickland* (Med. Rept. Local Government Board, 1912-13, Appendix B, No. 5) on the bionomics of the rat-flea—*Ceratophyllus fasciatus*. The following is a brief summary of his conclusions:

(i.) The duration of the various developmental stages is very variable even under the same conditions.

(ii.) Temperature and humidity are the two conditions which have most influence on the duration of the various stages. On an average, the egg hatches out in 5 to 14 days, an increase of humidity having a retarding, and a moderately high temperature a slight accelerating, effect.

The larva is soon killed by a high temperature (70° F.), combined with a low degree of humidity (40 per cent.). However, under these conditions, the larvæ will live longer if rubbish is present, for they are then able to bury themselves in it, and thus obtain a certain amount of moisture.

The pupal stage is much prolonged by cold, but this is partly due to the non-emergence of the imago even when it is fully formed.

The imago, at least when unfed, dies off much more rapidly in summer than in winter.

Eggs are laid by the imago even at comparatively low temperatures (50° F.).

(iii.) The larvæ and imagines like to bury themselves in rubbish, and under these circumstances their duration of life is much prolonged, even when other external conditions are somewhat severe.

(iv.) When copulating, the imago frequently lives at least two months, but it will not copulate unless it is fed on rat's blood. It feeds readily on man and many other animals, but

will not copulate after feeding on these facultative hosts, even though at least one of them—man—seems to be more attractive to it than its normal host, the rat.

Oviposition invariably takes place within twenty-four hours of copulation, even when the insect has been fed only once after being starved for a period of many weeks.

The rat's blood, therefore, probably contains some substance that possesses a stimulating effect on the flea's sexual organs.

When starved the imago will live for a very long time—at least seventeen months—but only in the presence of rubbish, in which it can bury itself.

In the absence of rubbish the flea will only live for about a month, even under the most favourable conditions of temperature and humidity.

(v.) From the foregoing observations it is clear that the presence of rubbish containing organic matter is essential for the development of the flea.

Control of Ship Rats.

There are three things which have to be taken into consideration in this connection:

(*a*) Extirpation of the rats on board.
(*b*) Prevention of their escape to shore.
(*c*) Exclusion of alien rats from the shore, from lighters, or from other ships.

(*a*) **Rat Destruction.**—This can be secured in several different ways:

(i.) By the use of poison.
(ii.) By trapping.
(iii.) By the use of virus.
(iv.) By fumigation.

The best agent for poisoning rats is *phosphorus* incorporated in a paste of glucose and starch (*Rucker*). The glucose reduces the liability to the spontaneous combustion of the mixture. It should be spread on small pieces of bread, covering all sides, care being taken that it is not placed where it may be eaten by domestic animals or children.

Another useful poison is *arsenic*, in a menstruum of lard.

By either of these means, large numbers of rats can be killed with a minimum of offence from the products of decomposition.

Other poisons, such as *strychnine, barium peroxide,* etc., are less valuable, as the rat corpses become highly mephitic, and are often hard to get at for removal.

Trapping is often useful. It should be started the first night that the ship is in port, and the traps should be widely distributed in likely places. The best *bait* is some fresh mutton, or some dried fish.

Unless care is taken it will be found that no rats are caught after the first two or three nights. The reason for that is the rat's keen sense of smell, which detects the former visit of his friend and scares him away. If you wish to avoid this, and catch them more regularly, you should change the location of the traps each night; and you should never omit to *boil the traps daily* and dry in the sun (if possible). Failing that, or even the better plan, is to use new traps each night. If spring traps are used, the expense would not be great.

The use of virus has been largely advocated. *Danysz's* strain is probably the best. It is a culture of an intestinal organism highly pathogenic to rats but harmless for ordinary domestic animals. It is claimed that there is no offensive smell from the bodies of rats so killed. This is, as a rule, true, though by no means invariably so; I remember the first rat I so killed was very offensive indeed.

The method of use is to incorporate the culture with some boiled potato and breadcrumbs as a bait. Large quantities should be put down, at widely separated locations, each night for a week. Unless this is done, immunity is quickly established, and the system fails. It is essential that a strain of high virulence should be used, otherwise the death-rate will only be from 20 to 30 per cent. instead of from 40 to 50 per cent.

Melville-Davison, who has for some years carried out a series of careful experiments in the ships of the Booth S.S. Co.'s fleet, is of the opinion that the virus treatment (if persistently and intelligently used) is of considerable value. He claims that, either by death or by apprehensive migration, a

ship can be thus ridden of about 60 per cent. of her rat population.

Lastly, we have to consider the extermination of rats by *fumigation*. The "methods" of fumigation will be found in the chapter on "Disinfection."

I am of the opinion that, even with cargo *in situ*, it is feasible under careful but quite ordinary conditions to kill at least 70 per cent. of a ship's rat population by the agency of a proper Clayton or similar machine. With empty holds, another 10 per cent. should be accounted for. The remaining residual population (say 20 per cent.) are a different matter. To get rid of them will need lengthy, detailed, and exhaustive treatment of every nook and corner of a ship, which seems to me scarcely justified except under very exceptional circumstances of *known infection*. Otherwise, even if you do get rid of all the rats in a ship, she is sure to collect more on her next voyage. If you can keep down the rat population to 20 per cent. of its average by periodical fumigation, this residuum will tend to make itself as scarce as possible, and danger is but little to be feared therefrom.

Various opinions have been expressed by different authorities as to the necessity for or advisability of rat-fumigation. For instance, *Giemsa* considers that it is absolutely necessary for all ships which have anchored at plague-infected ports, or which have got cargo from plague-infected ports, to have the whole of their rat population destroyed by some sure means in order to prevent the infection of rats in a new port.

On the other hand, *Haffkine* considers that the destruction of rats on ships, if imposed as a general measure, would cause a dislocation of traffic and an outcry formidable to face; but he points out that, as a result of inaction, plague is every day imported by ships into one or other of the world's maritime countries, though, fortunately, it need not necessarily spread ashore.

Personally, I should consider it perfectly safe to strike a mean between these opinions. I don't think ship-borne plague would be likely to get into a port (other than by human beings, who do not so much matter) if fumigation were always carried out under the following circumstances:

(i.) Routine fumigation *every five months* of all ships which have called at any port at which a case of plague is known to have occurred within the previous year.

NOTE.—Five months is chosen as being just short of the age when a young rat begins to reproduce. One year is chosen because plague has an annual periodicity, being probably carried over the waiting period by *M. decumanus*.

(ii.) Special fumigation of every ship on which dead rats have been found during the current voyage.

(iii.) Special fumigation of every ship on which a case of human plague has occurred, provided that the case did not manifest itself until more than five clear days had elapsed after leaving a port.

To carry out these fumigations would cause no dislocation of traffic, nor outcry on the part of shipping firms.

(*b*) and (*c*) **Prevention of Escape or Access of Rats from or to Ships.**—The control of the rat population of ships as a factor in checking the spread of plague is more important than the control of the human ship population. We know as yet so little about the preponderance of the species amongst ship rats, the special kinds of cargo that they favour, the frequency with which they may be mechanically discharged with this or that kind of cargo, that it is very hard to get the subject in proper perspective.

An example in question is the introduction of plague, a few years ago, into the Java port of Sourabaia and its hinterland, Malang, where it has since become endemic. The Dutch authorities (I believe) consider the origin to have been infected rats introduced with rice cargoes from Saigon.

The subject would seem to divide itself into two heads:

(*a*) Rats mechanically introduced or discharged with cargo.

(*b*) Voluntary embarkation or disembarkation of rats by gangways or hawsers, etc.

The former matter can only be dealt with by methods of fumigation, and is, I think, too often overlooked; while action is chiefly taken on the second heading.

As an example of modern practice I give two sets of rat

regulations. The first are those in force in the Port of London. It will be noticed, in these, that no precautions are taken with regard to rats in cargo.

PORT OF LONDON SANITARY AUTHORITY.

The Local Government Board have issued Regulations for the prevention of the introduction of Plague, Yellow Fever, and Cholera into this country, and whereas by such Regulations it is provided, *inter alia*, as follows:

Regulation 24 (2).

"The master of a ship which by reason of plague is an infected ship, or a suspected ship, or which has come from, or has, during the voyage, called at a port infected with plague, or in which there are rats infected with plague, or in which there is or has been during the voyage an unusual mortality among rats, shall, under the direction and to the satisfaction of the Medical Officer of Health, take all such precautions or employ all such means for effectually stopping the access of rats from the ship to the shore as in the opinion of the Medical Officer of Health are measures reasonably necessary for the prevention of danger arising to public health from the ship;"

This is to give notice that, in my opinion, given under the Regulation aforesaid, the following precautions are reasonably necessary for stopping the access of rats from the ship to the shore:

1. All ropes and mooring tackle for securing the vessel either to the shore or mooring buoys, shall be fitted with metal brushes, funnels, or other effective guards, the portions of such ropes and mooring tackle leading from the vessel to a distance from the vessel's side of at least four feet shall be coated each night with fresh tar. Ropes may, if desired, be protected by a covering of canvas or yarns before tarring.

2. When not engaged in discharging cargo, one gangway only shall be permitted to afford means of communication between the ship and the shore.

3. The end of the gangway near the ship shall be whitened for a length of 10 feet, and the watchman shall keep the gangway pulled in-board after sunset, or it shall be guarded in some approved manner.

4. When alongside the quay, the ports on the side of the vessel nearest the quay shall be kept closed after sunset.

5. All empty cases and barrels, especially those from the store-rooms, shall be examined before being landed, to ensure that no rats are contained therein.

6. It is recommended that all possible means be adopted for catching and destroying rats, both on the voyage and during the stay of the vessel in port. Any rats so caught shall be killed, then placed in a bucket of strong disinfecting solution, and afterwards burnt in the ship's furnace.

7. No rats, alive or dead, are to be removed from the ship without my permission in writing.

"If any person wilfully neglects or refuses to obey or carry out, or obstructs the execution of this Regulation, he shall be liable to a penalty not exceeding One Hundred Pounds, and in the case of a continuing offence, to a further penalty not exceeding Fifty Pounds for every day during which the offence continues."

The second set of regulations I quote are those of the Australian Commonwealth. It will be here seen that ultimate issues loom more largely on the practical horizon than do the commercial interests of the moment. Fumigation is comprehensively provided for.

In matters of minor detail, also, they are comparatively satisfactory—*e.g.*, the brilliant illumination of the vessel's side and of the wharf, which is a most effectual check on the migration of rats; the closing of portholes by wire screens instead of closing them entirely; etc., etc.

COMMONWEALTH OF AUSTRALIA.

Quarantine Act, 1908.

REGULATIONS FOR THE PREVENTION OF THE INGRESS TO AND EGRESS FROM VESSELS OF RATS AND MICE, AND FOR THE DESTRUCTION OF RATS AND MICE AND OTHER VERMIN ON VESSELS.

138. The master* or owner of any vessel in any port in Australia shall—

(1) effectively obstruct by means of stout wire-netting or other means all openings or holes in the side of the vessel next to any wharf, and, when cargo is being discharged into lighters, also in the side next to the lighters, and shall keep them so obstructed while the vessel is alongside such wharf or lighter;

(2) affix an effective rat disc or screen not less than 1 foot or more than 3 feet from the side of the vessel to every rope or hawser connecting the vessel with any wharf or lighter;

(3) when so ordered by a Quarantine Officer, thoroughly illuminate from sunset to sunrise with electric or other brilliant lights the whole of the side of the vessel next to the wharf, and remove the landing stages and all unnecessary nets and gangways between the vessel and any wharf for the whole of the same period unless cargo is being discharged; and

(4) take any other necessary and practicable measures to prevent the migration of rats to and from the vessel.

139. The master or owner of any vessel in any port in Australia shall—

(1) thoroughly empty or flush out and empty the bilges prior to berthing the vessel;

(2) keep all food stuffs and food refuse in rat-proof and mouse-proof receptacles;

* Master in relation to a vessel means the person (other than the pilot) in charge or command of the vessel.

(3) prevent the discharge of any organic refuse, galley scraps, and waste from the vessel on to the wharves or into the waters of the port;

(4) maintain on board and use effective means for the destruction of rats and mice; and

(5) when so ordered by a Quarantine Officer lay on the vessel poison baits effective for rats and mice.

140. The Master or owner of any vessel in any port in Australia shall, if so ordered by a Quarantine Officer—

(1) submit any part or the whole of the vessel to sulphur fumigation as prescribed, or to some other approved method of fumigation. If so directed by the Quarantine Officer, the fumigation shall be carried out while the vessel is alongside a wharf or while the vessel is in stream, and either before or after the cargo has been discharged;

(2) wash or spray thoroughly with the prescribed insecticidal solution all portions of the vessel likely to harbour or to afford a shelter for fleas, lice, bugs, and other vermin;

(3) empty and flush or disinfect and clean all lavatories, water tanks, or any closed space on board the vessel:

Provided that in any case where there is reasonable cause to apprehend that the vessel may be endangered by the removal of water ballast, the Quarantine Officer may cause any tank or other receptacle to be sealed; and thenceforward, so long as the vessel remains within the port, the Master shall prevent the breaking or removal of the seal or the discharge or removal from the tank or receptacle of any part of the water ballast, except with the written permission of the Quarantine Officer;

(4) cause to be disinfected or fumigated any articles specified by the Quarantine Officer.

140 (A). The Master or owner of any vessel on arrival at any port in Australia from a place proclaimed infected with plague, or as a place from or through which plague may be carried, shall—

(1) submit the vessel to fumigation and treatment as prescribed for the destruction of rats, mice, and other vermin:

Provided that the vessel may be exempted from fumigation if the Master produce—

(*a*) a certificate showing that at the port of departure the vessel, while empty or after loading for the current voyage, was fumigated as prescribed; and

(*b*) a certificate or certificates showing that at the port of departure (if a proclaimed place) and at every proclaimed place subsequently called at, effective measures were taken to prevent the migration of rats to the vessel. The measures adopted shall be specified in the certificate.

The certificate or certificates in each case shall be signed by the Port Health Officer or local Quarantine Officer if the proclaimed place is within the British Dominions, or be endorsed by the British Consul if the proclaimed place is a foreign port or country:

Provided further that, in the absence of such certificates, the vessel may, if no plague-infected rats or mice have been

found on board, be exempted from fumigation at any port of call in Australia excepting the terminal port;

(2) if so ordered by a Quarantine Officer, discharge the cargo into lighters in stream.

140 (B). The following processes are prescribed:

(1) For the destruction of rats and mice in closed spaces in vessels: Thorough sulphur fumigation for at least eight hours with a gaseous mixture containing not less than three parts per centum of sulphur oxides. The fumigation shall, wherever practicable, be effected by passing sulphur fumes under pressure into the closed space, the contained air being at the same time partially exhausted.

(2) For the destruction of insects and other vermin in vessels: Thorough application of an aqueous solution or emulsion of soft soap, cyllin, and kerosene, containing of each one part per centum. The application must be made by means of a mop or scrubbing-brush or similar appliance, or by forcibly spraying the mixture into all places infested with or suspected of being infested with fleas, lice, bugs, or similar insects or vermin.

140 (C). For the purpose of these Regulations, "wharf" shall include any pier, stage, landing-place, jetty, or similar structure at which a vessel may lie.

With regard to *rat-shields* for hawsers, several types are in use. A simple device, and one which is easily affixed, is that devised by *Rosenau* (*vide* Fig. 15).

With respect to all kinds of shields the points to be noticed are:

(i.) They should be at least 3 feet 6 inches in diameter.
(ii.) They should be placed about 5 to 6 feet from the ship's side.
(iii.) They should be fixed to *every* hawser.
(iv.) They are useless unless the ship is fendered off the wharf, and gangways, etc., raised.
(v.) The mooring ropes of lighters should not be forgotten, even if the ship is lying out in the roads.

If rat-shields are not procurable, I would suggest a method that recently occurred to me: Lash some oakum all round the hawser, beginning at a distance of 3 feet from the ship's side, and continuing it for a distance of 3 feet. Soak the oakum with kerosene oil, and renew the soaking each evening. Rats hate kerosene intensely, and they will neither face it voluntarily, nor can they jump over the distance of 3 feet to the clean hawser beyond.

BUGS.

The bed-bug belongs to the family *Cimicidæ*, sub-order *Heteroptera*, order *Rhynchota*.

This family, *Cimicidæ*, contains four genera: *Cimex*, *Œciacus*, *Cacodmus*, and *Hematosiphon*.

The bed-bugs belong to the genus *Cimex*, which at present contains five species, *Cimex lectularius*, Merrett (1667), *C. rotundatus*, Signoret (1852), *C. pipistrelli*, Jenyns, *C. columbarius*, Jenyns, and *C. hirundinis*, Jenyns, all of which have

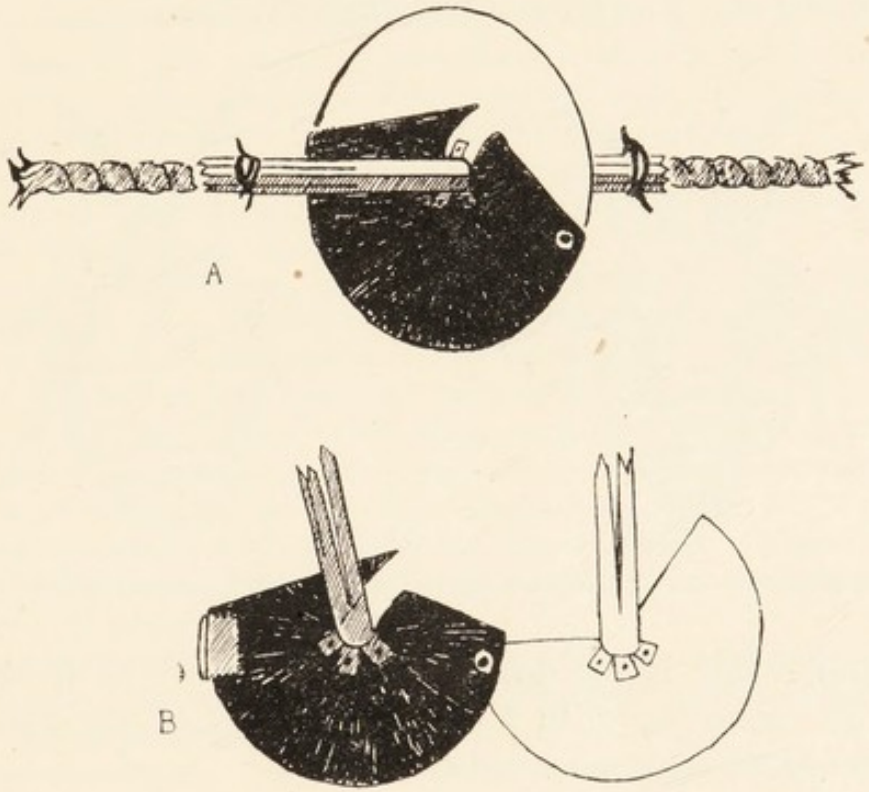


FIG. 15.—ROSENAU'S RAT-SHIELD: *A*, CLOSED; *B*, OPEN.

the following generic characters: The head is short and broad, with two prominent eyes, but no ocelli. The antennæ are four-jointed, the apical joints being slender; the elytra are rudimentary, and lie over the metathorax. The prothorax is semilunar in shape, with its anterior angles considerably extended. The abdomen, which is uncovered, consists of seven segments and an eighth anal appendage; the legs are slender, the anterior tibiæ more than twice as long, and the posterior three times as long, as the tarsi, which are three-

jointed. The proboscis is flexed in a groove beneath the head and prothorax.

Of these, the first two only are human parasites (Figs. 16 and 17).

C. columbarius is found in pigeon-houses but will attack man. It is smaller than *lectularius*. The abdomen is circular, and subacute at tip.

C. hirundinis is found in nests of house martins. It is more pubescent than *lectularius*, and the abdomen is narrower.

C. pipistrelli is found on some bats. It is very pubescent, almost hispid. The femora are more swollen.

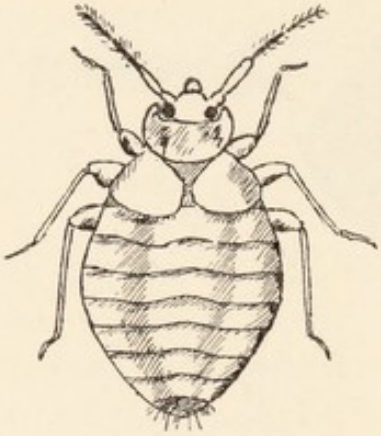


FIG. 16.—*Cimex lectularius.*



FIG. 17.—*Cimex rotundatus.*

The following is the description of four of the species as given by *Patton* (1907) in a paper in No. 31 of the *Scientific Memoirs of the Government of India :*

Type species, Cimex lectularius, Linn. The adult insect of this species is reddish-brown in colour and is covered with fine hairs; it varies in length from 4·5 mm. to 5 mm., the male usually being a little smaller than the female. The head is short and broad, and is inserted into a notch in the prothorax; it contains two lateral prominent eyes, in front of which are the two antennæ, and in the median line the thick first segment of the labrum, which is continuous with the dorsal integument of the head. The antennæ consist of four segments, the first two being the thicker, while the third and fourth are slender and covered with long hairs.

The prothorax is semilunar in shape, with two rounded horns extending close up to the eyes; its upper surface is raised in the centre and towards the sides, ending abruptly at a line a little beyond the level of

the eyes; the remainder of the surface, including the two horns, is flattened from above downwards. The ventral surface of the prothorax is concave, and hollowed out on each side of the mid-line where the first pair of legs are inserted. The mesothorax, as seen from the dorsal surface, is triangular in shape, with its apex projecting over the mesothorax and between the elytra. The mesothorax, next in size to the prothorax, is almost entirely covered on its dorsal side by the elytra, and on the ventral surface is seen as a small cleft on the inner side of the middle coxa. The elytra, which are inserted into the mesothorax just below the lateral angles, are two rudimentary scallop-shaped pieces of chitin lying over the metathorax and sides of the first abdominal segment. Their dorsal surfaces are convex and covered with bristles, while their ventral surfaces are concave. The abdomen is rounded, and consists of seven segments with an eighth and appendage. It is broadest at the third segment, and gradually becomes narrower towards the end, where it is covered with long hairs. In the male, the penis is seen flexed in a notch between the seventh and eighth segments.

This bug is distributed through Europe and North America, and is also found in Suez, Egypt, the Sudan, the North-West Frontier Province of India, China, South Africa, and Australia.

Cimex rotundatus, Sign., or the Indian bed-bug, is darker than the above species, being of deep mahogany colour; its head is not as long or as broad as that of *lectularius*. Its prothorax is also narrower and shorter, is more rounded, and not flattened at the sides as is the prothorax of the type species. Its abdomen is orbicular, being broadest at the second segment, and tapers more abruptly towards the end; in all other respects it is similar to *Cimex lectularius*.

Cimex rotundatus is distributed throughout India, Burma, Assam, Malay, and is also found in Aden, Sierra Leone, the Islands of Mauritius, Réunion, St. Vincent and Porto Rico.

Cimex pipistrelli, Jenyns, is similar in colour to *rotundatus*, its prothorax is also less marginal, and in all respects it is more closely allied to the Indian bed-bug.

Cimex columbarius, Jenyns, has a similar prothorax to *lectularius*, and is also of the same colour.

The bed-bug is of pretty ancient European habitat, for it was known to Aristotle as occurring in the Mediterranean region in his time. The earliest record in England, however, seems to be about the year 1503.

As regards distribution in time, a considerable number of fossil insects have been found in Devonian and Carboniferous formations, and some even in Silurian times. All these belong to an extinct division of insects—the *Palæodictyoptera*—which contained forms representative both of the *Rhynchota* and of the *Orthoptera* (*vide* "Cockroaches" hereafter).

Life History and Habits.

The bed-bug is purely a blood feeder, but has been observed (*Girault*) to feed on both a living and a dead mouse. Whether they will feed on rats or other animals has not yet been investigated.

Although they will feed by day, they are, generally speaking, of nocturnal habits. Most of their time is spent in cracks and crevices of beds, boarding, flooring, and the like; and there are many situations in crew's quarters, cabins, and other compartments of a ship, which constitute ideal situations for their love affairs and permanent domicile. They do not, however, care for surroundings of dirt and rubbish to anything like the extent that fleas do.

One of the most interesting things about the bug is the atypical nature of the phenomena connected with its fertilisation as first pointed out by *Berlese*, in 1898. This subject has been lately (1914) worked out most carefully by *Cragg*, of which interesting work the following extracts may be quoted:

"The anatomical features peculiar to the bed-bug are, briefly, as follows: In the right lateral half of the ventral plate of the fourth segment there is a longitudinal slit, extending through about half the width of the chitinised portion of the sternite. Lying upon the plate internally and immediately above this incision, there is a spherical organ, termed the *organ of Berlese;* this structure is a solid mass of cells, with no lumen, and no duct to establish connection with any of the internal organs. In sections of this organ taken from caught specimens one practically always finds it to contain very numerous spermatozoa, either collected together in a central mass occupying from a half to a quarter of the total area of the section, or in strands, fine or coarse, infiltrated among the cells. The cells themselves present very varied appearances, and may be simple and regularly nucleated, or containing numerous granules, or they may be vacuolated to any degree. Even more striking than the presence of this unilateral organ, and the connected incision in the integument, is the almost constant presence, in caught specimens, of great numbers of spermatozoa free in the hæmatocele of the abdomen.

"The ovaries, which are composed of seven ovarian tubes on each side, are of the usual type, and the common oviduct terminates at the posterior end of the body in the usual manner between modified ventral plates so arranged as to permit of expansion of the genital orifice at the moment of oviposition. The evident peculiarities of the female are,

therefore, the unilateral organ containing sperms and the presence of masses of sperms in the hæmatocele. It is to be noted that there is no connection, by duct or otherwise, between the organ of Berlese and the female organs proper.

"The spermatozoa do not enter the posterior genital orifice at the time of copulation; they pass directly into the organ of Berlese, through the incision in the integument already noted, and from thence into the hæmatocele. The genital orifice at the posterior end of the abdomen functions only in oviposition; the copulatory orifice is the incision in the fourth sternite.

"If a male and a female, two or more days old, and unfed since the last moult, be placed together in a small tube the mouth of which is applied to the skin of the forearm, they will usually feed readily and at once. After they are gorged they wander away from the skin and remain quiet for a few minutes, ejecting black excreta from the rectum at short intervals. After some time the male moves toward the female and places himself obliquely across her body in such a way that the penis is applied to the opening in the ventral surface of the female—that is, his body points forwards and to the left. The male remains attached in this position for a considerable time, retaining his hold by grasping the thorax of the female with his legs. The posterior end of the abdomen of the female can be seen to be quite free from all contact with the male, and the actual entry of the penis into the opening in the fourth segment has frequently been seen with the aid of a binocular microscope. Usually the pair remain at rest in this position for two or three minutes; at times, however, the female runs about the tube and endeavours, generally without success, to dislodge the male. If the act is interrupted it is often repeated after a short interval. Occasionally the pair will remain attached for quite long periods, even up to half an hour.

"Contrary to what is usually the case in insects, bed-bugs copulate very frequently during their sexual life. Individuals which have been kept isolated from the opposite sex will usually become attached at once when given the opportunity, if they are shielded from bright light and allowed to remain undisturbed. The act is not necessarily associated with feeding, though it only occurs in well-nourished individuals.

"The irregularity as regards oviposition is very striking; usually two or three eggs are laid on the third or fourth days after the first feed and the first copulation, but oviposition may be delayed for a week or more, or may not occur at all. In several experiments in which no eggs have been laid by a fertilised female after the requisite time, numerous spermatozoa within the oviduct, and partially mature ova, have been found in the sections, thus proving that fertilisation had really occurred, although it was not followed by oviposition. The number of eggs produced by different females, of the same age, after one meal of blood and one impregnation, may range from three to nine in the first four days; with an ample supply of food and unlimited access to the other sex the number of eggs produced may vary from an average of one every second day, or less, to one per day, or even more. These

wide variations in a normal process have made frequent repetitions of the experiments necessary."

Girault's observations bear out this irregularity of oviposition. He showed that a replete bug, afterwards fed periodically, laid 111 eggs during a term of 63 days, and died 18 days after depositing the last egg. Another replete bug, not afterwards fed, laid only 7 eggs in 10 days, and died 15 days afterwards.

The *ova* are white, flask-shaped bodies, which cohere in clumps, and they have opercula at one end. When deposited by the females in their hiding-places, the larvæ within are almost fully developed.

On emergence, these larvæ are small and of a transparent white colour, resembling the parent in form, but having no elytra and no prolongation of the angles of the pronotum. *Girault* observed that they fed immediately after hatching, and then fed again three times before moulting on the thirteenth day; thereafter it moulted four times, at successive intervals of nine, thirteen, four, and nine days, filling itself to repletion once between each moult, and became adult on the forty-eighth day of its life. Imprisoned larvæ have been observed to live without food to a maximum of sixty-five days. The rate of development is retarded by cold.

The *adult* has been shown to live at least 259 days (in cold weather) without food.

Economic Importance of Bugs.

Most textbooks give a long list of diseases for the transmission of which the bed-bug is held responsible. For the majority of these there is not a vestige of proof, and it is needless to enumerate them.

Patton, however, in 1907, proved the extra-corporeal development of the Leishman-Donovan parasite to take place in *C. rotundatus ;* and therefore the possible rôle of the bug in the causation of kala-azar brings that insect into important prominence.

The only other disease with which, by modern investigation, the bug seems to be at all connected is leprosy.

There are sufficiently good indications to warrant an interim theory that the bed-bug is one of the main agents in the spread of this disease.

Extermination of Bugs.

The extermination of bugs is rendered very difficult by their habit of hiding in inaccessible places.

If it is wished to rid of its bugs a badly infested cabin or other compartment of a ship, the matter is one which cannot be done offhand. A most careful and detailed treatment—often occupying some hours—will be necessary, and that by a skilled officer.

The methods of extermination might be twofold:

(i.) Biological.
(ii.) Chemical.

Biological methods would include the use of enemy insects. For instance, the cockroach is said to devour bugs with great avidity. This I believe is not one of the unfounded statements which are copied in textbook after textbook. Nevertheless, so far I have not been able to observe the process. I am inclined to think that the cockroach prefers starchy or other human foodstuff if he can get it easily. His liking for the flavour of his ship companion may possibly be "Hobson's choice," when other food has failed.

The bug has other enemy insects, such as several species of ants. One—a small black ant named *Monomorium*—has been said to clear a house of bugs in a few days.

In practice, these biological methods will rarely be effective because the necessary conditions are seldom present.

Even if they were effective, the disagreeableness and discomfort caused by the presence of the enemy insects would more than counterbalance their usefulness.

We have, therefore, to rely on chemical methods of extermination.

We cannot in this case use poison, for the bug is solely a blood-feeder. The only suitable agents will be:

(*a*) Fumigation.
(*b*) Contact insecticides.

Fumigation is not really a reliable method of killing bugs owing to the difficulty of getting any gas to penetrate properly into the crevices and cracks frequented by those insects.

The much more satisfactory method is by the personal campaign with a contact-insecticide.

For a long time I tried many different agents, as recommended by many different people. None of these quite answered all the requisites of a good contact insecticide, which are:

(i.) It should kill instantaneously on contact application.
(ii.) It should kill eggs quickly on contact application.
(iii.) It should not be corrosive.
(iv.) The working solution should not be inflammable.

Also, if possible, it is well that it should be cheap, and should not have too disagreeable a smell.

I early found that emulsions are more effective than plain solutions.

It has generally been said that turpentine and soap solutions are more effective than paraffin solutions. I recommend, however, a stock mixture of 20 parts of kerosene to 7 parts of sypol (or lysol); cleared, if necessary, with a little liquid petroxolin [E.P.]. It is a clear solution, which makes a good 10 per cent. emulsion with water. If used in a pressure-spray apparatus it can be methodically introduced into all crevices of a compartment. All mattresses, and pillows, and cushions, and upholstered fixtures should be removed first, and thrown overboard if the cabin is really badly infected. Then the spray should be used skilfully and conscientiously. It is a slow process, demanding much patience; but unless it is done thoroughly it is not much use doing it at all.

If the cabin is old, or the matchboarding at all in bad repair, it will be necessary to spray thoroughly *behind* it. This can be done, as *Melville-Davison* points out, by boring a hole in the woodwork, and using a special nozzle for the spray.

COCKROACHES.

The *Blattidæ*, or Cockroaches, are a family of the Order *Orthoptera*, Class *Insecta*.

From many points of view they are very interesting insects.

Large numbers of examples of various species existed in the carboniferous period, their remains being found in plenty in

the coal measures of Europe and North America. Indeed, a still earlier fossil has been found in Silurian sandstone, which has been considered as a fragment of a blattid tegmen.

One of the most characteristic features of the modern family is the inflexed position of the head. In repose, the front of the head looks downwards, the mouth pointing almost backwards, being incapable of full extension forwards. Viewed from above the pronotum generally conceals the head, and thus appears as the most anterior part of the body.

The following is the diagnosis of the eleven tribes into which the *Blattidæ* are divided:

Dichotomous Table of Blattidæ Tribes.

1 { Femora spiny beneath 2
  { Femora unarmed beneath 6

2 { Last ventral plate ♀ without valves 3
  { Last ventral plate ♀ with valves .. Tribe: * *Periplanetides.*

3 { Supra-anal lamina (both sexes) transverse and narrow wings—if present—Δ apical field .. .. Tribe: *Ectobiides*
  { Supra-anal lamina (both sexes) produced, Δ, or emarginate; wings—if present—without apical field 4

4 { Supra-anal lamina (each sex) Δ, not notched. Cerci projecting much beyond this lamina 5
  { Supra-anal lamina ♂ four-sided c̄ obtuse angles, ♀ broad, rounded or lobed. Cerci not projecting. Tribe: *Epilamprides.*

5 { Pronotum and elytra, smooth. Tarsal joints without pads. Tribe: * *Phyllodromiides.*
  { Pronotum and elytra holosericeous. Tarsal joints c̄ pads Tribe: *Nyctiborides.*

6 { Supra-anal lamina (both sexes) produced; post; margin notched 7
  { Supra-anal lamina (both sexes) short, transverse; post; margin straight or rounded 9

7 { Distinct pad between claws .. .. Tribe: *Panchlorides*
  { Pad absent or very small 8

8 { Wings, folded fan-like anal field. Pronotum smooth Tribe: *Blaberides*
  { Anal field single fold. Pronotum pilose Tribe: *Corydiides*

9 { Sub-gen. lamina ♂ produced and c̄ style. Tarsal claws c̄ pad 10
  { Sub-gen. lamina ♂ small; no styles. No pad. Tribe: *Panesthiides.*

10 { Ant. of wing pointed. Apical field produced. Tribe: *Oxyhaloides.*
   { Ant. of wing rounded. No apical field .. Tribe: *Perisphæriides.*

Of these tribes (sub-families) only two—*Periplanetides* and *Phyllodromiides*—are likely to have marine interest by presence on board ship.

Of the others, we have several species of interest for one reason or another. For instance, our only native species in Great Britain are three of the Genus *Ectobia*, which are of garden habitat.

One species—*Panchlora viridis*—is viviparous.

The largest species is the *Blabera gigantea* (2 inches long) of the West Indies. One of the *Blaberæ* has been found at the London Docks, also the *Rhyparobia maderæ*, so that both these might be occasional ship passengers.

Brief Notes on Species of Cosmopolitan Interest.

Of the sub-family *Periplanetides* we have:

Stylopaga rhombifolia, Stâl.
Blatta orientalis, Linn.
Periplaneta americana, Linn.
Periplaneta australasiæ, Fabricius.

B. orientalis is the "blackbeetle" so common in English kitchens. It is not indigenous to Europe, but is said to have been introduced from the Levant about 200 years ago by trading vessels.

The eggs are sixteen in number, deposited in a leathery capsule. The larvæ are white and wingless, and moult six times over a period of many months.

The tegmina in the male are a good deal shorter than the body. In the female they are rudimentary.

The bodies of male and female are of about the same size (20 to 23 mm.); and the pronotum in the male is 5 to 6·5 mm. fore and aft, with a beam of 7 to 7·5 mm., with rather larger measurements in the female.

Periplaneta americana is a much larger insect than the foregoing, measuring about 28 to 32 mm. both in male and female. The pronotum is 7·5 to 8 mm., by 9·5 to 11 mm. broad—the pronotum in the female being considerably larger.

The tegmina are well developed in both sexes, being about the same length as the body in each case.

The species has so far not spread widely in England. It is, however, very abundant at the Zoo.

It takes about a year to develop, but multiplies very rapidly, laying about thirty eggs at a time, also in a leathery capsule.

The great majority of ship cockroaches belong to this species, which is exceptionally omnivorous and cosmopolitan in habit.

Periplaneta australasiæ, Fabricius, very much resembles the

foregoing species in appearance, and is also cosmopolitan in habit. It is, however, rather smaller (male, 24 mm.; female, 26 mm.). The tegmina in the male are 3 mm. longer than the body; in the female, 2 mm. shorter than the body.

On the shoulder of each tegmen is a yellow mark, which readily distinguishes it from the last-named species.

Of the sub-family *Phyllodromimides* there are two well-known and cosmopolitan species:

Phyllodromia germanica, and
Phyllodromia supellectilium.

The former is one of the commonest European species.

It is, however, comparatively rare in England, but is found in large numbers at the Zoo in company with *P. americana*. It is also not uncommon now in cheap restaurants in London, to which it has probably been introduced from the Continent with consignments of "delicatessen."

It is even smaller in size than the "blackbeetle," the male measuring only 13 mm., and the female 11 mm.

The pronotum (male) is 3 mm. long by 3·5 mm. broad, being rather broader in the female.

Development takes place in a much shorter time than in the species before mentioned, usually occupying only a few months.

Cockroaches, on the whole, have established a "heat" habit. While there are only some twenty species indigenous in Europe, there must be over a thousand in the tropics.

Economic Importance of the Cockroach.

The cockroach harbours a good many parasites, including a filaria, some infusoria, a gregarine, amœbæ, a spirillum, and some nematodes, as well as several ectoparasites. This is what one would expect from its peripatetic and omnivorous habits.

Even though this odoriferous insect forms an article of diet or medicine in some parts of the world, it has never yet been incriminated by any specific charge.

As it does not (except, perhaps, on the most rare occasions)

bite human beings, it is unlikely that it will act, as a rule, in any other capacity than as a mechanical agent in the transfer of infectious disease—and even then only with regard to food-borne infections.

No cases of the latter have so far been traced or even remotely suspected; although the possibility should always be borne in mind, owing to the fondness of this dirty insect for the ship's galley and its contents.

On the other hand, the cockroach is reputed to enjoy the bed-bug as a change of diet, and thus to prove of use to man. In the previous section I gave as my opinion that extreme hunger is probably the rare excuse for such unwelcome attention.

Extermination of Cockroaches.

When cockroaches have once taken passage on a ship it is very hard to get them to disembark.

There are four ways of dealing with the pest:

(i.) Daily attention to the cleanliness of cabins and ship in general.

(ii.) Constant and careful attention to the cleanliness, tidiness, and control of galleys.

(iii.) Frequent treatment of crevices, dark corners, lockers, cupboards, etc., with a 1: 1,000 solution of Sanitas-Okol, to which some creosote has been added (1 ounce to the gallon).

(iv.) Periodical fumigations with SO_2 gas, every 5 months, as recommended for rat-destruction. The fumigation should be immediately preceded by a thorough wash down.

CHAPTER VII

QUARANTINE INSPECTION OF SHIPS

" I keep six honest serving-men
(They taught me all I knew);
Their names are What, and Why, and When,
And How, and Where, and Who.
I send them over land and sea;
I send them East and West;
But after they have worked for me,
I give them all a rest."

The Elephant's Child.

INSPECTION of a ship may be undertaken for various different reasons, each demanding quite different procedure. We have, for instance:

A. *Routine Inspections.*

(*a*) Inspection by Ships' Surgeons.
(*b*) Quarantine Inspections (by P.H.O.).
(*c*) Sanitary Inspections (by P.H.O.).

B. *Special Inspections.*

(*a*) Structural Sanitary Survey (by P.H.O.).
(*b*) Disinfection Survey (by P.H.O.).

The matter of Ships' Surgeon's inspections at sea is dealt with in Chapters I. and VIII.; "Sanitary Inspections" form the subject of Chapter IX.; "Structural Sanitary Surveys" have already been discussed in Chapter II.; while remarks on "Disinfection Surveys" will be found in Chapter X.

The majority of these inspections can be undertaken at leisure—that is to say, after the ship has received pratique, and while she is in enjoyment of ordinary commercial facilities.

The "Quarantine Inspection," which forms the subject of

the present chapter, is an exception. To prepare for it the ship has to make a special anchorage; no communication is allowed with the shore; and the mercantile operations, which are the *raison d'être* of the ship's very existence, are perforce suspended. It becomes a matter of the greatest importance, therefore, that the objects aimed at shall be clearly understood, and that the procedure required by the dictates of marine hygiene in the best interests of the general public shall be effected with a minimum of delay to the shipping community or of discomfort to those who travel.

Put in tabloid form, the rationale of the Port Health Officer's work can be summed up in two sentences:

(*a*) The exclusion or effective control of a wide range of infections or infective diseases, or of physical or mental unfitness.

(*b*) Such control of all ship-board conditions as may secure the actual or potential healthiness of crew and passengers.

Even a perusal of this sketchy little volume will be enough to show that the *duties* necessary to secure the above result are "multifarious as Spartan broth," and range widely over office and harbour and quarantine station.

I hope now to explain, for the benefit of the tyro in Port Health matters, *what* has to be done on board a ship awaiting quarantine inspection, and *how* it can best be accomplished.

To begin with the necessary *impedimenta*. In addition to the various forms, books, etc., which I shall shortly mention, there are a certain number of routine or diagnostic articles—small in size, but often of urgent requirement—which should always accompany a Health Officer, and which can be conveniently carried in a small leather attaché case 10 inches × 6 inches.

(*a*) *Two fountain pens* (red and black ink).

A long experience of ships has made me wonder for what purpose the nibs provided by the Companies can usually be employed. It is always better, therefore, to carry your own pens; but if you do so, let me warn you that, as often as not, the Surgeon or Captain will want to use *your* pen! The which to a pen-lover is, of course, anathema, and should not be for a moment allowed.

(*b*) *Chinosol soloids.*
A portable and powerful and non-toxic disinfectant; most useful for disinfecting your hands after your work on board is done. You will find it far preferable to the evil-smelling black compound which the Captain will provide in his basin; or to the hyd. perchlor. which the Surgeon will prepare for you in his cabin, and which will form a delicate silvery amalgam on your pet gold ring.

(*c*) *Two clinical thermometers* (30 sec.).
Most ships which have no Surgeon will have no clinical thermometer. I regret to say I have occasionally found the omission even when there has been a Surgeon on the Articles! It is as well to have two, for some patients seem to be dowered with a *cacoëthes rumpendi*.

(*d*) *A binaural stethoscope.*

(*e*) *Twelve microscope slides* (3 × 1).

(*f*) *A hypodermic syringe with two exploring needles.*
This will often be useful for taking smears of bubo contents, etc.

(*g*) *Half a dozen needles* (*straight surgical*).
Required for taking blood smears.

(*h*) *A small "killing-bottle."*
This can be conveniently made (sec. art.) in a glass tube, such, for instance, as those in which sterile drainage-tubes are often sent out by instrument makers. The killing-bottle is useful for the capture of mosquitoes in cabins, etc.

(*i*) *Half a dozen small phials with corks.*
Half of these should be empty and the other half filled with spirit. They are for the reception of insects, scabs, flakes of skin, etc., destined for subsequent laboratory examination.

(*j*) *An electric hand-torch.*
This is an adjunct which will be found invaluable in ship-searching work. In examining dark corners of 'tween decks, recesses of cargo, coalbunkers, etc., for stowaways; or dark corners of cabins, etc., for mosquitoes it is really indispensable. Refills should not be forgotten.

(*k*) *A tape measure or foot-rule.*
For measuring the size of portholes, air inlets, living spaces, etc.

So much for portable equipment.

The arrival of a ship in quarantine in most places will be notified to a Port Health Department either by a Customs or Harbour Office, whichever may be in charge of the signal station of the port. The need for promptness in boarding has already been emphasised.

It may often be annoying to have to leave half your breakfast untasted, or to go without your lunch, but it's all in the day's work!

Transport is generally provided by one or more launches kept at the disposal of the Health Department. For adminis-

trative convenience, Customs or Harbour Department officials in certain ports make use of the same launch. The best practice is for the Health Officer to have his own launch, with staff of boatmen, sanitary police, etc.

We will now suppose that the Health Officer has got alongside, made fast, and climbed the gangway ladder.

Some ships you will find that have no gangway ladder, in which case it will be necessary to swarm up a rope-ladder—usually covered with coal-dust. Occasionally ships will give you a rope-ladder to save trouble, even though they have a gangway ladder. In such cases you will be quite justified in laying by until the ship takes the trouble to provide for your reasonable comfort.

At the head of the gangway will be (or ought to be, in a well-regulated ship), the Captain, the Surgeon, and the Purser. These officers, of course, you salute. The Captain, after learning from you the probable length of the inspection or other details, at once leaves you. Your questions to the Surgeon (or, if no Surgeon, to the Master or Mate) will be:

1. All well?
2. No infectious disease?
3. No deaths?

You then ask to see the Bill of Health from the last port, and a complete numerical passenger-list, showing origin and destination by classes.

This takes place near the gangway, and only occupies a minute.

You then give your instructions (as will be mentioned later) and proceed to the nearest saloon or smoking-room, where an "*Entry Declaration*" of some kind is signed by the Surgeon and Captain.

The accompanying "Entry Declaration" will show the chief points on which it is highly important to obtain authentic and certified information. There is more in this than meets the eye. All ships are not, alas! equally honest. It is on this Entry Declaration that prosecution for excess or deficit of passengers, or concealment of infectious disease, will be in-

ENTRY DECLARATION.

1. Name of ship ———————————————
2. Tonnage (net) ———————————————
3. Number of crew: Officers ————; Men ———————————
4. First port of voyage, and date of sailing ———————————
5. Intermediate ports called at ———————————
———————————————

6. Number of Passengers for this port (*including children and infants*):

Port of Origin.	*1st.*	*2nd.*	*3rd.*	*Deck.*	*Total.*
Total ..					

7. Number of Transit Passengers:
   1st————; 2nd————; 3rd———— ; Deck———
8. Cases of Infectious Disease during voyage.

	Plague.	*Cholera.*	*Smallpox.*	*Yellow Fever.*	*Other Infectious Disease.*
Cases ..					
Deaths ..					

9. Other deaths and cause thereof———————————
10. Nature of cargo———— Any grain ? ———————
11. Name of Agents ———————————
12. Remarks ———————————

We declare that the above information is correct.

———————,
Master.

Before me,

———————,
Surgeon.

———————,
Port Health Officer.

———————,
Chinchew,
or
———————, *Supercargo.*

stituted. Bearing this in mind, the following points are to be noted.

1. Get the form filled up and signed *before* proceeding to any part of your inspection.
2. *Always write in ink*, never in pencil—not even copying-ink pencil. A document for permanent record, and which may at any time be produced in court, should never be indited in the slovenly medium of pencil.

We will suppose that no infectious disease has been reported. The interim instructions you will have given on boarding the ship were:

1. Muster crew.
2. Muster any "deck" women and children on poop deck.
3. Muster all "deck" males, coolies, or pilgrims, etc., on the after main deck.

This muster (1) will have taken place while you were filling up the Entry Declaration form. You then proceed to examine the crew, of which the saloon and deck hands will probably be on one side of the ship, and the engine-room hands on the other.

Instead of passing down the lines of men, you will find it most convenient to take up a fixed position for'ard, and let the whole crew file past you one by one. One of your staff should be with you to check the number. See that they have all opened the front of their jackets, clothes, or vest, before they reach you. As each man passes you in file on your right hand, put your hand upon his bared chest to see if he has any fever, at the same time looking at his face to see if he presents any facial signs of illness. There will probably be two or three firemen left on watch in the engine-room, who should be replaced when you have seen the others, so that you can inspect them also. Make sure that you see every one according to the totals given you by the ship. If you find a raised temperature when doing your manual examination, do not stop the procession, but simply let your attendant pull the man indicated to one side, and a detailed examination with thermometer, etc., can then be made at leisure after the rest have been dismissed. In this way you will be able to

make sure of attaining your object—which is the exclusion of plague, cholera, smallpox, or yellow fever. It is possible, of course, that a man may be in the incubation stage and thus escape notice, but when it is remembered that the voyage has probably already occupied several days the possibility becomes sufficiently remote to be negligible. It is one of those million to one chances which we cannot avoid, nor reasonably take action on. With regard to the *officers*, the inspection need merely consist in counting them to the correct total. Your visual *impressions* will be sufficient.

So much for the examination of the crew.

While this was in progress, the requested muster of deck passengers at the after end of the ship will probably have been completed, leaving the for'ard main deck and 'tween deck accommodation quite empty.

You should now ask the Purser if he would be good enough, while you are examining the deck passengers, to collect all the *disembarking* first and second class passengers in a convenient spot on the promenade deck, so that you can inspect them later.

(NOTE.—If there is no Surgeon on board, you should make a point of seeing *all* the first and second class passengers, whether disembarking or not.)

You then proceed to the empty 'tween decks for'ard, in order to make sure that no deck passengers are remaining or secreted there. This may need some care. You should have a staff of sufficient size to render you suitable assistance. Experience will give you in course of time a shrewd judgment as to which ships are likely to be suspicious. Having completed your search, take note as to whether there is an alley-way connection with the after 'tween decks. If there should be, then station one of your men to guard it, so that none can enter from the after end while you are examining up above. (That is one of the guileful methods adopted by a supercargo to keep excess passengers out of sight!)

You then go on deck and take up a suitable position at the for'ard end of one of the alley-ways, leaving the other alley-way guarded and closed. Send word along to the waiting coolies to strip to the waist and come through the alley-way

one by one. One of your staff should count aloud while another tallies in tens, either with a pencil or a watch-counting-machine. You will find it best to roll up your sleeves. Let them pass on your right, and make sure that you have a good light thrown on the faces of the men you examine.

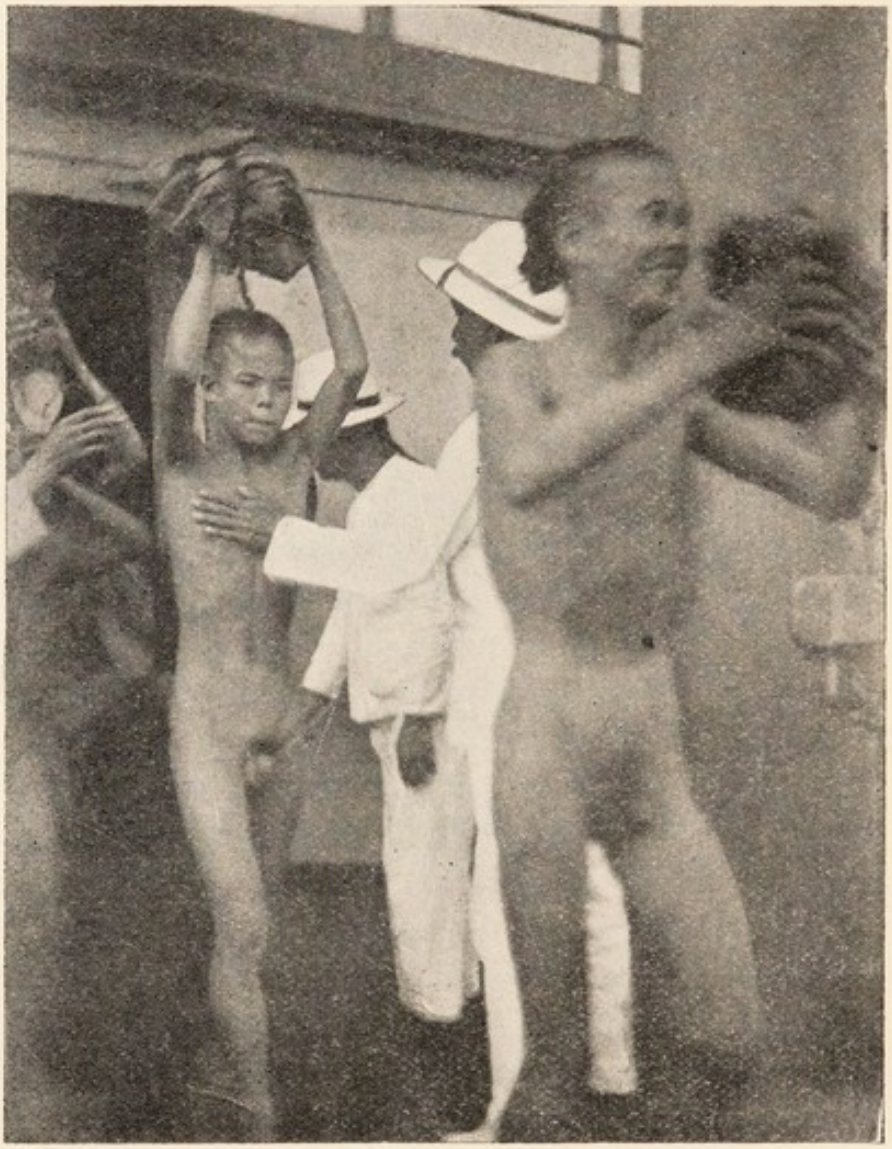


FIG. 18.—EXAMINATION OF IMMIGRANTS.

(NOTE.—The question of light is important. Never conduct your examination of deck passengers except *during daylight.*)

The accompanying illustration shows the method of procedure. In those days I adopted the more reasonable method of complete stripping in the privacy of an alley-way at the

exit of which the examination is made, as will be seen in the photo. This, however, I abandoned for the less satisfactory stripping to the waist, in deference to the wishes of the Chinese Government, who said that the coolies disliked the process—which the photo will at once disprove! (Fig. 18.)

You will now let them pass you in single file as you did with the crew, feeling each man on the chest with your right hand, and carefully examining his facies at the same time. A suspicious-looking person, or one with fever, should be put on one side for subsequent examination. Your assistant will pull the man out of line when you indicate him, and will get the Ship's Surgeon to take his temperature and mark it on his chest with copying-ink pencil.

You will find that the judging of temperature by the hand will soon come to you with practice, and should be accurate to within a degree or two.

If the people are properly stripped, and the file properly arranged, and the light good, and yourself accustomed to the work, you should be able to examine large numbers in quite a short time with perfect safety. (I think my own record was 2,000 in forty-five minutes.)

In this examination the main object is, of course, to exclude the major infectious diseases, and this is secured by the method I have outlined. But a port is not a charitable institution for welcoming the afflicted outcasts of neighbouring countries, and there are consequently other classes which may need exclusion or isolation for treatment under local enactments—such as leprous, blind, trachomatous, deformed, or unfit persons. The majority of such cases can be easily spotted during the march past, and put on one side for subsequent examination.

We will now suppose that you have finished with the men. You then go through the alley-way to the now deserted after main deck. Here you will look down in the 'tween decks to make sure there are no passengers left below. You then go up to the poop deck to examine the women and children. You will probably have a female inspectress, who will already have examined them all for fever, buboes, and rashes. You yourself should, however, also pass them one by one before

you, having them counted at the same time. I find the most suitable way for a rough estimate of the temperature of such Asiatic deck women as they pass you is to put the back of your right hand against the right side of the woman's neck, just over the main vessels. The neck is generally sufficiently unclothed for this operation without any preliminary preparation; and you will find it as easy to educate thermally the back of your hand as the palm. The sense is a little more sluggish, however, and the back of your hand will have to remain slightly longer in contact.

When you have done this examination, you now go to the promenade deck to examine *all* the *disembarking* first and second class passengers. This you should always do, whether there is a Surgeon or not. A kind of instinct will often tell you whether you need examine the *transit* cabin passengers or merely trust to the Surgeon's written guarantee of their health. For the first four or five years of your boarding work you would be better advised to see everyone on board personally.

In the following chapter, I enter fairly fully into the remarkable freedom of saloon passengers from infectious disease, and the reasons therefor. The very fact that it is so, while being a fortunate safeguard, does not, of course, relieve the Health Officer of responsibility, though it may lessen his anxiety. The examination of these cabin passengers in such an uninfected ship as we are now dealing with need, as a rule, only consist in a scrutiny of their facial appearance, and the feeling of the wrist and pulse to detect any rise of temperature. Any suspicious case should be examined more fully in a cabin.

To those who have not had experience of a large coolie port, and have given no thermal training to their hands, my precepts may give rise to some astonishment. It has been even recommended that the clinical thermometer shall be universally and habitually used in routine examination! Imagine taking 4,000 temperatures a day, as would have to be done sometimes in Singapore! My advice to Health Officers is: train your hand, and let your thermometer follow rather than precede it.

Such routine examination of a clean ship as outlined above will have to be modified as necessary in the case of:

(*a*) Non-coolie passenger steamers.
(*b*) Non-passenger cargo-boats.
(*c*) Cold climate work.
(*d*) European emigrant ships.

The details of such modification will be a matter of common sense, and hardly call for comment here. To get the work done not only efficiently but expeditiously, well-thought-out method is necessary; and the aid of a trained staff is indispensable.

In cases where examination of *outgoing ships* is required, the main principles are the same, the objects to be remembered being:

(*a*) absence of infectious disease;
(*b*) absence of mental conditions likely to endanger safety of others;
(*c*) absence of such physical or infective conditions as may be barred by the country to which the ship is sailing;
(*d*) disinfection of all effects of deck or steerage passengers and crew; and
(*e*) vaccination of deck or steerage passengers.

The *Board of Trade Regulations for Medical Inspection of Emigrants* are (Edition of 1911):

Reg. 59. *Medical Inspection.*—An emigrant ship may not clear outwards until the steerage passengers and crew have been medically examined on behalf of the Emigration Officer, and the Emigration Officer is satisfied that none of them appear to be by reason of any bodily or mental disease unfit to proceed or likely to endanger the health or safety of the other persons on board.

The inspection will be made by a Sanitary Surveyor or other medical officer appointed by the Board of Trade for the purpose, and will take place either on board or at some convenient place appointed by the Emigration Officer.

Each class of the passengers who are subject to medical inspection should be examined separately when circumstances will permit.

60. *Medical Inspection at Port of Call.*—When a vessel touches at a second port any steerage passengers who are embarked there must be medically examined, but the other steerage passengers on board and the crew need not be again examined unless there is some special reason to make this necessary.

61. *Relanding Passengers.*—If any person is from sickness unfit to

proceed, or is in such a condition as to be likely to endanger the health or safety of the other persons on board, he may be prohibited from embarking or may be relanded. If absolutely necessary, all the passengers may be relanded for the disinfection of the ship.

With regard to incoming ships, we have:

78. *Voyages to the United Kingdom.*—In the case of vessels bringing steerage passengers to the British Islands from any port out of Europe and not within the Mediterranean Sea, the rules as to the number of steerage passengers allowed, apply as if the ship were an emigrant ship, and the steerage passengers must be supplied during the voyage with provisions and water in the quantities required by the scale for emigrant ships. The Master of the ship is also bound to deliver a return of the passengers carried to the Collector or Chief Officer of Customs at the final port of destination in the United Kingdom.

The chief inspection of incoming ships in the United Kingdom does not, however, lie with the Board of Trade, but is governed by Local Government Board Regulations.

These regulations ignore smallpox, and only deal with plague, cholera, and yellow fever.

The Customs Officer is the first to visit the incoming ship! The following excerpts from the L.G.B. Regulations will show the official details of the situation:

ART. 4.—If he (*i.e.*, the Customs Officer) has reason to suppose that the ship has come from, or has during the voyage called at, a port infected with cholera, yellow fever, or plague, he *may* detain the ship, and *shall* order the Master to moor or anchor in such a position as the Officer of Customs directs, and the Officer of Customs shall forthwith give notice of the same to the Sanitary Authority of the place in which the vessel is lying.

5. Such detention ceases as soon as the ship has been duly visited and examined by the M.O.H., or if such examination be not commenced within 12 hours after the ship has been moored or anchored.

7. On receiving notice of the detention of any ship by a Customs Officer, the S.A. must forthwith send their M.O.H. to visit and examine the ship, and to discover whether or not it is infected.

8. If the M.O.H. have reason to suspect that any ship within the jurisdiction of the S.A. is an *infected* or *suspected* ship, he *must* visit and inspect it, whether it has been examined by the Customs Officer or not. If he has reason to suppose that any ship has come from, or during the voyage has called at, an infected port, he *may* visit and examine it.

In either case he may order the Master of the ship to bring it to, and, if necessary, to moor or anchor it in, some specified place. The Master of the ship must obey any such order, and allow the M.O.H. to visit and examine the ship.

12. As soon as possible after certifying that the ship is *infected* or

suspected, the M.O.H. must examine every person on board, and must certify every person he finds suffering from cholera, yellow fever, or plague, or from any illness which he suspects may be one or other of these.

20. The M.O.H. may serve a certificate to prevent the landing of any person from a ship which may be suspected or which may have come from, or has during the voyage called at, an infected port. A ship having passengers in a filthy or unwholesome [*sic!*] condition, or rats infected with plague, or an unusual mortality among rats during the voyage, may be similarly dealt with.

21. When a certificate has been given under Art. 20, no person shall leave or be allowed to leave the ship unless he satisfies the M.O.H. as to his name and intended address.

We will now conclude that, after examination, the P.H.O. has found the ship to be clean.

It will be necessary to give some sort of written permission to leave the Quarantine Anchorage. This is called *Pratique.*

The wording of it may be laid down by law or left to the discretion of the P.H.O. A point to note is that occasionally it may be compatible with hygienic safety to allow a limited or conditional pratique, and the wording of the document should allow for this. The form adopted should be in perforated book style, with a counterfoil of detail for office record.

I may state here that in the United Kingdom pratique is issued by the Customs department, an anomaly which is indefensible.

I attach a sample form as a type for reference:

PRATIQUE.

I hereby certify that the s.s. ———————————————

from ——————————arrived on the————————day of————————19——,

$\frac{\text{free from}}{\text{infected with}}$ Plague, Cholera, Yellow Fever or Smallpox; and after being duly $\frac{\text{inspected}}{\text{disinfected}}$ by the Port Health Department, has been in this port granted permission———————————————————————

———————————————————————————————————

———————————————————————————————————

Given under my hand and seal,

———————————————,

Port Health Officer.

QUARANTINE ANCHORAGE,

————————————19 .

NOTE.—This Certificate should be exhibited to the Pilot (if any) removing the ship from the Quarantine Anchorage. (Rule 23 (3).)

In all the foregoing considerations we have been dealing with the inspection of a ship on which the Surgeon has told us that no infectious disease has occurred.

Why was she in quarantine?

She was subjected to such inspection because she was a suspected ship as being either:

(*a*) from an infected port;
(*b*) from a suspected port; or
(*c*) a ship with immigrants or coolies, and these three classes should always await inspection as "suspected ships."

It may be asked, What is an infected port? What is a suspected port? Briefly speaking, an infected port is a port at which epidemic infectious disease exists; and a suspected port is a port at which the infectious disease exists only in sporadic form. My views on epidemic and sporadic standards will be found in Chapter XII. It is high time that concerted action were taken in this matter throughout the Empire. It should not be left to chance or to a lay Customs official to decide what ports are infected or what ships are suspected or infected.

What is wanted is a proper *British Intelligence Bureau* in London, on the lines of the Paris Bureau, but much more prompt, and more up to date. There should be two sub-bureaux, one in the Far East and one in the West Indies. By means of special correspondents these offices would collect weekly telegraphic reports of infectious disease in every main part of the world, or the immediate hinterlands of such ports, and transmit to the head bureau in London. Any British port which required returns from such and such ports could obtain them from London, or from the sub-depots, by weekly telegraph in code at a fixed rate per annum.

In this way nothing would be left to chance. Every P.H.O. would know exactly the conditions of the ports with which he had or might have dealings. If, in addition, a universal British standard of epidemicity and sporadicity were adopted, the whole Imperial quarantine procedure would be admirably and rationally simplified.

There is one other point: Should ships which do not come from an infected or suspected port, and are not themselves suspected ships, be medically examined? The answer, I think, is that, in default of a worldwide and satisfactory intelligence department as outlined above, it is so impossible to know the health conditions of many ports from which ships may come, that *every* incoming ship should properly be inspected on her arrival by the Port Health Officer. If, on the other hand, an up-to-date Intelligence Department were in working order, the control of non-suspected ships from clean ports might well consist solely in the filling up of an "Entry Declaration Form" by the Master and Surgeon of the ship, which forms could subsequently be forwarded to the P.H.O. by the Customs officials.

Infected Ships.

We will now go back to our original coolie ship, and imagine that the Surgeon has notified the existence, or suspected existence, of a case of major infectious disease.

The first thing to do will be to get the "Entry Declaration Form" filled up and signed. That being done, you should go at once with the Surgeon to see the case or cases. Your experience may lead you to confirm or revise his diagnosis at once, or, on the other hand, the case may offer difficulties.

In such circumstances, without expressing a premature opinion, and without undue haste, you should carefully examine the case in all its clinical aspects. Having made your weighed diagnosis, state your opinion crisply and decidedly, and stick to it. If there is a lingering doubt in your own mind, don't show it—plump for the disease. Decided and prompt action is half the battle, and saves all the irritating and begrudged delays caused by an indecisive and vacillating official. If you get through your infection procedure and secure a quick release for the ship, it will not so much matter even if the diagnosis *has* to be revised later: no great harm will have been done—no harm at all commensurate with that caused by possible dissemination of the disease ashore, or probable

demurrage for the ship during the several days you may be observing the case or making cultures, etc.

Having seen the case, you should now proceed with your general inspection of passengers, as in the previous instance, having a special regard to the presence of early cases of a like nature, and to other cases possibly secreted. The quite unjustified but perhaps partly understandable dread felt by Eastern races for quarantine measures, of which they know nothing but think the worst, is often responsible for clever concealment of infectious disease.

In one instance, on a small coolie ship carrying about 500 passengers, which purported to be "clean," I was walking along the deck when a slight noise was heard in one of the ventilating cowls. Inspection resulted in the materialising of the noise into a smallpox patient! In another case certain suspicious circumstances led to a search of a ship which was rewarded by finding a nearly moribund cholera patient in the chain-locker.

On yet another occasion I found a smallpox patient in one of the ship's boats. Several times I must acknowledge defeat at the hands of the wily Chinese comprador, but, fortunately, in most cases I was in time to prevent serious results ashore.

Your inspection of ship and passengers being now completed, it remains to be considered what should be done with our infected ship.

The very first thing is to send the case or cases with their immediate contacts to the quarantine station, or—a less sound practice—to a hospital for infectious diseases ashore. You will probably have a small ambulance boat ready for this purpose.

You then *muster all disembarking first and second class passengers and require them to sign an "undertaking"* to report themselves for such number of days as may be required to the M.O.H. of the district to which they propose to go. When they have done this there is no objection to their leaving the ship in the agents' tender, as soon as possible.

Native deck passengers, or deck pilgrims, or immigrants, should then be landed as soon as possible on a quarantine

PASSENGER'S UNDERTAKING.

(*For record in Port Health Office.*)

Date of undertaking ———

Full name or names of passenger or passengers——

Full address of passengers:

Ship's name———

SHIP INFECTED WITH

Serial Number

PASSENGER'S UNDERTAKING.

TO BE FORWARDED BY THE PORT HEALTH OFFICER TO THE EXAMINING OFFICER.)

I *or* (We)——of—— having arrived at this Port by the ship——and being desirous of proceeding to the premises at—— (which I *or* (We) hereby declare to be my *or* (our) address) hereby undertake, in consideration of being permitted to land, [to present myself *or* (ourselves) for examination at the office of the Examining Officer situate at——daily at—— o'clock for——days from the date hereof, and to report immediately at the said office any change in my *or* (our) address] *or* [to proceed direct to the said premises and to submit myself *or* (ourselves) for examination daily by the Examining Officer for—— days from the date hereof].

I *or* (We) herewith deposit the sum of dollars—— *or* (dollars——each).

I am *or* (We are) aware that failure to comply with the terms of this undertaking will render me *or* (the defaulter) liable to be arrested, to be isolated and to be fined a sum of $500, and will cause the deposit *or* (the sum deposited by the defaulter) to be forfeited.

Dated this——day of——, 19——.

(*Signatures of Passengers.*)

Before me:

Port Health Officer.

Date of undertaking——

Full name or names of passenger or passengers:

Address of passengers——

Ship's name——

Address of Examining Officer——

Period for which examination is ordered: days.

station for observation and further action as necessary in each case.

The actual landing may be carried out either by the Port Health Authorities, or by the agents at the request of the P.H.O. The latter is often the most convenient and economical method. Legal powers should in that case be obtained to secure prosecution of the agents in the event of their not landing the requisite number.

The length of time for the actual detention of the contacts or suspects on a quarantine station will vary from a couple of days for disinfection, vaccination, etc., to the full quarantine period, according to the circumstances of each case, as will be seen hereafter.

By many people it has been objected that the quarantining of contacts or suspects is unjustifiable nowadays. Were such remark only to be applied to cabin passengers and educated persons of responsibility, the contention would be reasonable enough. But, unfortunately, both East and West have to deal also with thousands of Asiatic deck passengers and pilgrims, as well as illiterate European steerage emigrants, all of whom quickly scatter far and wide.

To neglect detaining the latter classes for such action or observation as may be indicated by the circumstances of each case would be culpable foolhardiness.

Quarantine action must always be guided by the nature of the conditions or disease with which we are concerned at the moment. But the action should be crisp. A reasonable course of procedure having been decided on, it should be fearlessly followed out. Occasionally awkward circumstance may arise, as in the case of the s.s. *Katoomba*, which arrived at Plymouth from the East on June 7, 1918, infected with smallpox and carrying about 2,000 European troops. The latter refused to go to a segregation camp, and had finally to be allowed to go to their dispersal centres, as originally arranged.

Your further action will then depend on:

(*a*) The origin of the infection.
(*b*) The nature of the disease.
(*c*) The location of the case.

The special circumstances of any case may often demand the exercise of common sense rather than the slavish following of the letter of regulations which have been drawn up to meet general conditions; but the principles of safety must on no account be sacrificed.

The *origin of the infection* will be important, covering the following points: Was the disease contracted ashore before the patient embarked? If so, when did the first symptoms appear, and was the patient in a relatively feeble infectious stage when first isolated? Was the isolation promptly effected, and were precautionary measures of disinfection adopted?

If such has been the case, the situation is the most favourable and the disease (except occasionally in the case of cholera) will be unlikely to spread. It is unlikely that many other cases will have been contracted ashore, and such as have been will all probably make their appearance at about the same time. The deck passengers, after being landed at a quarantine station, would be disinfected and detained for the minimum incubation period.

If, on the other hand, it seems likely, from a comparison of the dates of sailing and of the first case, that the disease has been contracted on board, from food or water (cholera), from infected rat-fleas (plague), or from infected mosquitoes (yellow fever), then it becomes impossible to say whether many others may not have become infected from the same source, and quarantine observation of the deck passengers should extend to the full limit, counting from completion of their official disinfection on a quarantine station.

With regard to the *nature of the disease*, I have already pointed out that I consider the danger of spread on board to be inversely as the length of the incubation period. *Cholera* is by far the most dangerous of these major diseases, and the utmost care will be necessary in dealing with this disease. If the case has occurred amongst the deck passengers, their detention on the quarantine station should be for the full legal limit after disinfection (seven days) and in nearly all the cholera-infected ships with which I have had to deal

further cases have occurred after they have been removed from the ship.

If the cholera should have occurred amongst the crew, then it will be necessary to remove to the quarantine station for observation all that portion of the crew who occupied the same compartment as the sick man. If several cases have occurred it may even be necessary to remove the whole crew. In either case the deck passengers should also be detained, but in a different part of the station; and in their case the detention need only consist of disinfection and observation for a total of forty-eight hours.

The spread of cholera is a very speedy and sometimes a mysterious factor. It may die out or develop into an explosive outbreak; and, owing to the existence of "carriers," it is especially difficult to deal with effectually. Occasionally, after ten or twelve deaths on board, no further spread will occur after removal. In one instance I remember, a coolie ship arrived four days out from a cholera-infected port, reporting no cases or deaths. I detained her for one day to complete her five days' quarantine, and a case occurred on the fifth day—obviously from some infected material on board; and many cases occurred after removal of the passengers to the quarantine station. Disinfecting measures will consist of washing with Okol under pressure all the deck and 'tween deck spaces occupied by passengers or crew, and dealing with water or food as necessary. If the disease has been *plague*, judging from my experience in Singapore, as a rule, only one case will be found, and this will almost certainly have been contracted ashore before embarkation. If it is of the bubonic variety, it will be of very little actual danger as a focus for infection except in dirty and flea-stricken surroundings. In a single bubonic infection I have never known a subsequent case to occur amongst contacts after removal and disinfection. If the case was of the pneumonic variety, or if there have been multiple cases, it is a different story.

In any case, the deck passengers should be removed to a quarantine station. If a single case had occurred amongst themselves, they and their baggage should be disinfected and

detained for observation for the incubation period (three clear days). If more than one case had occurred amongst them the detention should be for the quarantine period (ten days), unless inoculation can be performed, when five days would be sufficient.

If, on the other hand, a single case had occurred amongst the *crew*, the case would be removed; the rest of the crew inoculated; disinfection done; and the deck passengers should also be removed, but only for two days for disinfection of person and effects. Disinfestation of *holds*, cargo, crew's quarters, 'tween decks, etc., will then be carried out with SO_2 gas.

If the case has been *yellow fever*, the deck passengers should be removed for seven days' quarantine observation, whether the case occurred amongst them or not. If the case occurred amongst the crew, then they, too, should be removed for observation for a similar period; but if the case had *not* been amongst themselves, then daily medical observation on board for seven days would be sufficient. In any case, after removal of the deck passengers, energetic measures would be taken to free the ship of mosquitoes and their larvæ.

If the disease has been *smallpox* after removal of the case, the deck passengers should all be invariably removed for disinfection of clothes and effects and vaccination, after which they could be discharged unless the case had actually occurred amongst themselves. In the latter circumstance they should be detained till the fourth day to see if vaccination had been successful. Where it had not been successful revaccination should be performed, and then the whole lot immediately discharged without further detention.

In any case, every member of the crew also should be vaccinated or revaccinated when an individual certificate of recent (five years) *successful* vaccination cannot be produced. Do not rely on their word. When vaccination scars have become white there is no clue to their age—it may have been done six months before, or not since infancy. If the smallpox case has occurred amongst the crew themselves, it will not be necessary to remove more of them than the actual

patients. The rest will be vaccinated, and all the crew's quarters (with complete contents) should be fumigated with SO_2 after washing down the deck with liquid disinfectant. In such case it is, of course, not necessary to disinfect the holds, nor even the 'tween decks from which the deck passengers have been removed—although it is advisable to wash them down with disinfectant and then air thoroughly.

With regard to the *location of the case,* I have already indicated to some extent the varying treatment which must be adopted to meet the circumstance of infection amongst crew or amongst deck passengers; and we have noted that in every case, wherever the infection may have occurred on board, the cabin disembarking passengers must sign an undertaking to report ashore, and the deck passengers must all be landed. Should the case have occurred amongst cabin passengers (which, fortunately, is very rare), the patient and immediate contacts (such as husband, wife, child, etc.) should be landed at the quarantine station hospital. Beyond the measures mentioned in the last paragraph, the only further action necessary will be to disinfect the infected, and (if necessary) the contiguous, cabins. And it may also be necessary to keep under special observation those of the Chief Steward's department who have been in attendance on the patient on board; such observation or other action will, of course, depend on the nature of the disease from which the patient had been suffering.

The details and method of *disinfection* are dealt with at length in Chapter X., and need not be discussed here.

When everyone who ought to be removed has been removed, and when all vaccination, disinfection, etc., is completed, written pratique may then be given. Being an infected ship, it is advisable to write the pratique in red ink in order that it may not be overlooked by subsequent Health Officers.

After the ship has left the quarantine anchorage, it is as well during her subsequent stay in port that you should visit her daily at a fixed hour for muster and examination of crew and transit passengers as necessary.

Do not forget also, when she departs, to *telegraph brief*

particulars to the Health Officer at the next port, as well as to *endorse in red ink her Bill of Health* with full particulars of what has occurred and what has been done.

Minor Infectious Diseases on Board.

In this term I comprise: Enteric, diphtheria, chicken-pox, measles, mumps, scarlet fever, dysentery, cerebro-spinal meningitis, malaria, and influenza.

Such a case may be serious or mild; may be amongst cabin passengers, deck passengers, or crew; and may be either amongst disembarking or else amongst transit passengers.

The Health Officer is faced with the problem as to what action should be taken.

The matter should be dealt with on common-sense lines.

A transit cabin passenger thus infected should be left on board for treatment, unless at the special request of himself or of the Surgeon or Agents, when he should be removed to some public or isolation hospital ashore, rather than to a quarantine station hospital.

If the infected cabin passenger was due for embarkation the above remarks will also apply.

If the infection is amongst the crew, the sick man, if considered necessary from the nature or gravity of the disease, should likewise be removed ashore; but in the case of native crew, it may be more expedient to remove the patient to a quarantine station hospital.

If the disease is amongst deck transit passengers, and proper facilities for isolation and treatment are to be found on board, there will be no need to remove the case.

When a disembarking deck passenger is infected, he should be sent to the quarantine station hospital, accompanied (if advisable) by immediate contacts, such as husband, wife, child, etc.

If the patient is being left on board (as outlined above), the P.H.O. should personally satisfy himself that sufficient isolation is being secured.

If the patient has been removed from the ship, the P.H.O. should instruct the Surgeon as to what simple disinfection

(if any) he wishes to be carried out in the cabin or compartment previously occupied by the patient.

The ship need not be detained for this disinfection; and, if the action recommended has been duly complied with, pratique may be at once given, in black ink. It is as well, however, to endorse particulars on the Bill of Health taken by the ship before departure.

Infective Diseases on Board.

By the term "infective," I intend to convey: Syphilis, phthisis, leprosy, and trachoma.

Such cases occurring amongst the crew themselves are of very little danger to the port, and can well be left to the care of the Ship's Surgeon, who will treat or get the men discharged as and when he thinks fit.

Infective diseases are generally comparatively rare amongst cabin passengers; and as regards action by a P.H.O., may be neglected, for, as a responsible class, such passengers may usually be trusted to seek medical advice without compulsion. Although exclusion of these diseases has been advocated, and even practised in some countries, it is doubtful whether such action is necessary when dealing with persons of independent means, who are not likely to be a burden to the State.

When we consider the question of deck passengers or immigrants the matter assumes a different aspect. We have then to deal with a more or less proletariat population, whose education has scarcely been calculated to dower them with a sense of responsibility, nor to guide their footsteps in the paths of sanitary righteousness. They are, moreover, mostly dependent on their daily wages for their bare existence. Infective disease, which will exist to a considerable extent amongst such a class, would, owing to the massive movements of emigration, be very likely to prove a menace to the public health of the country or a serious tax on her public purse.

It would be sound legislation to exclude deck passengers suffering from these diseases who are not natives of the country into which they wish to enter. Special permits might be

given in special cases—*e.g.*, those possessed of private means or those in Government employ, etc. In ports where emigration is very large, examination sufficiently extended to detect a majority of cases would not be feasible. It would have to be done at leisure at the port of embarkation.

It will be noted that the latter half of this chapter, dealing with the quarantine examination and treatment of an infected ship, has, like the first part of the chapter, dealt with passenger steamers in the tropics which have accommodation for deck passengers. The main principles are, however, equally applicable to any ship in any latitude, subject to minor alteration of detail, and to the requirements of local enactments.

In crystallised form, the *main objects aimed at* are:

1. To find out how many persons *ought* to be on board the ship.
2. To see all those who *are* on board, with a view to:
    - (*a*) Strict control of major infectious diseases.
    - (*b*) Limitation of the spread of the minor infectious diseases.
    - (*c*) Rejection of aliens suffering from—
        - (i.) Infective disease.
        - (ii.) Mental disease.
        - (iii.) Physical defects.
3. To despatch the ship in such a condition that:
    - (*a*) The health of those on board is not likely to be endangered.
    - (*b*) An infected or suspected ship is not let loose on another port.

The last point (3 (*b*)) is one which is often overlooked, even in quite recent legislation. It is, however, none the less important, and represents the culmination of experience towards which all modern marine quarantine is tending—viz., that measures should be taken when possible at the port of departure rather than at the port of arrival.

In conclusion, may I recapitulate six hints to the examining Health Officer:

1. *Be methodical.*
   It will make for efficiency and expedition.
2. *Be thorough.*
   Don't shirk or scamp even the small details. A slack officer is easily imposed on.
3. *See everyone.*
   Even the passenger-list is not necessarily correct!
4. *Be crisp.*
   With a truculent skipper or recalcitrant cabin passenger a firm but polite brusqueness goes a long way.
5. *Be tactful.*
   Our cousins are sometimes very irritating (one wonders what they say to the much stricter quarantine in America!)—but keep cool.
   Love or money will not induce a Jew to sign his name on a Saturday (although he uses his hands to eat freely!)—do not let it worry you. Purdah ladies will not leave their cabin for a muster. Never mind, go later, and see them yourself.
   Natives may have objectionable habits of expectoration, or they may smell highly of garlic, etc.—but they are not dirt! Treat them like human beings, even if firmly, and—keep smoking!
6. *Walk warily.*
   Alley-ways are not lofty, and overhead steam-pipes are common—mind your head!
   Alley-ways are often dark, and bunker hatches, sound-pipe combings, steam-pipe covers, etc., are aboundingly plentiful—mind your feet!

CHAPTER VIII

SHIP-BORNE INFECTION

" Sick now ! droop now ! this sickness doth infect
The very life-blood of our enterprise;
'Tis catching hither, even to our camp."
(1 Henry IV., IV., i., 28.)

INFECTIOUS disease, which was in ancient times slowly carried from place to place along the limited caravan trade-routes, has, of course, found an easy and far-reaching means of progression with the introduction of trains and steamships.

This chapter deals with such sea-borne infection; chiefly with the so-called " major " infections—*i.e.*, plague, cholera, smallpox, and yellow fever.

I have, in this chapter, considered especially the point of view of the Ship's Surgeon—that is to say, a standpoint rather epidemiological and marine than clinical or administrative. The ultimate treatment of the infected ship with its passengers, etc., will be found in Chapter VII. (Quarantine Inspection), Chapter X. (Disinfection), and Chapter XI. (Quarantine Organisation).

General Considerations.

Owing to the ease with which infectious diseases may be spread by ships, the subject of disease epidemiology, diagnosis, and ship-board control is, of course, of first importance in marine hygiene. In fact, a Port Health Department is the " first line of defence " against the introduction of such disease.

For purposes of shipping and quarantine, the modern practice is to divide *infectious diseases* into two classes—" *major* " and " *minor.*" In the former category we place

plague, cholera, smallpox, and yellow fever; in the latter class, typhoid, diphtheria, chicken-pox, measles, mumps, scarlet fever, dysentery, cerebro-spinal meningitis, and malaria.

The reason that the diseases in the former class are called "major," and bulk so largely in our quarantine legislation and procedure, is twofold:

(*a*) Speaking generally, they are graver diseases, with a higher mortality; and,
(*b*) they tend to assume very much more wide and vivid epidemic proportions.

The minor infectious diseases—the epidemic spread of which is more limited, and the mortality usually much less serious—are treated with a minimum of general quarantine measures, as was seen in the previous chapter. Their marine importance being so insignificant, and their clinical features so well known, further reference will not be made to them in this chapter. The Ship's Surgeon should, however, of course see to the efficient isolation of any cases that may occur on board. There may be occasional exceptions, however. For instance, influenza and cerebro-spinal meningitis will sometimes assume the proportions of a virulent pandemic, as occurred in 1918. In such cases it would be reasonable to transfer the disease to the "major" list, as a temporary measure, in order that more stringent precautions could be taken as thought necessary. It is fortunate that these two diseases seldom travel fast and far, nor assume the virulence which has recently attended them, for the short incubation period and high infectivity of influenza and the "carrier" aspect of C.S.M. render the problems of quarantine very anxious and difficult.

There is, as mentioned in the previous chapter, another class of communicable disease, which I prefer to call *infective disease* rather than "infectious." (The suffix "*ous*" denotes "abounding in"; the suffix "*ive*" denotes "tending to"—*i.e.*, rather more potential than kinetic.) In such class I should include syphilis, tuberculosis, leprosy, and trachoma.

There is also a small class of diseases, such as puerperal fever, dengue, etc., which are not usually dealt with on board ship.

We are here chiefly concerned, therefore, with the " major " infections. Highly important as it is for the Ship's Surgeon to be practically familiar with these four diseases, it is for the Port Health Officer one of the most essential points of his equipment. In the Utopian future—of which I sometimes permit myself to dream—it will be a *sine qua non* of a P.H.O.'s appointment that he will previously have made himself familiar with all the clinical aspects of each disease.

Early detection and isolation are, of course, even more important on sea than on land, owing to the curtailed and crowded environment, which cannot be avoided. A consideration of this point will serve to emphasise the necessity for frequent observation by the Ship's Surgeon of everyone on board.

Isolation aboard is always a matter demanding careful attention. As the origin and spread vary in their nature with the different diseases, common sense will dictate the necessary measures of isolation. In yellow fever, for instance, a mosquito net is sufficient isolation; in bubonic plague, a clean cabin and clean clothing are all that is necessary; in cholera, as little communication as possible, and prompt disinfection of all dejecta will be indicated; while in the case of smallpox, special isolation, as far aft as possible, will be required, with a bare minimum of communication, and general vaccination. These, and similar points, will be dealt with seriatim when treating of the diseases later on in this chapter.

Not only will the diagnosis and isolation of a case be important, but the Surgeon should also know the stage and method of maximum infection. For instance, it is almost certain now that the desquamation in smallpox, scarlet fever, and measles is non-infectious; while the nasal and oral discharges of both the latter diseases are infectious early and late.

Another most important point has to do with the *incubation periods* of the diseases. We know, for instance, experimentally, that the incubation periods are almost certainly as follows:

Cholera	½ to 2 days.
Plague	1 to 3 ,,
Yellow fever	3 to 7 ,,
Smallpox	12 to 14 ,,

Now, when we first look into this point, there are two strange things that impress us. The first is, that any conventions or legal enactments which may deal with the point at all give the *quarantine periods* within the following approximate limits:

Cholera	5 to 7 days.
Plague	5 to 10 ,,
Yellow fever	5 to 12 ,,
Smallpox	14 to 17 ,,

The second fact is that, after a ship has left an infected port a case of disease will occasionally break out on board *de novo*, after a lapse of time which will be found to be greater than the true incubation period of that disease, and sometimes even after the arbitrary quarantine period has been exceeded!

Why should these things be?

Dealing with the second point first: What is the reason for these apparently "deferred incubations"?

I think the cause will in every case be due to one of two factors, which, for the sake of brevity, I will call:

(*a*) *Intrinsic* infection—*i.e.*, infection referable to human "carriers"—that is to say, persons suffering from the disease in a mild, ambulant, or unrecognised form; or,

(*b*) *Extrinsic* infection—*i.e.*, infection referable to insects, water, food, fomites, etc.—the source of infection being, so to speak, "untapped" until some time after leaving the port.

With regard to the "intrinsic infections," the remarks will chiefly apply to cholera, in which disease carriers have been found to be much more common than was previously supposed. Cerebro-spinal meningitis may also be spread by carrier. To a much less extent plague, in the form of *pestis minor*, might constitute a human carrier source. My own experience, however, leads me to suppose that "intrinsic infections" as a cause of ship outbreaks of either disease are almost negligible, although (with cholera) it might be a distinct factor to be considered ashore after the passengers have landed.

With regard to "extrinsic infections," I think it will be

found that most cases in which infectious disease occurs after the conclusion of the normal incubation or quarantine periods, will be referable to this class. For instance, a *Stegomyia fasciata* may have bitten a yellow-fever patient, ashore, during the first three days of the patient's illness, and may have then taken refuge on a neighbouring ship. Such mosquito will become an infective focus twelve days later, and the disease carried by it will not become apparent until the yellow-fever incubation period has been superadded to the twelve days!

Then, again, plague-infected rats may be on board a ship; and if their fleas should by some chance gain access to a person on board, it will probably be only after the ship has left port for some days or weeks. Or, again, some food or water may have been contaminated by cholera vibrios before being taken on board ship, and may not be broached until the ship has been at sea for days. Or, again, some box containing clothing infected with smallpox may be opened up during the voyage, with a resulting occurrence of the disease fourteen days thereafter.

Such situations, many of which can be imagined as occurring in practice, will explain the apparent contradictions of the incubation period. But it should be distinctly understood that these deferred cases on ships are quite rare, and that the usual infection on a ship will first occur in a person who has contracted the disease ashore and come on board during his incubation period, and that subsequent cases will be either in the same box, or will have contracted it from the first case.

The next question which will naturally occur is: If the incubation period is known, and the causes of deferred cases are known and avoidable, why, then, is the arbitrary quarantine period made to exceed the known incubation period?

The reasons are many.

(*a*) The hygienic education of native deck passengers or steerage immigrants is not such as to justify our relying either on their word or cleanliness. Consequently, a time margin is essential as a precaution against introduction by intrinsic or extrinsic infection.

(*b*) The sanitary staff and time at our disposal are usually insufficient to carry out such stringent disinfecting and other precautions as will be necessary to ensure *no* loopholes in the sanitary defences if the bare incubation period is adopted. We thus add an arbitrary margin which, in practice, tends towards a similar result by allowing time for an intrinsic or extrinsic infection to have a tangible result.

(*c*) Many ports have not yet adopted the most modern and rational practice—that measures of disinfection and general precaution should be taken at the port of departure rather than at the port of arrival. Such sound practice will, I hope, be one day generally adopted. If a ship, before departure from an infected port, has not only had a medical inspection of all on board, but has had her holds and cargo de-ratted; has had all her deck passengers under a three days' depot inspection (including vaccination and disinfection of person, clothes, and effects); has had the native crew's effects similarly dealt with; and has taken on board her food and water supply under the observation and control of the Ship's Surgeon—*then*, every day of such ship's voyage is a day of effective quarantine, and can be counted towards such with safety; while the total quarantine period need only in such case coincide with the actual incubation period. The majority of any cerebro-spinal carriers will have been spontaneously cured. An occasional cholera-carrier will filter through—but the risk is small on a non-infected ship bringing passengers from a district which is not badly infected. Recruiting districts which are badly infected would be closed altogether.

Before proceeding to deal with the four major diseases, I should like to give a few words of advice to the Ship's Surgeon. I have already pointed out the need for familiarity with the clinical features of the diseases, and the great importance of keeping all on board under routine observation; but there are other things.

Especially in the tropics and amongst non-European races, familiar aspects of disease are apt to appear distorted, fevers and bowel complaints are common, and death is often swift.

I would urge Ship's Surgeons to keep most careful clinical notes of all cases in the medical log. You should take a

blood film in all cases of fever; let it dry in the air, wrap it in paper, and label it with name and date. In cases of pneumonia, take a sputum smear, fix with heat over a spirit lamp, wrap in paper, and label. In bubo cases, put in an exploring needle, smear the contents on a slide, fix with heat, wrap, and label. In diarrhœa cases, take a stool, smear on a slide, fix with heat, wrap, and label.

You have no idea of the extreme use such slides may be to the examining Health Officer at the next port, who may not have a chance of inspecting the corpse.

Such details of practice will at once show whether you are worth your salt, or whether you are one of a *laissez faire* brigade who might do so much to bring the mercantile marine into disrepute.

People who die at sea are, of course, generally buried at sea. But if anyone dies within twelve hours of reaching port you should always insist that the body is kept for examination by the Health Officer.

There is one other point: Get a copy of the Quarantine Laws, Rules, and Regulations at every port you go to. Keep them in a folio spring file. Master their contents yourself, and see that they are kept in your surgery for the use of your successors.

In the following remarks on the four major infectious diseases the marine point of view is especially considered. Etiology and treatment are not dealt with. Each disease is treated under the four headings:

(*a*) Geographical distribution.
(*b*) Diagnosis.
(*c*) Pathology.
(*d*) Danger and control.

Plague.

Geographical Distribution.—The distribution of plague is historically of some interest. An epidemic which visited all Europe in the time of Justinian (A.D. 527-565) was probably plague. This lasted for about fifty years.

In the twelfth century the disease was probably present in India, judging from contemporary writings, and this is

especially interesting as recognising for the first time the rôle of the rat—instructions being given to leave any place when rats die in numbers.

A pandemic known as "the Great Black Death" ravaged all Europe and Asia in the fourteenth century, when many millions succumbed.

Europe was visited with another pandemic in the second half of the seventeenth century, and the English share of it is known as the "Great Plague of London" (1664-5), when 70,000 of the 460,000 inhabitants died.

Thereafter plague seemed gradually to disappear.

The great existing modern pandemic apparently began about 1878 in the Chinese province of Yunnan. It took about ten years to reach Pakhoi, and later (1894) appeared at Canton, Hong-Kong, and Amoy. Having once reached such a large ocean port as Hong-Kong, a worldwide extension was, of course, provided for. During the next year (1895) the disease had spread northwards up the China coast to Swatow and Foochow. By 1896 it had appeared in Bombay. It reached Calcutta while I was there in 1897.

In the course of the following few years it had been carried by trade-routes to Mauritius, Madagascar, Delagoa Bay, the Philippines, Japan, Australia, the Pacific islands, Egypt, Paraguay, Brazil, and Argentina.

The extent of the epidemic, which still exists widely, can be realised a little when we see that, in 1904, over one million deaths from plague were registered in India alone! And the haunting tragedy is that all this worldwide waste of life might most likely have been avoided if, in the year 1894, Hong-Kong had possessed a large Port Health staff, with such facilities for fumigating every departing ship as have been devised and widely employed in more recent years.

We now come to the distribution of plague in its practical bearing on the Ship's Surgeon's and P.H.O.'s work.

From the recorded occurrence of plague in the ports of the world for the past five or six years (as given in Cofer's Statistical Tables) I have made out tables in four different classes, as follows:

(A) *Chief Ports of Call from which Plague is very likely indeed to be conveyed by Ships.*

Country.	*Port.*
China	Amoy.*†
,,	Hong-Kong.*†
Ecuador	Guayaquil.
India	Bombay.*
,,	Calcutta.*

(B) *Chief Ports of Call from which Plague is not unlikely to be conveyed by Ships.*

Country.	*Port.*
Brazil	Bahia.
British East Africa	Mombasa.
China	Amoy.*
,,	Hong-Kong.*
,,	Swatow.*†
Egypt	Alexandria.
,,	Port Said.
India	Karachi.
,,	Madras.*
,,	Bassein.‡
Burma	Rangoon.‡
Indo-China	Saigon.
Java	Sourabaia.
Mauritius	Port Louis.§
Persia	Bushire.
Siam	Bangkok.
Tripoli	Tripoli.
Turkey-in-Asia	Jeddah.

(C) *Chief Ports of Call from which Plague might possibly be conveyed by Ships, and which should be viewed with Suspicion.*

Country.	*Port.*
Arabia	Aden.
Brazil	Pernambuco.
,,	Rio de Janeiro.
Ceylon	Colombo.
Chili	Iquique.
China	Shanghai.
Japan	Kobe.
,,	Yokohama.

* As a rule, from February to July inclusive.
† When deck emigrants are embarked.
‡ As a rule, from April to September inclusive.
§ As a rule, from September to February inclusive.

Country.	*Port.*
Peru	Callao.
,, ...	Salaverry.
Philippines	Manila.
Straits Settlements	Singapore.
Turkey-in-Asia	Beyrouth.
,, ...	Trebizond.
Venezuela	Caracas.
Zanzibar	Zanzibar.

(D) *Ports of Call which, for the time being, are unlikely to be dangerous, and to which a minimum of attention need be paid.*

Most other ports.

N.B.—The above cannot, of course, be considered as absolutely correct. It is merely intended to indicate the probabilities based on the conditions of the last few years, and may serve as a rough guide to such Ship's Surgeons and others as are not furnished with current returns.

Diagnosis.—It should be remembered that plague has four different types of manifestation:

(*a*) Pestis minor.
(*d*) Septicæmic.
(*b*) Bubonic.
(*c*) Pneumonic.

Pestis Minor.—This is really a kind of ambulant form of plague. It may precede an epidemic, or may follow it as a result of diminished virulence.

A lymphatic gland becomes enlarged and the enlargement may be accompanied by a slight rise of temperature to 101° F. or 102° F., the fever declining to normal by about the fourth or fifth day. The gland is slowly absorbed. There is very little constitutional disturbance throughout—a fact which makes the patient rather a source of danger. Fortunately, the condition is not extremely common (except in the midst of a major epidemic), for the diagnosis is naturally often overlooked.

Septicæmic Plague, except as a last phase in the bubonic type, is not common. In the rare instances reported it is possible that infection may have occurred via the intestine.

Bubonic Plague is the most common of all varieties. The most frequent situation for the bubo is in the inguino-femoral region; axillary buboes are not uncommon; cervical are more rare.

After an incubation period of one to three days, the symptoms generally begin suddenly with a headache and perhaps a rigor (convulsions in children). The temperature rises quickly up to a maximum on the second or third day. Profound constitutional disturbance sets in early. The headache (frontal) increases rapidly. The gait is reeling and drunken; the expression anxious. The face is flushed, and conjunctivæ injected. Examination discloses a bubo—hot, painful, and indurated. The pulse is fast and full, but usually of unexpectedly low tension. The tongue becomes swollen and furred, but its edges and tip are usually red.

This is the usual clinical picture—typical of the disease.

In severe and fatal cases the anxious expression becomes apathetic; the pulse, dicrotic; and a condition of stupor supervenes, with a rapid fall of temperature, collapse, and death. The mortality in bubonic plague varies. Amongst Eastern races it may be as high as 60 to 75 per cent. in some epidemics. Amongst Europeans it is usually about 20 per cent.

In the usual typical case the diagnosis should not be a matter of much difficulty.

I remember a suspicious case amongst a large batch of Chinese coolies reaching Singapore. A boy passenger had been ill for a day or two before arrival. When I saw him he had a temperature of 103·5°, with a reeling gait, and the tongue and facies of a plague case. I could find no glands and no sign of pneumonia. I therefore removed him to the Quarantine Station for observation, as a possible case of septicæmic plague. The next day he was delirious, and his appearance even more suggestive than before. The diagnosis was, however, cleared up on the following day, when a small-pox rash appeared!

Pneumonic Plague.—In an epidemic of bubonic plague a certain number of cases of primary plague pneumonia usually occur, probably spread directly as a result of a rare secondary pneumonic infection occurring in a bubonic case.

A primary pneumonic plague will only be contracted by the inhalation of the fine and highly infective sputum spray coughed out by another pneumonic case. A most interesting example of a plague epidemic, consisting solely of pneumonic cases, occurred in Manchuria during the winter of 1910-11, and caused the death of nearly 50,000 people. Such an epidemic was previously unheard of. The local conditions would, of course, account for it. During the bitter Manchuria winter, the small huts and houses will be kept closed as much as possible for the sake of warmth. They are also often overcrowded. The introduction of a single case of pneumonic plague would, of course, be in such circumstances a perfect focus for a rapid spread from person to person.

The diagnosis will not call for special mention here. The clinical symptoms are those of a disseminated broncho-pneumonia, but the constitutional disturbance is much more profound, and the mortality is 100 per cent.

There is, of course, no reason why a case should not occur on board ship, and very dangerous it would be amongst crowded immigrants. But, fortunately, the percentage incidence is rare in any plague centre, and therefore relatively likely to be very rare indeed on board ship.

But, none the less, the Surgeon and Port Health Officer should never fail to keep the possibility in view, especially amongst native crew and passengers coming from suspicious ports.

Pathology.—The Indian Plague Commission summarised the pathological conditions as follows:

"The distinctive pathological changes produced by the virus of plague would appear to consist of universal dilatation and engorgement of veins and smaller bloodvessels, with hæmorrhages, both minute and of large amount, in nearly every part of the body; and of enlargement of the lymphatic glands, with œdema and hæmorrhage in the surrounding tissues, generally mainly implicating the external glands, but occurring likewise throughout the body, and involving in a series of cases the entire system of lymphatic glands.

"In the lymphatic glands, the characteristic conditions are

largely explainable by vascular changes, and even in the pneumonia of plague, vascular dilatations and hæmorrhagic extravasations give a special character to the lung inflammation. In no other infective disease are these features represented, but it is of some interest to note that the vascular changes, and especially the prevailing and characteristic tendency to extravasation of blood in almost every part of the body, are closely reproduced in toxæmia caused by the organic poison secreted by the venom glands of several species of serpents, such as the black snake (*Pseudechis porphyriacus*) of Australia."

I would again urge on Ship's Surgeons the importance of taking a juice smear from the bubo of any bubo-fever case on board ship, fixing by passing three times quickly through a spirit flame, and then keeping in clean paper for the inspection of the P.H.O. at the next port. The same thing should be done with the sputum in pneumonia cases. Although the patient may have died and been buried at sea, the P.H.O. would, nevertheless, have something definite to go on.

Another warning to Ship's Surgeons: If you do a post-mortem on board ship, always remember the possibility of plague, and take every possible precaution. A plague corpse is most violently infective—the bacillus swarms in the blood, juices, and every part of the body. Some years ago I lost a Resident Medical Officer at my Quarantine Station, and also an Assistant Surgeon who had been with me for years. They were both doing a post-mortem on a body, and had no thought of plague. They both got small scratches from jagged rib-ends, and both died of plague within a week. Since then we have ordered rubber gloves always to be worn for every post-mortem.

Don't forget also that a plague corpse, even though no post-mortem is done, is a source of danger. Many undertakers died in Hong-Kong from handling plague corpses.

The danger, of course, lies in any discharges from nose, mouth, buboes, anus, etc., which may get smeared about and which are loaded with bacilli. Such bacilli might gain access to others who handle the corpse by cuts, scratches, or other

abrasions on their hands; or might be mechanically carried, by their own hands, to their mouth or nasal mucous membrane.

Flies also might act as carriers.

From what has been said, it is seen that the prompt wrapping up in a disinfectant sheet of a plague corpse is a matter which should not be delayed directly death has taken place.

For those Surgeons who are provided with or carry their own microscope, the following *bacteriological notes* may serve to refresh their memory.

B. pestis is a short round-ended rod, of coccoid or oval shape, measuring 1·5 to 2·0 μ in length by 0·7 μ in breadth.

Flagella are supposed to have been demonstrated; while ordinarily non-motile, *Kitasato* states that it is motile at a temperature of 37° C.

The bacillus is a facultative anaërobe, and does not form spores.

It does not retain its stain when treated by Gram's method.

It does not liquefy gelatin.

It is very easily killed with ordinary disinfectants, or with weak mineral acid solutions.

The bacillus generally occurs singly, but pairs or chains are sometimes seen.

It has a staining peculiarity, in that, when stained with an ordinary basic aniline stain, the ends of the bacillus are more deeply stained than the centre—called "bipolar staining." The best stain to use for this is a concentrated solution.

℞	Fuchsin	1 gramme.
	Abs. alcohol	10 c.c.
	Sol. ac. carbol. (5 per cent.)	100 c.c.

For use, add equal parts of this solution and of distilled water. After fixing by heat, stain while the slide is hot by quickly dipping into the staining solution, removing, and washing in water as quickly as possible. Dry, and examine with $\frac{1}{12}$ oil immersion. The bacilli will be seen with the characteristic bipolar staining.

There is also a diagnostic cultural peculiarity. If faintly alkaline peptone broth be inoculated with some plague material, and a few drops of clarified olive-oil floated on the top of the medium, the growth will appear in about twelve hours as a diffuse cloudiness, which will gradually coalesce as a kind of stalactite formation, hanging from the under surface of the fat.

Danger and Control.—The diffusion of plague by ships and the control of it on board are matters of paramount importance. The present pandemic has undoubtedly spread over the world by shipping channels—partly human, partly muscidine. It should be understood, however, that this spread is very insidious. Out of the vast number of ships sailing the sea a

very microscopical percentage will be infected with plague. Instead of this fact making the authorities more careful (as it should do), it often has an opposite effect.

The amount of care necessary, however, will depend on many circumstances. In Europe, or, rather, especially in Great Britain, precautions against the introduction of plague might be relaxed much more than in the tropics, without damage to the country, and this for four reasons:

(*a*) *Mus rattus* has been largely displaced by *Mus decumanus*, which, while not minimising the danger of rat plague, will enormously minimise the danger of human plague.
(*b*) Modern general sanitary conditions militate against any spread of plague even if introduced.
(*c*) Very few of the class of hygienically dangerous deck passengers arrive from plague-infected centres.
(*d*) The great length of voyage from the nearest infected or endemic ports will usually automatically dispose of infection before arrival.

It is otherwise with most tropical ports, where the utmost care will be necessary to prevent the entry of plague.

The disease may be introduced to a ship from an infected port in several different ways:

(*a*) By a human being who is in the incubation stage.
(*b*) By a human being who is actually suffering from the disease in one or other of its types.
(*c*) By infected rats shipped with cargo.
(*d*) By infected rats themselves boarding the ship by means of gangways, hawsers, etc.
(*e*) By human clothing, rags, or other articles containing infected fleas, which may (on release) subsequently infect either the rat or human population of the ship.

With regard to (*a*) and (*b*), it should be noted that plague will occur very rarely indeed on ship-board amongst the class who travel as first or second saloon passengers. In the examination by my department during the past sixteen years of many thousand ships, I have never known a case amongst the cabin passengers.

The liability to an attack proves to be greater amongst

European deck passengers, and also amongst European crews —though even then it is uncommon.

The majority of cases of plague infection on ship-board will be found to occur amongst native deck passengers or native crews. This, of course, is not due to any class or race idiosyncrasy, but is merely a result of the varied habit of life and hygienic surroundings amongst the different social classes.

To exclude from embarkation a passenger in the incubation stage of the disease is, of course, a difficulty. It could be met by adopting my previous suggestion of depot-detention of deck passengers for a few days before going on board. The cabin passengers, as I have shown, may be safely neglected.

To exclude a person actually suffering from the disease should be easy, for it should be part of a Ship's Surgeon's duty to examine every passenger embarking at a plague-infected port. If he does not do so, and if he does not examine his crew on the day of sailing, he has been wanting in one of his most important functions.

The entry and exit of rats into and from a ship by gangways, hawsers, etc., can, and probably often does, take place. This migration will probably be limited, as a rule, to healthy rats seeking new food-supplies. Rats sick and dying of plague will be less likely to indulge in these olympic exercises. But because this fact is a soothing one, the danger should not on that account be overlooked, and no reasonable precautions should be neglected.

Rat regulations are dealt with in Chapter VI., and rat fumigation in Chapter X.

Infected rats, shipped *in situ* with cargo, are a different matter. A nest, or hole, or receptacle embedded in packages of cargo may be as likely to contain a sick rat as to harbour a sound one. But here again we are met by a fortunate circumstance. A quite small minority of cargoes will be likely to contain rats *in situ*. The following are the chief of such cargoes:

(i.) Grain in sacks (*e.g.*, rice, corn).
(ii.) Forage.
(iii.) Skeleton crates containing hardware or other goods packed in straw.

Such cargoes are always suspicious, and if coming from a plague-infected port should be fumigated with SO_2 before discharge.

Practically every ship after its first voyage or two has a permanent rat population, which is a potential source of danger.

The human ship population is much more transitory, and a case of human plague will probably never (or extremely rarely) infect the rats on a ship. But the converse does not necessarily hold good. Once infected, such rats may infect the people on board—more especially native deck passengers and native crew, whose habits are the rats' paradise. Another point to remember in this connexion is that, if infected ship rats do not convey the disease to anyone on board, their presence may be unsuspected and the source of danger consequently overlooked. This has been demonstrated many times—*e.g.*, *Kossel* and *Nocht* found dead plague rats on two ships which had supplied no cases of human plague; also the s.s. *Rembrandt* arriving at Bristol; etc., etc.

The converse of this should always be borne in mind. In 1899 there was much plague in Brazilian ports. Ships from thence to New York were carefully examined for two months and fumigated. All the rats so killed were examined, but none were found to be plague-infected, although two of the ships had been infected with human plague.

We now come to the infection of a ship by clothing, rags, etc. In early days this was thought to be the chief source of sea-borne plague. Later, it was thought to be hardly a source at all. Now it is probably assessed at its proper value.

If there are no rats secreted in them there are only two possible means by which clothing, rags, etc., can convey plague:

(i.) They may be contaminated with plague bacilli from some infected discharges.
(ii.) They may give refuge to infected fleas (? eggs or larvæ).

In the first instance, the contaminated material will have to infect the person handling it through some cut or skin abrasion; such infection will have to be effected fairly soon after the original contamination, for the bacillus is not in such

circumstances long-lived; and it is most unlikely that rats would be thus infected.

For these reasons I think that the "contamination" method will be the most rare cause of plague propagation by clothes, rags, etc.

In most cases where these articles seem to be incriminated I think the wily flea will be found at the bottom of the box! The flea can live a good long time in such surroundings. The theory would explain many incidents. For instance, plague was introduced into Durban in 1900 from Mauritius by means of infected clothing (*Simpson*). A boy from the latter plague-infected port went to East London to avoid quarantine at Durban, but later proceeded there, reaching the port on April 1st. On May 13th he unpacked part of his luggage and died of plague about five or six days later—a Mauritian flea had probably had her first square meal for some weeks.

Another instance: A man lost his wife from plague in Bombay, and started for his native village, near Hurnai, ten days later, taking his wife's clothes with him. There had been no plague in the village, but a week after his arrival the rats in and near his house began to die, and human cases quickly followed.

This case was obviously due to fleas with an affection for the clothing of his wife. Very likely the box contained not only clothing but food also. The rats would scent a meal, and so subsequently would the fleas in the box also.

We have now to consider what the Surgeon should do when he is confronted with a case on board.

If, as is probable, it is a case of bubonic plague amongst the native deck passengers or crew, the case should be removed at once to the ship's hospital; the patient's clothing promptly burnt, and a clean hospital suit issued; the patient's box cautiously opened, 10 ounces of 40 per cent. formalin sprinkled on the top layer of contents, and the box quickly shut, locked, and retained by the Surgeon. The case can be treated in the ordinary ship's hospital without any special isolation—there will be no danger from that source; but the immediate relatives or friends forming the patient's travelling party should have

their clothes thrown overboard, be given clean garments, and be isolated on the poop or other convenient place for three days' observation. The 'tween decks or emigrant quarters should be kept as clean as possible; no food débris should be permitted to lie about; and the lower hold hatches should on no account be allowed to be opened until the Health Officer at the next port has dealt with the situation.

Should the case happen to be of the fortunately rare pneumonic type, it will be a different story, and spread is highly probable. In such circumstances do not treat the case in the ordinary ship's hospital, but get a temporary canvas tent at once rigged up at the after end of the poop, and *isolate* the patient as soon as possible. Turn out all the other emigrants from their 'tween decks, and have the place thoroughly washed out with disinfectant at once before allowing them to return.

A bubonic case in a cabin passenger can be safely treated in his own cabin. There is no need to inform the other passengers beyond that the patient is very ill and cannot see visitors.

A pneumonic saloon case is not likely to occur. If it did it should be promptly isolated in the most complete manner possible.

Cholera.

Geographical Distribution.—The endemic habitat of the disease from remote times has been India. There have been annual or periodical exacerbations traceable to movements connected with religious festivals, etc.; and the outbreaks at intervals have taken on a violently explosive character. Such have been in the years 1826, 1831,* 1840,† 1852 ‡ 1863,§ 1879,‖ 1892, 1900, and 1908. On each occasion it has

* Half pilgrims died at Mecca in 1831; 4,000 deaths in Great Britain, 1832; 7,000 in Paris in 18 days, 1832; 15,000 in Mexico, 1833; 4,000 in Malta, 1837.

† Spread to China and returned; 25,000 deaths in Russian Turkestan, 1844; 22,000 in Lahore, 1845; 15,000 in Mecca (pilgrims), 1846; 15,000 in Paris, 1849; Severe at Hull. Spread to West Indies, 1850.

‡ Europe, America, and West Indies, 1853; 20,000 deaths in England, 1854; 140,000 in France, 1854; 24,000 in Italy, 1854; recurred everywhere, 1855.

§ 30,000 deaths in Mecca (pilgrims), 1865; 4,000 in London, 1866; West Africa for first time, 1868.

‖ 6,000 deaths in Mecca, 1881; 50,000 in Egypt, 1883.

been widely spread along the lines of human intercourse—
—a pandemic in Asia, Europe, North Africa, and even North America and the West Indies.

The chief landmark in our knowledge of the disease was the discovery by *Koch* in Egypt, in 1883, of the specific "comma bacillus."

In the practical bearing on marine work, cholera—unlike plague—has no favourite ports with annual recurrences. It is, therefore, hard to lay down definite tables for the Ship's Surgeon. Beyond the fact that nowadays the disease in an epidemic state has been kept more or less within tropical boundaries, little can be said. An epidemic may break out anywhere and at any time.

The following list of the better known ocean-going ports may, however, be of some use.

From the conditions of the past decade or so, it is as well to treat these ports tentatively with suspicion until the actual state has been investigated.

In consulting the list, bear in mind that the cholera season in Indian and neighbouring ports is, generally speaking, April to June; while farther east, as in Siam, Southern China, etc., the season may begin earlier and extend later—say, February or March to July.

Chief Ports of Call which should be viewed with Cholera Suspicion.

Country.	*Place.*
Arabia	Jeddah.*
Asia Minor	Smyrna.
Ceylon	Colombo.
China	Amoy.*
,, ...	Hong-Kong.*
,, ...	Shanghai.
,, ...	Swatow.*
Dutch Indies, Java	Batavia
,, ,, ...	Samarang.
,, ,, ...	Sourabaia.
,, Sumatra ..	Palembang.
India	Bassein.
,, ...	Bombay.

* If carrying emigrants or pilgrims.

Country.	*Place.*
India	Madras.
,, ...	Negapatam.
,, ...	Rangoon.
,, ...	Calcutta.
Indo-China	Saigon.
Japan	Kobe.
,, ...	Nagasaki.
,, ...	Tokyo.
,, ...	Yokohama.
Philippines	Manila.
Siam	Bangkok.
Straits Settlements	Singapore.
Turkey	Constantinople.
Zanzibar	Zanzibar.

Diagnosis.—In about 75 per cent. or more of cholera cases the onset is sudden and acute after completion of the half to two days' incubation period. After an hour or two's abdominal discomfort diarrhœa sets in. In the course of another half-hour or hour vomiting begins, and the character of the stool alters from a bilious type to an almost colourless watery evacuation, with suspended white flocculi like rice grains—the so-called "rice-water stool." The retching and diarrhœa become almost constant, the stool being passed involuntarily. Very painful cramps in legs and abdomen are usually prominent symptoms.

In the short space of an hour or two a stage of profound collapse has been reached. The voice is husky, and scarce above a whisper. The urine is completely suppressed. The body is cold, and clammy, and shrunken. The face is especially characteristic, with its anxious, pinched, and drawn appearance, its prominent cheekbones, and the eyes receded into great hollow sockets.

The skin of fingers and toes is livid, and becomes shrivelled like a washerwoman's.

If untreated, 60 per cent. (or more) of these cases are fatal, death taking place in ten to thirty hours from the onset.

In favourable cases a reaction sets in. The pulse is again felt; the body becomes warmer; the secretion of urine re-

commences. The vomiting and diarrhœa gradually decrease, and the stools become bilious.

To one who knows cholera a typical case should call for no diagnostic hesitation, and should need no microscopical confirmation, especially in the presence of other similar cases.

Ptomaine poisoning and phosphoretted hydrogen poisoning are the only acute conditions which are likely to simulate the symptoms of cholera. The former is rare; the latter very rare indeed. Ptomaine poisoning will appear when one or more people have partaken of tainted food, and the symptoms of all the batch of people will occur almost at the same time. Cholera, on the other hand, will continue to crop up at irregular intervals, and the stools will have the rice-water character, which is absent in ptomaine poisoning.

Poisoning by phosphoretted hydrogen on ship-board will probably never come within the ken of any Ship's Surgeon who may read this book. It is a result of emanations from disintegrating ferro-silicon (in the presence of moisture)—a substance used in the preparation of steel, and occasionally carried as cargo. The last recorded instance was the death of five immigrants on the s.s. *Ashton* at Grimsby, on December 13, 1908.

It will thus be seen that the diagnosis of cholera is one which should, as a rule, offer no difficulty to a Ship's Surgeon.

In my dealings with many hundreds of them I have, alas! come across a considerable number who, either from ignorance or design, make a false report of cholera on board. The causes of death which they give to the Captain for entry in the ship's log will perhaps hardly be credited. They are generally one or other of two diagnoses: (*a*) sea-sickness, or (*b*) want of opium! I need hardly point out to such Eastern Ships' Surgeons that people do not die of sea-sickness (except perhaps one in a million, who may have bad heart disease). Nor does a partial curtailment of some of the opium supply of habitual opium-smokers lead to several deaths in a short voyage of half a dozen days, although it may produce some insomnia and a bilious diarrhœa. Port Health Officers should therefore be on their guard; and they will, in my opinion,

be quite safe in quarantining any ship on which deaths are reported as having occurred from such diagnostic causes !

Pathology.—The condition is a toxæmia (not a septicæmia) caused by the growth of the "comma" bacillus, or vibrio of cholera, whose special seat of election is the alimentary tract. The chief pathological conditions will therefore be connected with that tract. The peritoneal surface of the bowel is usually dry and sticky, with injected vessels; and the mucous membrane within will be found to be acutely congested. The contents, if seen early, are often like an old and liquid Camembert cheese. Usually, however, they contain a typical rice-water stool, or more rarely the bowel will be nearly empty, with viscid albuminoid material between the rugæ.

It will be remembered that the specific organism is a curved rod of 1·5 to 2 μ in length, shaped like a German comma. It is motile, and does *not* form spores. It liquefies gelatin in about fifty hours. It does not retain its stain when treated by Gram's method. A characteristic reaction is known as the "*cholera-red reaction.*" A tube of peptone-broth is inoculated, and incubated at 37° C. for twenty-four hours. If then, on adding a drop or two of pure sulphuric acid, a red colour is produced, it will show that the bacillus under investigation is that of cholera. The reaction is due to the formation of a red nitroso-indol body in the presence of H_2SO_4, which reacts with the indol and nitrite formed by the vibrio. (The *Bacillus coli* forms indol, but not nitrites, during its growth.)

In all doubtful cases the Surgeon should take a smear to keep for the Health Officer of the next port. A little of the rice-water stool should be thinly smeared on a slide, which is then prepared in the same manner (either unstained or stained) as was suggested in the case of plague.

Danger and Control.—Unlike the comparatively limited outbreaks of smallpox and yellow fever, and unlike the relatively low European mortality in modern plague, cholera is a disease which spreads far and swiftly, and spares neither old nor young, Caucasian nor Asiatic.

However much, under favourable circumstances, plague may spread ashore, its original passage by sea is quiet and insidious, and almost unnoticed.

With cholera it is very much otheriwse. The short incuba-

tion period, and the ease with which it is communicated from person to person amongst Asiatic natives, and the frequency of ambulant or "carrier" cases, all combine to make the disease one of the most appalling ship diseases with which we have to deal.

The need for instant diagnosis and the promptest action is of a paramount importance, which, alas! is seldom realised by the newly qualified Ship's Surgeon.

The first thing to consider is the *method of spread.* This I have gone very carefully into, both on our quarantine station and on ships, and ashore—not only in the Straits Settlements, but in India and elsewhere.

We know definitely that the disease is not conveyed by inoculation, nor by the bites of insects. The one and only means of contracting the disease is by the ingestion of the specific germ via the mouth. The issue is therefore narrowed.

Speaking generally, there are three ways by which this mouth infection is accomplished:

(*a*) Personal spread.
(*b*) A general infection of some water-supply.
(*c*) Infection of food by flies.

I will begin with the last—(*c*)—which is the least common method of infection, and extremely rarely so on board ship. One of my many reasons for saying that spread by flies is rare is based on the following incident:

In June, 1911, a batch of 3,400 Tamil coolies were landed on our quarantine station, infected with cholera. It happened to be a "fly season," which was aggravated by the ingress of Tamils, whose promiscuous habits of defecation conduce in the highest degree to the prompt reproduction of most of the common fly species. Of these coolies most were of the lowest class—on contract. But 122 were deck passengers of a rather better class, who had paid their own passage. This batch I put in a ward which was completely surrounded at a distance of about fifty yards by the wards in which the contract coolies were segregated. No restrictions were placed on the movements of anyone. The same food was served out to all the wards. The water-supply was identical in each

case. *And*, the flies were as the plague of Egypt—millions of them everywhere! Result: Every ward occupied by contract coolies had cases of cholera, the daily totals being 2, 3, 17, 12, 14, 18, 13, 18, 9, 9, etc.; *but* not a single case occurred in the wardful of "free passengers."

The same experiment I have repeated on other occasions, and I am led to the conclusion that the spread of cholera by flies is one of the rarest methods by which this fatal disease progresses.

We now come to the two other methods—water-supply and personal spread.

By charting out daily returns of cholera cases in any town you can usually tell at once whether the origin is traceable to an infected water-supply or to the more usual personal spread. If a water-supply is to blame, a large number of people are attacked at once. The rise in the chart curve will be sudden and high—as seen in the daily variations. Such explosive outbreaks will continue until the water-supply has been artificially or naturally purified, and will then die out. Examples are not uncommon—contaminated river supplies in India, for instance. Then the Broad Street pump case, investigated by Dr. Snow in 1849. The well supplying the pump was contaminated by a leaky cesspool. In a few days several hundred cholera cases occurred amongst the habitués of this well; and two ladies in a distant part of Hampstead, who were wont to find virtue in this particular water, were also attacked.

In later times we have the Hamburg epidemic of 1892, which provided a large number of cases amongst those who drank the unfiltered Hamburg water-supply derived from the river; while the contiguous suburb of Altona, supplied with filtered water, escaped.

Beyond imported cases, such general infection of a water-supply is the only likely cholera focus in Europe under modern sanitary conditions; and, as the source of the disease would be easily found and dealt with, and most unlikely to spread, the control of cholera in Europe will therefore lie more in the hands of the Municipal Authorities than in those of the Port Sanitary Authorities.

With regard to cholera-infected water-supply on ships, it is so rare that it can almost be neglected, but should, nevertheless, be kept in mind. Amongst the many cholera-infected ships I have dealt with, I have not known a case due to such a cause. If it did occur, it would be at once obvious, for the majority of the ship's inhabitants would be stricken with the disease. There are only two ways in which such ship water-supply would become infected:

(*a*) *The water embarked at any port might be infected.*

This is unlikely, for most ocean ports have now a good water-supply, filtered or artesian; and if they have not, the Surgeon should refuse to allow water to be taken on board at such port.

In some river ports, where the shipping has to lie in mid-stream, the town water may be good, but the water-boat conveying it to the ship may be contaminated. I think several ship infections at Bangkok a few years ago were due to that cause.

(*b*) *The ship tanks might become infected from an actual cholera case on board.*

This would be most unlikely unless the ship epidemic became extensive. In that case infected material might gain access to the tanks via the sounding-pipes, especially if the latter were not provided with a raised combing, as they ought to be.

We now come to what I previously called the *personal spread* of cholera, for want of a better term.

Amongst native races this is the usual and common method of spread. On ship-board it is practically the only method of communication of the disease.

By "personal spread" I mean the transference of the disease from an infected person to a non-infected person in a more or less direct personal way, and not in a general way, as by contaminating a large water-supply.

It will be asked, what is the *modus operandi?* The causes at work are various:

(*a*) The latrine soiling of the hands of a "carrier" or early case, and the subsequent handling of other people's food by him.

(*b*) The use of unwashed cups, etc., by healthy persons after previous use by a cholera case.
(*c*) The handling of a cholera case, and subsequent handling of food, without precautions.
(*d*) The transference, by the feet, of cholera discharges, and the subsequent placing or eating of food on such infected areas.
(*e*) The annexation of an opium-pipe previously used by a cholera patient.
(*f*) The contamination of chop-sticks, plates, or leaves used as plates, or the rind of fruit, by manual infection.
(*g*) The handling of soiled garments of a deceased patient, and the subsequent eating of food with unwashed hands.
(*h*) The rinsing of contaminated hands in small receptacles of water intended (or used) for drinking purposes.

Many other conditions will occur to one as likely to conduce to the personal spread of cholera. Most of these will naturally apply to native races, whose habit it is to eat off the ground, and to eat with their hands or with chop-sticks, especially if they belong to a class or race who are not sanitarily sound in their conduct of latrine affairs.

"Personal spread" where European races are concerned will generally be traceable either to improperly washed utensils or to the consumption of uncooked and contaminated green vegetables or fruit.

With regard to the conduct by the Ship's Surgeon of an outbreak on board, more care will be needed in the case of cholera than in any other infectious disease. The disease is apt to spread with appalling rapidity, especially when large numbers of native deck passengers are carried. This is one of the most important reasons for the daily observation of all on board by the Surgeon.

The only hope of controlling the disease will lie in the very promptest removal and isolation of each case at the earliest possible moment; and the immediate disinfection (by an efficient liquid disinfectant) of the original area occupied by the sick person. Only by this means will you be able to prevent the disease getting a firm foothold. Should it unfortunately do so, the confined conditions aboard will render impossible

the necessary measures of segregation, and the situation will be one of increasing anxiety until the next port is reached.

There are only three further things I can suggest to the Surgeon, in the presence of an epidemic, and those are:

(*a*) Give everyone eucalyptus-oil ℿx. twice daily (in emulsion) as a prophylactic.
(*b*) Insist that everyone wash their hands in disinfectant (with use of a nail-brush) immediately before eating.
(*c*) Have every food utensil kept in a disinfecting solution between meals.

All the cases should be isolated in shelters, on the poop deck rather than in the ship's hospital, and no parsimony in the use of disinfectants should be allowed.

Another point to remember is, that convalescents may be as dangerous as cases or "carriers."

The International Sanitary Conference at Paris, in 1911, stated that the duration of the excretion of vibrios is, as a rule, short (2 to 3 weeks), but may extend to a year. This excretion is irregular, and may exhibit bacilli-free intervals of 8 to 12 days.

Greig, in India (1913), recovered vibrios from urine in 8 out of 55 cholera cases; and the same investigator found the gall-bladder to be infected in 80 out of 271 cases. This infection of the gall-bladder is probably via the intestine, and not via the blood, as in enteric. The bile, being an alkaline medium, and harbouring no other visitors, will be a most favourable haven for the vibrio, and the "carrier" problem is thus illuminated.

One other point. Remember that, in your sanitary ablutions, infected liquid is running into the scuppers and discharging down the side of the ship. Cargo-lighters will soon be tying up alongside, and will be fendered off in the process by the hands of the boatmen, who will thus possibly get infected. See, therefore, that all liquid leaving the scuppers has been rendered innocuous before discharge.

SMALLPOX.

Geographical Distribution.—In the older days plague and cholera visited Europe in periodical epidemics, dying out in the intervals. Smallpox, on the other hand, was endemic

in Europe, as in the East, its first introduction being probably during the Moorish conquest of Spain in 710 A.D. For centuries it was the rule rather than the exception to see people pock-marked; but from time to time the endemic character burst into epidemic flame—*e.g.*, Iceland in 1241 and 1707; Sweden in the fifteenth century; the West Indies in 1507; and London in 1871.

Since the discovery and introduction of vaccination by *Jenner* in 1798, smallpox has, however, largely died out where the practice has been general, such as in Great Britain, France, Germany, etc.; and, although a considerable focus exists in parts of Spain, Portugal, Italy, Russia, and Turkey, the disease in modern times is largely tending to become a purely tropical one—that is, a disease chiefly prevalent in the favourable environment of the tropics.

It is a matter of some difficulty to give a list, for the guidance of the Ship's Surgeon, of those ports which have a smallpox danger; for, in any one port, the disease is now epidemic, now sporadic, or now absent.

The following list is compiled from some records of recent years, and may serve as a rough indication until the actual conditions of any place are ascertained.

It should be remembered that, in any case, such smallpox ports are, as a rule, of very little danger to transit cabin passengers or to European crews; although in a bad epidemic some member of the native crew will be not unlikely to contract the disease during a liberty exeat.

The danger of the port, to the ship, will lie in the embarkation of passengers there—the least danger to be expected being from cabin passengers; and the greatest danger from deck emigrants.

List of ordinary Ports of Call to be viewed with Smallpox Suspicion.

Country.	*Port.*
Algeria	Algiers.
,, ...	Oran.
Arabia	Aden.
Argentine	Buenos Aires.

Country.	*Port.*
Australia	Sydney.
Brazil	Rio de Janeiro.
,, ...	Pernambuco.
British East Africa ..	Mombasa.
Canada	Montreal.
Ceylon	Colombo.
Chili	Valparaiso.
China	Amoy.†
,, ...	Canton.
,, ...	Hong-Kong.†
,, ...	Shanghai.
,, ...	Swatow.†
Dutch Indies	Batavia.
,, ...	Samarang.
,, ...	Sourabaia.
Egypt	Alexandria.
India	Calcutta.*
,, ...	Bombay.*
,, ...	Madras.*
,, ...	Rangoon.*
Indo-China	Saigon.
Italy	Trieste.
Mauritius	Port Louis.
Mexico	Tampico.
,, ...	Vera Cruz.
Newfoundland	St. John's.
Philippines	Manila.
Portugal	Lisbon.*
Russia	Petrograd.*
Siam	Bangkok.
Spain	Barcelona.*
,, ...	Cadiz.
,, ...	Valencia.*
Straits Settlements ..	Singapore.
Turkey	Beyrout.
,, ...	Smyrna.
,, ...	Constantinople.
,, ...	Jeddah.*†
Uruguay	Montevideo.*
Zanzibar	Zanzibar.

* Generally infected at certain times each year.

† Practically no danger except when coolies or pilgrims are carried.

NOTE.—In India and China the smallpox season, generally speaking, begins about January and is finished by June.

Diagnosis.—While Surgeons who have been educated and have qualified in the East should be thoroughly familiar with plague, cholera, and smallpox—which, alas! is far from being always the case—Surgeons who have recently qualified at home can hardly be expected to know anything of the clinical side of plague or cholera. But they should at least know something of smallpox. I have boarded many a ship with pilgrims from Jeddah, on which there have been cases of smallpox which could be diagnosed at a distance of about a hundred yards, and have been informed by the Surgeon that he had some cases of " skin disease " for inspection!

I would state here very clearly that I think it is undesirable that any student should be allowed to pass his qualifying examination before he has examined at least three cases of smallpox. Such omission on the part of the examining boards may be responsible for a number of quite unnecessary deaths.

After an incubation period of twelve to fourteen days, the disease usually manifests itself by the onset of severe frontal headache, with considerable lumbar pain, and a rise of temperature. The temperature attains its maximum on about the second day; while, on the third day of the fever, the characteristic eruption begins.

In mild cases, the headache and lumbar pain may be almost absent, and these symptoms should not therefore be relied on as definitely diagnostic.

Nor should any reliance be placed on the idiotic idea that smallpox can occur without an eruption.

The eruption, and the type and distribution of eruption, are the only definite diagnostic features.

The eruption begins on the forehead and face in the shape of raised red papules which, under the fingers, feel rather hard, as if there were small shot under the skin. Within a very few hours the whole crop becomes generally developed throughout the body, but *the sites of maximum distribution are: the forehead and the distal part of the upper and lower extremities*—*i.e.*, forearms, wrists, hands, legs, ankles, and feet.

(NOTE.—This distribution is an important diagnostic feature.)

An excessive distribution of the eruption (traumatic) is frequently found in situations which have been exposed to pressure at the onset of the rash—*e.g.*, round the waist when stays or a belt have been used; at the site of a garter; or round the neck where chafing from a collar has occurred, etc.

The papules enlarge, become somewhat indurated, and the contents become vesicular by the second day. The vesicles attain their maximum limit of growth by the fifth day, and by the eighth day their contents have become opaque and pustular.

Although the distribution of the rash is fairly constant in smallpox, the type of the lesion will be influenced by previous vaccination or its absence.

The types are:

1. *Modified Smallpox* (*Varioloid*).

   Modified by successful vaccination within a reasonable number of years.

   The lesions at first sight are not unlike a grave chicken-pox, but they are more deeply seated, and have not the same distribution; nor are they of oval and polymorphous shapes.

   In this type of smallpox there is often no secondary rise of temperature at the pustular stage, which is generally abortive.

   Subsequent pitting may be very slight.

2. *Ordinary Smallpox.*

   The full-blown lesions are large and quite distinctive.

   In cases where successful vaccination was performed a great number of years before, the individual lesions may tend to be quite far apart (*Discrete Smallpox*).

   In more severe cases, the lesions will coalesce—on the face especially.

   In the most severe cases coalescence of lesions will occur in other parts of the body besides the face—a condition known as *Confluent Smallpox*. This is accompanied in the early stages by a considerable amount of erythema.

3. *Hæmorrhagic Smallpox.*

   This is a fatal but fortunately rare type of the disease characterised by cutaneous and internal hæmorrhages.

The prodromal and initial symptoms are generally exaggerated.

On the first or second day of the fever, patches of erythema appear, and these develop into red or purple petechiæ. Epistaxis and other hæmorrhages are common. The symptoms are complicated by the advent of the usual eruption on the third day of the fever, with considerable subcutaneous œdema. There is generally continued fever, with delirium. Death generally occurs between the seventh and tenth days of the disease.

In a small proportion of cases of this type, the typical eruption of the third day is partially suppressed; hæmorrhages occur widely; large skin areas become purpuric. There is collapse, with subnormal temperature; and death occurs on the fourth or fifth day (*Black Smallpox*).

The chief diagnostic difficulty will be the exclusion of chicken-pox. The later stages of a severe attack of the latter may reasonably be confounded with modified smallpox on occasions. I, therefore, give a differential table which may be of some use.

In the section on plague I recalled a case which seemed at first sight highly suspicious of plague, and which later turned out to be smallpox.

Another case is worth quoting: A coolie, amongst a batch of quarantined compatriots, was removed to hospital suffering from lachrymation, suffused conjunctivæ, pyrexia, and a more or less typical morbiliform eruption over neck and trunk. On the third day that which had been diagnosed as measles turned out to be hæmorrhagic smallpox.

Another point for the Surgeon is: When investigating the health conditions of a port you are calling at, you may see a nil return for smallpox. In such case always look for the heading "Varioloid." The authorities in Manila (I cannot at the moment recall other instances) will give a "nil" smallpox return, and yet show dozens of cases of varioloid.

This, of course, is most misleading. The one is just as much smallpox as is the other, and is just as dangerous to the world at large.

However modified your ship cases may be, do not make this mistake. Label them all "smallpox."

Differential Diagnosis.

CHICKEN-POX. *Diagnostic characters most marked in trunk lesions :*	SMALLPOX. *Diagnostic characters most marked in lesions of face and extremities :*
Rash first day of fever.	Rash third day of fever.
Prodromata insignificant.	Headache and lumbar pain often pronounced.
Fever insignificant and may continue after appearance of rash.	Fever often high; falls when rash comes out.
Rash most abundant on trunk, especially chest. Is least on hands and feet.	Rash most abundant on forehead and extremities.
Papules become almost immediately vesicular.	Papules remain shotty for twelve hours or more before beginning to become vesicular.
Vesicles may be oval or circular, and are tense and dome-shaped. When grasped they are felt to be superficial, and when pricked they collapse.	Vesicles are rarely oval, and are not dome-shaped till the pustular stage. When grasped they are felt to be deep-seated, and when pricked do not collapse.
Lesions occasionally occur on palms, and soles, and buccal mucous membrane.	Lesions practically always occur on palms, soles, and buccal mucous membrane.
Eruption continues to come out in crops for several days, so that all stages may be seen.	Whole eruption out within twelve hours, so that at any period the lesions are all practically at same stage.

NOTE.—Do not forget that in chicken-pox there *may* be some umbilication, a small proportion of vesicles may become pustular, and consequently a limited " pitting " may occur.

Pathology.—The specific cause of the disease has not been discovered. The only thing we can say for certain, judging from the known facts of the spread of the disease, is that the agent cannot be of protozoal origin by any possible means. No delicate protozoal body (such, for instance, as the malarial parasite) could have a long independent existence apart from an intermediate host or from some tangible medium such as water, food, etc. Such an origin would fail to explain its practically certain conveyance by air, by a third person, by letters, by books, by rags, etc.

The cause will eventually be almost certainly found to be bacterial. Whether the organism described by *Copeman* and *Klein* in 1896 (the *Bacillus albus variolæ*) will be finally incriminated, one cannot say.

That bacillus is apparently of the diphtheria group; it is non-motile, does not liquefy gelatine, and retains the stain when treated by Gram's method.

At any rate this, or whatever the specific germ may be, apparently is inhaled and causes a primary infection in the lungs, where the most marked pathological conditions occur.*

Some congestion of the lungs is found in nearly all cases, and bronchitis is marked in severe cases. Catarrhal pneumonia is exceedingly common in confluent and hæmorrhagic cases, and is a frequent cause of death in children's cases.

From the lungs the organism enters the circulation, showing a selective partiality for the skin and respiratory tract.

In the pustular stages secondary infections usually occur, due to *S. pyogenes* or other organism—such infections being lobar pneumonia, pleurisy, thromboses, local necroses, etc.

Danger and Control.—As a matter of anxiety and danger on board, smallpox is less to be feared than plague, and very much less so than cholera.

As I said before, the dangers and difficulties connected with ship-board major infections are primarily in inverse ratio to the length of their incubation periods.

The long incubation period of smallpox is therefore a saving feature of the situation.

If, in addition, we consider the admirable safeguard we have in vaccination as a means of prophylaxis, the problem will be seen to be still further solved.

In order to tackle the problem properly, it is necessary first to be familiar with the various ways (other than that of the old-fashioned inoculation) by which the disease is com-

* See paper by *Stokes* in the *Bulletin of the Johns Hopkins Hospital*, 1903.

municated from the sick to the healthy. The following are, I think, definitely recognised:

1. *By Patients.*—This is an atmospheric method of propagation.

A patient is apparently not infectious at all during the incubation period. The infection seems to be only slight during the primary fever and the papular stages of the eruption, but becomes very dangerous during the vesicular and pustular stages, and still more so during the stage of desquamation.

The specific organism is probably imparted to the air of a room by the breathing, talking, or coughing of the patient; and this infected air may be breathed in by a newcomer, or may by subsidence infect the walls, floor, and furniture, etc., of the sick-room. At a later stage of the disease the infected desquamation may have a similar result.

2. *By Wind.*—This is really an indirect result of No. 1 method. The infected air of the sick-room may be disseminated by wind currents. This would explain the high incidence of the disease amongst people living in the neighbourhood of a smallpox hospital—an incidence which diminishes to zero at a distance of about three miles (*Thresh*). The investigations of *Thresh* at Purfleet, of *Barry* at Sheffield, and of *Power* at Fulham, seem to support the theory. In the tropics, this method of diffusion is probably counteracted to a considerable extent by the strong bactericidal effect of sunlight, and by the strong upward currents of the heated surface air.

3. *By Various Articles.*—This also is an indirect result of method No. 1.

The infected air of the sick-room deposits its specific germ on bedding, furniture, rags, etc., which then become media for the spread of infection.

An infected letter in 1906 started an epidemic (with thirty-four fatal cases) at Saginaw, Michigan.

The European Sanitary Conventions exempt mails from disinfection. It would appear that no practical Health Officers were on the International Committee ! !

4. *By a Third Person.*—Again an indirect result of No. 1. A person, himself immune, may infect his clothes in a sick-room and so carry the infection elsewhere.

5. *By a Smallpox Corpse.*—The last and final indirect result of No. 1. It is apparently certain that infection can be thus carried, but it is hard to see exactly in what manner. The gases insensibly leaving the body can hardly be infected. There is no breathing going on. It is true that the wind might carry skin-flakes; or it is possible that "contagion" might be the indirect factor.

On board, the Surgeon will find that a case of smallpox is comparatively rare. As a rule, only odd sporadic cases will be met with.

The exceptions will be: ships returning with pilgrims from Mecca (which will nearly always have a dozen or more cases on board), and those carrying immigrants from China—say between January and June.

If a case occurs amongst the cabin passengers, care will be needed to secure proper isolation. The number and structure of ventilating openings communicating with alleyways and with contiguous cabins render it inadvisable to treat an air-borne disease in a modern cabin. The case should therefore be removed to a situation as isolated as possible. The ship's hospital might serve in lieu of a better place. The patient having been removed, the evacuated cabin should be disinfected as soon as possible, together with all its contents. The clothes, effects, and person of any other occupant of the same cabin should be submitted to the same disinfecting measures. Such persons, together with the occupants of all adjacent cabins, and their cabin stewards, should then be vaccinated as soon as possible, and subsequently be kept under close daily observation, including the taking of temperatures.

Should the case have occurred amongst native deck passengers or crew, it will be necessary to isolate them as far as possible from the rest of the ship—if possible on the poop-deck in a special temporary hospital.

The means at disposal will probably be insufficient to suitably disinfect the 'tween decks or crew's quarters, which should be left for the P.H.O. at the next port.

The remainder of the deck passengers or crew should be vaccinated as soon as possible, and kept under careful daily observation.

With regard to vaccination, it would seem necessary to make a few remarks:

1. *Re Lymph.*—One of the most important things is, not only that lymph should have been recently prepared, but that it should have been properly stored. Scarcely any Surgeons recognise that, in the tropics, even the best lymph becomes useless after being kept for a fortnight. What usually happens is that the Medical Superintendent of the Line

supplies the Surgeon with a quite inadequate number of tubes of lymph. These are probably kept in an empty cigarette tin in the Surgeon's cabin. After leaving Suez the average mean temperature as far as Japan will be about 80° to 82° F. By the time Perim is reached the lymph is quite useless. A case of smallpox occurs off Colombo and the Surgeon does a general vaccination! He might just as well have used cylinder oil! If the Medical Superintendent had a practical experience of the East, he would have procured a large, wide-mouthed Thermos flask; put in a stock of lymph suitable for the maximum requirements of the voyage; packed the flask with ice; and given strict instructions to the Surgeon that the flask must be kept in the ship's ice-chest, and under no circumstances removed until required.

In lieu of such action by the Medical Superintendent, I would recommend the Surgeon to jettison his stock of lymph at Port Said, and requisition a new stock at each tropical port he touches at, for otherwise his operations will be ignored by all P.H.O.'s who inspect his vessel. If the lymph from one port does not take, he should obtain a fresh supply at the next port and promptly revaccinate.

2. *Re the Operation of Vaccination.*—Apart from the question of the freshness of the lymph—which is of first importance—it may perhaps seem superfluous to discuss the clinical details of vaccination. I would not do so were it not for my own practical experience.

I regret to say so, but it is a fact that at least 80 per cent. of the Surgeons (on ships) who have qualified in India and the East are as little capable of doing a proper vaccination as they are of firing a torpedo. I only say this after long experience. The Surgeon is given instructions to vaccinate So-and-so on board. I examine afterwards. What I find in nearly all cases, is this: *One* microscopic puncture, about the size of one pin's head, has been made in the centre of the most vulnerable part of the forearm, and this minute hole is freely exuding blood. This useless acupuncture is usually made in arm after arm without any precautions or preparation.

For this reason I ask indulgence for redescribing the method of carrying out this simple little operation where a number of deck passengers have to be vaccinated.

(*a*) Let the intended victims strip to the waist.
(*b*) Let an assistant efficiently wash with soap and water (and then dry) the upper and outer aspect of the biceps muscle of the left arm.
(*c*) Let your fresh lymph be all ready collected on a clean watch-glass.
(*d*) With your left hand, grasp the victim's left upper arm, from underneath, stretching the skin tightly at the seat of election.
(*e*) With the flat of your vaccinating lancet, pick up some lymph from your receptacle, and smear it over the stretched skin in *two places—each place having an area of at least a square half-inch.* (As a matter of fact laws should be passed insisting on a minimum of three insertions.)
(*f*) *Through* the smeared lymph, make three or four parallel scratches in one direction, and then three or four parallel scratches at right angles to the first, with the point of the lancet. This should be done in both places, and the wet lymph rubbed into each with the flat of the lancet blade.
(*g*) These scarifications should pierce the epidermis, but should not be deep enough to draw blood. The ideal operation will merely cause a little oozing of serum.
(*h*) Before proceeding to operate on the next person (whose arm has been already prepared), the lancet should be carefully wiped on a piece of lint ready prepared by soaking in Sanitas Okol solution or other similar disinfectant.
(*i*) The lymph will take five or ten minutes to dry. See that it is properly dry, and that the garments are clean, before allowing him to reuse them.
(*j*) Take a careful note of the name of every person vaccinated, and the date of vaccination. Also inspect on the eighth day and make a note of the result of the vaccination.

If a copy were given to each person vaccinated, recording the operation and its result, it would form an invaluable record for the person concerned, and might excuse him subsequent restrictions.

Yellow Fever.

Geographical Distribution.—The first definite epidemic of which we have reports was that of the West Indies which began at Barbados in 1647 and reached Cuba in the following year (140 years after the first Spanish occupation). By 1655 it had reached Jamaica and San Domingo, where it seems to have died out, only, however, to reappear at Martinique in 1688, and at Vera Cruz in 1690.

Since then, broadly speaking, the disease in epidemic form has been confined to four endemic centres: West Indies, Mexico, Brazil, West Africa (Guinea Coast).

For centuries the disease was one of the curses of the shipping which did business in the tropical parts of the Atlantic, the Gulf of Mexico, and the Caribbean Sea. Carried from one place to another over these areas, many ports became perfect hotbeds of the disease, which caused the deaths of many thousands a year.

Although in the course of trade the disease has been many times introduced into Europe, it has never shown any inclination to spread, except to a limited extent in Spain—nor has it ever been transmitted from the "West" to the "East."

The reason for this eccentric epidemiological behaviour was shrouded in mystery until the U.S.A. Yellow Fever Commission (1900) worked out the somewhat complicated scheme of transmission, and proved the intermediate host to be the "brindled" or "tiger" mosquito — *Stegomyia fasciata* (Fabricius, 1805) or, as it has recently been wrongly designated, *Stegomyia calopus* (Meigen, 1818), which has to give way to the earlier nomenclature by right of priority.

The distribution of the disease was, of course, at once understandable. It was limited by the presence of this mosquito.

Now, the *Stegomyia fasciata* is a pest of enormously wide distribution; *but*, only in the tropics between the latitudes 40° N. and 40° S.—or, more exactly, between the isothermal lines of 20° C. (68° F.). Elsewhere it does not thrive.

It is essentially a lover of the sea-coast or river banks, and is, moreover, of highly domestic habit.

These facts should be borne in mind by the Surgeon when he is considering the danger to his ship at any port.

The following list, based on returns of previous years, may be of use as a rough guide, until the existing conditions of the port be ascertained:

List of Ordinary Ports of Call to be viewed with Yellow Fever Suspicion:

Country.	*Port.*
Brazil	Bahia.
,, ...	Manaos.
,, ...	Pernambuco.
,, ...	Rio de Janeiro.*
British East Africa ..	Mombasa.
Canal Zone	Panama.*
Cuba	Havanna.*
Ecuador	Guayaquil.†
,, ...	Bathurst.*
Nigeria	Lagos.*
Sierra Leone	Freetown.*
Venezuela	Caracas.

The supreme danger of the moment lies in the possibility of the introduction of the disease to Asia via the recently opened Panama Canal. The *Stegomyia fasciata* is the common coast mosquito of tropical Asia, and the introduction of one yellow fever case (at the suitable stage of the disease) might be as a spark to tinder, with consequences for the teeming millions of the East which would be too appalling to imagine.

Had the Panama Canal been open in the old sailing ship days, the trick would probably have been done within a year. Fortunately, our recent knowledge has resulted in considerable control of the disease in the old endemic centres, thus reducing the quantity of dangerous material for possible export. We have also, in modern ships, much better hygienic

* Very little danger to be anticipated.

† The most dangerous of existing ports.

NOTE.—Occasional sporadic cases have been noted in recent years at: Barbados, Trinidad, Callao (Peru), etc.

conditions. These facts, coupled with the peculiar requirements of infection in yellow fever, are a considerable safeguard against the introduction of the disease to Asia.

The possibility, however, is a haunting one; and I think it is quite likely that it may creep in during the years to come, and get a fatal foothold at the site of introduction before it is recognised.

Diagnosis.—The diseases for which yellow fever is most likely to be mistaken are: malaria, blackwater fever, and perhaps relapsing fever. Several cases I saw in the West Indies had, in their early stages, some superficial resemblances to plague—such as the abrupt onset, temperature, headache, condition of tongue, anxious expression, etc. But the resemblance is only shortlived and is not likely usually to present any difficulties.

As a rule there are no prodromata in yellow fever.

The onset is sudden, with a rise of temperature, severe headache, and much pain in loins and limbs.

The face soon becomes swollen and red, and the conjunctivæ injected. The gums are spongy and liable to bleed, and the tongue is furred, with red edges.

Epigastric discomfort is accompanied by much thirst, and the stomach becomes sufficiently irritable to induce frequent vomiting of a clear acid fluid.

The bowels are usually constipated. The urine is scanty, with diminished urea, and contains albumen from the second day.

As a rule, about the third day, the temperature and pulse fall, and there is a general amelioration of all the symptoms, but the skin and conjunctivæ at this stage begin to get jaundiced.

In favourable cases the improvement now continues until a usually protracted convalescence is established.

In severe cases, however, this improvement on the third day is only shortlived; the fever returning, and the gastric symptoms becoming aggravated, with the occurrence of a chocolate-coloured or blackish vomit ("black vomit"). This symptom seldom appears until the fourth to the sixth

day, and is an extremely serious though not necessarily fatal symptom.

The mortality varies from 1 to 85 per cent. in different epidemics, and is greatest amongst newly arrived Europeans.

Death usually occurs between the fourth and tenth day of the disease and is generally caused by toxic exhaustion or uræmia.

Pathology.—Post mortem the blood is found to be fluid, and the serum tinged yellow with free hæmoglobin.

The changes in the liver are the most pathognomonic. It is not much enlarged, but is soft and of a mottled yellow colour. The intralobular connective tissue is œdematous, the organ as a whole anæmic. Microscopically there is fatty degeneration of the hepatic cells.

The stomach will contain a thin or tarry black fluid, found to consist of deformed red cells, epithelial and mucous cells, and a granular debris—all coloured with hæmatin. The mucous membrane is congested.

The kidneys show a parenchymatous nephritis.

The other organs are more or less normal.

The specific organism of yellow fever has not yet been isolated.

It is probably ultra-microscopic, for, in the serum of a patient, the virus will apparently pass (without dilution) through a Pasteur F bougie, but not through the B bougie.

Danger and Control.—In order to consider rationally the danger and control of yellow fever, it is necessary to understand the rather peculiar methods of infection. I will set out the details seriatim.

1. The incubation period in the human body, calculated from experimental bites, is from three to seven days—generally five.

2. The patient's blood is only infective during the first three days of his illness; that is to say that a Stegomyia (to become infected) must bite the patient during those days only.

The patient is a potential danger only during such time.

3. If, during these first three days, the patient's serum

is injected into a healthy person, it will give rise to an attack of the disease in the latter.

If, however, it is merely deposited on a superficial skin abrasion, it is apparently not sufficiently active to convey the disease thereby.

4. When a Stegomyia has bitten a yellow-fever patient during the dangerous three early days of his illness, the mosquito is not capable of conveying the disease to another person immediately thereafter; but a period of twelve days is necessary for the germ to develop in the mosquito before the insect is capable of infecting a healthy person. Thereafter, the mosquito continues infective during the remaining ten or twenty days of its life.

5. Ova laid during the infective period of the mosquito's life seem to be capable of infecting their imagines; but such hatched mosquitoes are not infective until the fourteenth day of their existence in the perfect state.

As we have seen, the *Stegomyia fasciata*, which carries yellow fever, is a common coastal mosquito in the tropical belt between the isotherms of 68° F.

If the mosquitoes frequenting ships be examined, the *S. fasciata* will be found to be the commonest of all on board. They may even be carried out to sea by the wind for considerable distances; I can recall one instance in which considerable numbers reached our ship at a distance certainly not less than a mile from the shore. Another source, sometimes overlooked, is that of cargo-lighters. These always contain a certain amount of bilge-water. Fortunately, this residual water is usually sea water in which the Stegomyia will not breed out. In river-ports the matter is otherwise; and care should be taken to pump out or kerosene the bilge-water regularly—or mosquitoes will be frequently brought to ships by this means.

In the old sailing-ship days, such mosquitoes would live for weeks in the cabins, holds, etc., breeding freely in the various collections of water which were then only too frequent aboard, and perhaps also in the bilge-water. If, therefore, a case of yellow fever broke out on board after leaving a port, the excessive length of the voyage would give ample time to infect the numerous mosquito population; and when

the ship reached her next port these infected mosquitoes would easily convey the disease ashore, especially to the people living near the water-front.

This is exactly what was found to happen in ships from yellow-fever ports reaching Philadelphia and New York. They continually introduced the disease, which spread almost entirely amongst the water-front inhabitants.

Philadelphia,	1793	4,041 deaths.
New York,	1795	732 ,,
,,	,, 1798	2,086 ,,
Philadelphia,	1798	3,506 ,,
New York,	1803	606 ,,

Subsequent outbreaks occurred until 1856, since when (if we except a limited outbreak in 1870) there has been no occurrence of the disease in either of those two ports. This cessation approximately sychronised with the general replacement of sail by steam.

The conditions of a modern steamer are very different to those of an old-time ship. The cleanliness is a marked feature. Collections of water, suitable for breeding of mosquitoes, are few and far between. Bilge-water, water tanks, etc., are now so enclosed as to be practically inaccessible even to the wily mosquito. Speed has so increased (with resulting benefit to mechanical ventilation) that the mosquito is apt to find things rather too draughty!

In consequence, although the number of culicidine visitors, to a ship in port, may be considerable, it is generally found that they will all have disappeared within two days of going to sea. In a few instances recently, however, *S. fasciata* has been reported as found on ships up to twenty days after sailing. These had probably bred out in some collection of water on board—which reflects somewhat badly on the arrangements of the Surgeon and Chief Officer.

The actual life span of an adult Stegomyia (♀) is usually about three to four weeks. By careful treatment in captivity it has been kept alive for the unusual period of four months.

The adult is very susceptible both to cold and dryness, and does not hibernate like various other genera.

There is, however, a remarkable and dangerous peculiarity about the eggs, which are very resistant and can withstand long exposures to cold and dryness. When dried, they may be kept for at least three months without more than 40 per cent. of them dying. *Newstead* describes an experiment in which eggs of *S. fasicata* were dried (over calcium chloride) and sent from Manaos—away up the Amazon—to Liverpool, where they were placed in water at 23° C., and several hatched out within twelve hours.

The danger latent in this resistance to desiccation is obvious, when dealing with ships.

The subject of yellow-fever transmission by ships is most interesting. Of course much rubbish is occasionally reported. For instance, I think I read somewhere of a barque at Sierra Leone, whose whole crew had died of yellow jack, and after she had remained empty for three months, a new crew immediately got the disease on boarding her. It is a pity that such yarns are perpetuated. Provided even that two generations of mosquitoes *had* remained for three months infected (which is *most* improbable) the emergency crew would be very unlikely to show symptoms of the disease for a week or two, at the earliest, after going aboard. Perhaps this was an instance of the supposed rôle of the monkey in providing a transmitting reservoir for the disease!

It has sometimes been suggested that cargo, such as crates, etc., might convey mosquitoes, but all experiments so far have shown that insects introduced into boxes, etc., on board ship did not survive confinement for more than thirty hours.

Although many of the proper mosquitoes may board a ship, it will, of course, rarely be the case that any of them will be infected. A case on board will usually have contracted the disease ashore, and finished his incubation period after sailing. Other cases occurring on board at intervals thereafter will be to the credit of mosquitoes who had fed on the first case. A most interesting example of this drama is quoted by Dr. *Guiteras*—the Director of Public Health for Cuba—in the "Yellow Fever Bulletin," vol. iii., No. 1.

Dr. Guiteras suggested that the attacks might be due to

infected mosquitoes which had not been killed during the fumigations, and had escaped from the holds when cargo was moved at the different ports. I think, however, most of the cases can be traced to the original port of departure, and the italic entries in the following diary are my own suggestions:

S.S. "Hydra" at Manaos (Brazil), 1913.

Two Cases amongst crew. One died. One left in hospital.

June 13 FUMIGATION (1).
,, 14
,, 15
,, 16 FUMIGATION (2) repeated at Captain's request.
,, 17 Sailed from Manaos. (33 cases reported in 1913.)
With some infected mosquitoes embarked after last fumigation. They forthwith lay infected eggs on board.
,, 18
,, 19 *Infected eggs hatch out as larvæ.*
,, 20
,, 21 Called at Para (mouth of Amazon). (No cases reported in 1913.)
Mate bitten by an infected mosquito on board.
,, 22
,, 23
,, 24 *Infected larvæ become pupæ.*
,, 25 *Infected pupæ become adults.* (*See July* 9.)
,, 26 *Steward bitten by infected mosquito on board.*
27 **Mate** taken ill. (Case 3.) *Boatswain bitten by infected mosquito on board.*
27 Reached St. Lucia. (No cases reported in 1913.)
27 FUMIGATION (3) of ship. *More infected pupæ become adults.*
,, 28
,, 29
,, 30 Arrived at Guantanamo (Cuba). (No cases reported in 1913.)
July 1 **Steward** taken ill (Case 4).
,, 2
,, 3 **Boatswain** taken ill (Case 5).
,, 4 Left Guantanamo.
,, 5 Steward died.
,, 6 Boatswain died.
,, 7
,, 8 Arrived at Cienfuegos (Cuba). FUMIGATION of ship (4).
,, 9 *Captain bitten by infected mosquito hatched out on June* 25, *or perhaps hatched out after fumigation of June* 27.
,, 10
,, 11 Left Cienfuegos.
,, 12 Arrived Havana. (Only 1 case reported in 1913.)
,, 13
,, 14 **Captain** taken ill (Case 6).

NOTE.—A careful examination of the above diary shows that if infected mosquitoes came on board *after fumigation No.* 2, they will account for every case of yellow fever which subsequently occurred—

all of which (except that of the Captain) were originated *before fumigation No. 3 took place* at all!

Infected mosquitoes hatched out *after fumigation No. 3*, and biting the Captain before or *at the time of fumigation No. 4*, would convey the disease to him.

☞ Thus we see that, although on superficial examination we might point to the uselessness or faulty application of these fumigations, they were not necessarily either useless or faulty; but that *the great primary mistake lay in doing the final fumigation* (at the port of departure) *twenty-four hours before sailing*—thus giving time for any amount of infected mosquitoes to board the ship afterwards.

The essence of sound practice in yellow-fever fumigation is to carry out that operation *only when the ship is actually ready to sail;* and to conduct the process at some quarantine or other anchorage, at a distance of at least two miles from any wharves, town, or foreshore.

If the Surgeon is faced with a case of yellow fever on board, the first thing to do will be to remove him to any empty cabin and isolate him simply by means of a mosquito net. His deserted cabin should then be properly fumigated, and a systematic search made throughout the ship for Stegomyiæ. The adult insects should be properly eliminated, and all collections of water containing (or likely to contain) larvæ should be evacuated. The immediate friends or cabin mates of the patient should be kept under daily observation (temperatures, etc.) for at least a week.

In this way the disease will not spread on board, nor will your ship be a danger to other ports.

TYPHUS FEVER.

This acute infectious disease (which was of old so prevalent in gaols and on ships that it was indiscriminately known as "Gaol fever" and "Ship fever") has now fortunately almost died away entirely in both those situations.

Had it not so disappeared I should have included it as one of the major infections. The disease still continues in certain endemic centres in America and Europe, and has recently reappeared in seriously epidemic form amongst some European armies in the field.

I, therefore, give a brief description of the disease, which might even now break out at any time on an overcrowded emigrant ship.

Geographical Distribution.—Chiefly occurs in temperate climates; very rarely indeed in the tropics. Has been more prevalent in Ireland and Russia, but centres have occurred in parts of the Caucasus, U.S.A. and elsewhere.

Incubation Period.—Twelve days.

Etiology.—Specific germ undiscovered, but it is probably only conveyed by head and body lice.

Symptoms.—Invasion abrupt, with rigors and high temperature. Vomiting is frequent.

The special feature of the disease is the early delirium, stupor, or coma.

A rash appears on the third to fifth day—first on the trunk, the face being often spared. It consists of crimson-red maculæ, which at first disappear on pressure, but in two or three days become darker (petechiæ) and permanent.

The tongue is brown, fissured, and tremulous; and sordes collect on the teeth and lips.

Termination by crisis on fourteenth to seventeenth day. Mortality is 1 to 20 per cent.

Pathology.—Rigor mortis delayed. Blood dark and fluid. Muscle, dark, with granular degeneration.

Ecchymoses of the serous membranes. Spleen enlarged, soft, and blue-red. Kidneys congested or show nephritis. Lungs may or may not show pneumonic patches.

Treatment.—Symptomatic.

This sketchy outline will give a brief idea of this increasingly more rare disease.

The method of propagation will give a clue to the Ship's Surgeon, as to what means should be adopted to prevent its spread. A most interesting review of all the latest work on this disease will be found in an article by J. F. Anderson, in the United States "Public Health Reports," vol. xxx., No. 18, April 30, 1915.

General Remarks.

A. Prevention and Control of Disease on Board.

The following summary of points is most important:

1. Keep under daily observation all persons on board.
2. Inspect all latrines and crew's quarters daily.
3. If deck passengers on board, see that their 'tween decks are sprinkled with disinfectant, and swept, daily.
4. See that crew's quarters are turned out and washed weekly.
5. See that your whole crew are vaccinated (or have *proof* of recent vaccination) at the beginning of each voyage.
6. Promptly *isolate*, at the earliest possible moment, for observation and diagnosis, every case of *fever, skin eruption*, or *diarrhœa*.

B. Hints for Ensuring Quick Despatch at your next Port.

1. Find out from the Marine Department at the previous port whether a quarantine examination will be required.

Hours are often wasted, both for the P.H.O. and the ship, by the habit of putting up a quarantine flag when it is not required, or *vice versa*.

2. Before reaching port see that all loose rubbish and dirt is thrown overboard, and that the decks and 'tween decks are clean.
3. See that your medical log is written up to date.
4. Let crew and passengers be given the qui vive for muster.
5. Meet the P.H.O. promptly at the head of the gangway with the following papers all ready:
   (*a*) Bills of health.
   (*b*) List of crew.
   (*c*) Full list of passengers, by class, origin, and destination.

C. Hints on Disinfectants and Disinfection at Sea.

Your company will probably supply you with some disinfectants—useless in type and inadequate in quantity. Legal enactments will also require you to have "So-and-so." The majority of such are perchloride of mercury, carbolic acid powder, and sulphur.

Not one of these is of the slightest use to you.

You have no apparatus for generating sulphur dioxide under pressure; while, to burn it in an open pan, will be most dangerous as giving you a false sense of security. Leave the SO_2 business to the Port Authorities.

There are only four things wanted in the shape of disinfectants by a Ship's Surgeon:

1. Sanitas Okol (or Izal)	25 gals.	for each 100 persons.
2. Formalin Solution (40 per cent.) ..	1 gal.	
3. Potassium Permanganate	8 lbs.	
4. Chinosol Soloids, gr. 8·75	100	

The first of these items will furnish you with a good liquid coal-tar disinfectant for general use on board.

Jeye's Fluid or similar black homogeneous soap mixtures

which make a white emulsion with water, are useless on board ship, as the emulsion is thrown down and loses its disinfecting power in the presence of sea-water, urine, or other chlorides.

I have chosen *Sanitas Okol* (a cresol ready emulsified with dextrine), or *Izal* (a cresol ready emulsified with gelatine), because these two are the most powerful liquid disinfectants which we can get at a reasonable cost for everyday work. They have the enormous marine advantage that, as already permanent emulsions, they can be mixed for use with sea-water equally as well as with fresh water, and their action is not impaired thereby. Okol is, if anything, slightly the more powerful, and appreciably cheaper. I therefore recommend it.

It should be freely used throughout the ship for decks, scuppers, 'tween decks, cabins, etc., at a strength of 1 part in 1,000 parts of sea or fresh water, for ordinary use. For disinfecting cholera sites, discharges, clothing, etc., the strength should be double the above (*i.e.*, 1 : 500).

Infected linen should be soaked for one hour in a 1 : 1000 solution before being sent to the ship's laundry.

For disinfection of bilges, Okol 1 : 250 should be used.

Items 2 and 3 are intended for the generation of formaldehyde gas, which is a powerful aerial and surface disinfectant and deodorant. It should be used only in cabins. The following is the technique:—

See that all openings in the cabin are closed with strips of paper, also by shutting ports and by closing ventilators.

Leave all drawers, lockers, and trunks open. Put a tin tea tray on the deck of the cabin, and stand on a tray a small bucket, in which you have previously placed 1 pint of formalin solution. Add to the solution about ¾ lb. of potassium permanganate crystals, and quickly leave the cabin, making the door fast. Leave it shut up for an hour; then open, air, remove contents for further airing or treatment, scrub out the cabin, and then have it repainted.

If 'tween decks or crew's quarters need disinfecting, you should not attempt more than a thorough surface disinfection with Okol solution. Leave further treatment for the next Port Health Authorities.

With regard to the *Chinosol*, it will be found one of the most practically useful disinfectants for hands, instruments, midwifery, and general surgical work.

It is non-toxic, does not corrode instruments, does not damage the skin, does not precipitate albumen, and at the same time is a very powerful disinfectant.

It has thus all the advantages and none of the disadvantages of the now discredited perchloride of mercury.

One soloid dissolved in 20 fl. oz. of water makes a solution of 1: 1000, which is a suitable strength for general use.

CHAPTER IX

THE SANITARY INSPECTION OF SHIPS

Quo semel est imbuta recens, servabit odorem testa diu.
HORACE: *Epist., I., II.*

THE Sanitary Inspection of Ships is one of the routine inspections which has to be carried out by a Port Health Officer, but is quite distinct from the Quarantine Inspection dealt with in Chapter VII., and is only indirectly or remotely concerned with infectious disease.

This inspection should not be made at a quarantine anchorage, but at a wharf or inner anchorage after pratique has been given.

One or more Health Officers should be detached solely for the purpose in a large port. In a small port the work can be done by the officer or officers who do the quarantine inspection boarding.

Every new arrival should undergo this sanitary inspection at some time during her stay in port—preferably soon after receiving pratique. The only exception to this rule should be in the case of coasting vessels, mosquito fleets, etc., which might be inspected at intervals of a month or more as most convenient.

The inspection need not in any way detain a ship, nor interfere with the working of cargo; and no muster or detention of passengers or crew is required. With the exception of one Ship's Officer to answer questions with regard to live stock, cargo, water, etc., on board, the whole inspection is a matter of personal observation by the Health Officer himself, and no one on board should be interfered with.

The whole object of the inspection is to find out whether or not:

1. The sanitary condition of the ship is unsatisfactory or likely to be prejudicial to the health of those on board;
2. The condition of the cargo for discharge is likely to be a menace to the health of the port; or
3. The nature of the cargo is likely to be directly or indirectly dangerous to the crew or passengers of the ship.

To begin with the first point. By "sanitary condition" I mean the hygienic state of the ship's structure, supplies, and waste products. This will include: the cleanliness, ventilation, and dryness of crew's quarters and 'tween decks; the efficiency and state of latrines; the cleanliness of the galley; the condition of the bilges; the derivation and condition of the water supply; the quality and disposition of the food stores; the presence of live stock and condition of their surroundings; the presence or excess of vermin; the quantity and sufficiency of medical stores; the proportion of crew protected by vaccination, etc.

On each of these points I will touch briefly.

The Examining Officer should take with him the following:

(*a*) A supply of "Sanitary Inspection Sheets"—of which a sample sheet is annexed (page 247).
(*b*) A wet and dry bulb thermometer. A suitable instrument in a portable form is put up by Messrs. Dolland of London; or the "whirling" instrument (Fig. 7).
(*c*) An electric hand torch. This is essential for examination of many dark corners.
(*d*) Three wide-mouthed bottles and three narrow-mouthed bottles, 20 oz. each, with glass stoppers. These are required for possible samples of water or food.
(*e*) A tape measure or foot-rule.
(*f*) A counterfoil book of orders for nuisance abatement (page 250).
(*g*) A counterfoil book of orders for destruction of suspected articles (page 254).

I give a suitable sample sheet for the last named two books.

Having boarded the ship the P.H.O. will find that method is essential to successful work.

The first thing to do is to get hold of an officer and go straight

ROUTINE SANITARY INSPECTION SHEET.

1. Name of Ship——————————— S.S.S. No.———
2. Date and Time of Inspection———————————
   Sea temperature ———————°F.
3. Master——————————Agents ———————
4. Qualification of Surgeon (if any)———————
5. DRUGS: Sufficient in quantity and quality ? ———————
6. Percentage crew vaccinated within previous 5 years:———————
7. MAIN DECK: Condition of———————
8. SAILORS' QUARTERS: Condition of———————
9. FIREMEN'S QUARTERS : Condition of———————
10. CREW'S QUARTERS (8 OR 9): Temperature of ——————— °F.
    Relative humidity of ——————— %
11. PAINT LOCKER: State of———————
12. LIVE STOCK: No. on board: Horses———Cattle———
    Sheep———Pigs———Fowls———
13. LATRINES: State of———————
14. GALLEY: Condition of———————
15. FOOD-SUPPLY: Sufficient in quantity and quality———
    Condition of rice———
16. TWEEN-DECKS (*if used for passengers*): Condition of———
    Temperature of———°F.
    Relative Humidity of———%
17. WATER-SUPPLY:
    Present supply where obtained ?———
    Appearance, taste, and smell ? ———
    Result of analysis (if necessary) in parts per 100,000:
    Cl———HNO_3———
    Free NH_3———Fixed NH_3———
18. VERMIN: Reported prevalence of rats ? ———
    ,, ,, ,, cockroaches ———
    ,, ,, ,, bedbugs———
19. BILGE-WATER: Offensive or not ?———
20. GENERAL SANITARY CONDITION of ship and passengers———
21. Date of last disinfection ———
    Date of last inspection———
22. Remarks ———

(*Signed*)———
Inspecting Health Officer.

Dated at———
the———day of———19—.

to the crew's quarters and hang up your wet and dry bulb thermometers.

Then get someone to pump you a sample of water from the fresh-water tanks into one of your narrow-mouthed 20 oz. stoppered bottles.

You should then go with the accompanying Ship's Officer to his cabin or to the saloon, or to some suitable place where you can fill up items 1, 2, 3, 4, 6, 12, 17, 18, and 21, with informa-

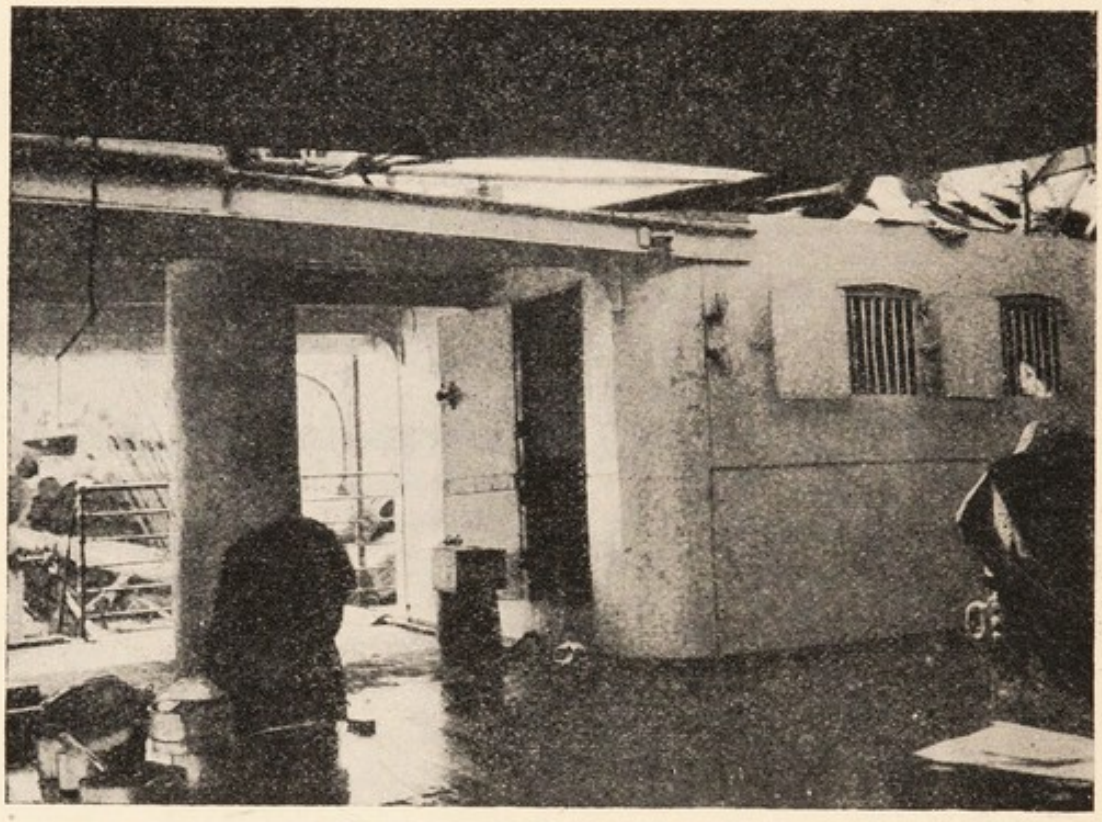


FIG. 19.—FAULTY GALLEY DRAINAGE.

tion furnished by him; the sea temperature can be got from the Engineer's log.

You should also look through a copy of the ship's *manifest* to see what cargo is on board.

Then go right for'ard and start your inspection from the fo'c'sle, gradually working aft and noting in the proper place on your "Inspection Sheet" the required information as to cleanliness, etc., of each different compartment or space which you come to.

As an example of things to be on the lookout for, I have put in a photograph (Fig. 19) of the galley on a large ship of a

well-known line. It will be noticed that there is a fairly high coaming at the doorway, and through this a small pipe leads on to the deck. This pipe was the only means of drainage for the galley floor, and the mess of refuse and dirty water can be seen trickling across the deck, in the picture.

Proceeding with your inspection, the wet and dry bulb temperatures will have adjusted themselves by the time you reach the crew's quarters, provided the thermometers had been suspended when you first boarded the ship.

The temperature and relative humidity of the 'tween decks should also be recorded—if that space is in use by passengers.

Items 19 and 20 should be left to the end.

If, during your inspection, you find any compartment or space to be in a filthy state, you should point it out to the Captain or Chief Officer; and, on a repetition of the condition, a nuisance abatement order might be served on the Captain, stating what you require to be done in the way of cleansing, whitewashing, painting, etc. On p. 250 is a sample abatement order which might be incorporated in legal enactments.

Do not forget that your examination, in the routine matters with which we are dealing, has nothing to do with structural defects, although it may be concerned indirectly with the results of such defects.

The main points to be noted in your examination will be:

(*a*) Cleanliness of surfaces.
(*b*) Sweetness of atmosphere.
(*c*) Dryness.

The Board of Trade expect a daily cleansing (? dry) of crew spaces, washing out every three or four months, and painting every two years.

Even in temperate climates this treatment is inadequate; in the tropics, very much so.

Health Officers should make a point of seeing that all crew spaces, besides being cleaned daily, are thoroughly emptied and scrubbed or douched with disinfectant *at least once a month*, and that they are either whitewashed every six months or painted once a year.

It has been sometimes remarked that the commonest fault

ORDER FOR ABATEMENT OF NUISANCE.

S.S. ———————————

Date———————————

Nature of nuisance:

———————————

———————————

Name of Master:

———————————

Measures to be adopted:

———————————

———————————

Officer issuing

———————————

ORDER FOR ABATEMENT OF NUISANCE.

To the Master of s.s.———————————

HAVING this day inspected your ship within port limits and found the

———————————

to be in a dirty or insanitary state: TAKE NOTICE that you are hereby required within ———————(*state time*) to carry out to my satisfaction the following measures, to wit ———————————

———————————

and that neglect to comply with this Order will render you liable to a fine not exceeding $50 and to an additional fine of $10 for each day's subsequent default.

Given under my hand this———day of———, 19——.

———————————

Port Health Officer.

in the cleansing of ships is to employ water too much and too often.

Although there might have been some justification for this dictum in the days of the old sailing ships, there is little to be said for it in the days of the modern, well-ventilated, steel steamer.

For passenger and crew spaces, however, which cannot be properly emptied—such as 'tween decks, etc.—the best method of cleansing the decks is to pour Sanitas Okol into buckets nearly full of sand, and then to sprinkle this wet sand all over the exposable deck area, and sweep off with hard brushes.

While a "damp ship is an unhealthy ship," there is little reason for any ship to remain damp however often it may be washed. If it does, it is a sure sign that the mate should be moved to another ship!

We have seen that the second object of your inspection will be to ascertain whether or not the **condition of the cargo** for discharge is likely to be a menace to the health of the port.

In Europe, this aspect of things is resolved chiefly into the control of foodstuff cargo, which will come under some kind of Pure Food and Drug Act, and will be dealt with by a special staff ashore.

In the tropics, however, the conditions are otherwise.

There is generally an immense movement of vegetables, fruit, fish, etc., quite apart from the ordinary food cargoes of tinned or frozen products. These consignments are sometimes carried in the hold, but more often on deck; and are generally the property of the owners or else the special pidgin of the Captain. These deck cargoes are often a remarkable sight. For instance, during the onion season large ships will come from Bombay having the whole of their main-deck wells packed fore and aft with a regular sea of wicker crates of onions. So also in the Chinese vegetable season, ship after ship will leave that country with her decks stacked with crates of leeks, celery, and other vegetables.

In many parts of the East, local coasting boats do a big trade in dried fish which has a powerful odour; or in a preparation of

decomposed fish called "blachan," dear to the Cathayan heart, of which the smell is veritably mephitic. To deal with such a cargo in a small and hot hold would require a fortitude and philosophy not yet attained by Western races!

Fruit cargoes are, as a rule, less objectionable, except in the case of a fruit peculiar to Malaya, Burma, and East Africa, and known as a "Durian" (*Durio Zibethinus*). This is a large fruit with a roughish green rind and a creamy edible pulp. Wallace said of it, "It is worth a journey to the East to taste it, because it has such an exquisite flavour." The rind, however, has a smell which can only be likened to that of a sewage pumping station, and the majority of people have probably, in consequence, never yet found out what the taste *is* like—which may account for the old definition that "a durian is a fruit which tastes like sour cream that has passed through a dirty gas pipe!"

In the midst of such novel olfactory surroundings, it may take the Examining Health Officer some time to appreciate the permissible limits of decomposition; but he will eventually learn in what cases these fruit or fish cargoes should be condemned.

The vegetable deck cargoes will seldom be dangerous unless they are carried on coolie ships. I did not realise the situation until one day many years ago, on board a coolie ship, I saw the not unusual sight of an immigrant micturating into the deck scuppers. In this case a full deck cargo of vegetables had left the man very little space for his operation, and the majority of the scupper was already filled with vegetable crates! The condition of such vegetables can better be imagined than described. Typhoid bacilli are common in the urine of convalescents, and in 1913 *Greig* recovered cholera vibrios in and out of fifty-five cases of that disease. If, therefore, we got "carriers" of either disease amongst the coolies, it is easy to see the potential danger to the vegetables, and through them to the port. Before condemning such cargoes it will be necessary to consider all the circumstances of the case—*e.g.*, What are the health conditions of the port from which the ship has come? What has been the length of the

voyage? What has been the health of the passengers during the voyage? Are the crates properly stacked on deck—well away from the scuppers? If some packages are dangerously placed, are other sections, in other parts of the deck, more safely situated? These and other points will have to be taken into consideration and common sense applied.

In all cases where you find it necessary to order the destruction of any such cargoes, you should do it properly on a printed

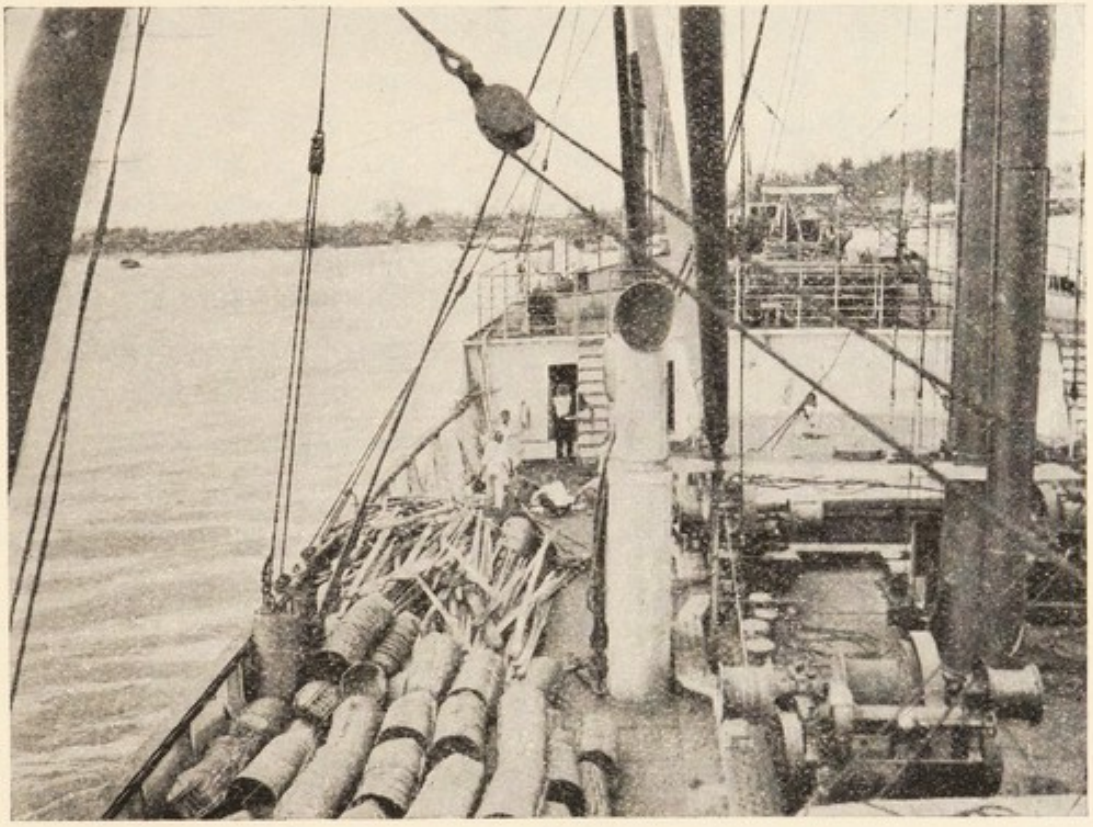


FIG. 20.—OBSTRUCTED SCUPPERS.

form. I give a sample of such form to illustrate the principle (page 254).

The report of any action taken with regard to the cargo should be noted in the remarks column of your Inspection Sheet.

It is a great pity that official action is not more insisted on with regard to the prohibition or regulation of deck cargoes generally. The accompanying illustration (Fig. 20) shows a not uncommon condition, even on large liners. In such circumstances it is, of course, quite impossible to clean the

ORDER FOR DESTRUCTION OF SUSPECTED ARTICLES.

Date _____

Articles _____

_____

Per s.s. _____

Owner _____

Address _____

Officer issuing:

_____

ORDER FOR DESTRUCTION OF SUSPECTED ARTICLES.

I hereby order that the following articles or goods imported by s.s. _____ (*or* by train *or* road) to wit _____

_____

_____

which in my opinion are infected or unfit for human consumption or likely to create a nuisance or likely to be a danger to health, be immediately destroyed.

Dated at _____ this _____ day of _____, 19—

(L.S.) _____

(*Port*) *Health Officer.*

decks or flush the scuppers. In the middle distance of the picture will be seen a group of cargo-coolies having their meal on the small deck space available, and disposing of food remnants in the occluded scupper.

We now come to the third object of the inspection—that is, to find out whether or not the **nature of the cargo** is likely to be directly or indirectly dangerous to the crew or passengers of the ship.

This danger from the nature of the cargo can be briefly summarised under three heads:

(*a*) Owing to the cargo itself being infected.
(*b*) Owing to the nature of the cargo being especially attractive to the rat population.
(*c*) Owing to physical and chemical exhalations from the cargo.

It is very rare indeed that the cargo itself will be infected; and the chances of dissemination by that channel are remote, although the possibility should be kept in mind.

The Venice Sanitary Convention of 1897 recognised the principle by inserting a list of things which may not be imported from a plague-infected port:

1. Body linen and wearing apparel—if not as baggage.
2. Rags and shoddy.
3. Bags, sacks, and carpets previously used.
4. Raw hides.
5. Hoofs, hair, felt, raw silk, wool.
6. Hair of all kinds.

In a recent consolidation of the Quarantine and Prevention of Diseases Ordinances of the Straits Settlements, we suggested two lists (instead of one as above), and have omitted "hides," about which much fuss has been made, but which have never been incriminated, and are quite harmless as a source of danger for anything except anthrax—which is not here in question.

The Paris Convention takes no notice (in this connection) of anything but plague and cholera. It will be seen that I have included smallpox also, which shares—if it does not exceed—the very limited danger to be expected from infected cargo.

Extract from Quarantine Ordinance of Straits Settlements.
(Ordinance XXXIII. of 1915.)

61. (1) The articles mentioned in this subsection shall not be imported from any ports within or without the Colony, or exported from any ports within the Colony, when such ports have been declared by notification in the *Gazette* to be infected with plague or smallpox—that is to say, clothing and bedding other than personal baggage, rags and shoddy, blankets, sacks, and carpets which have been used, hair, and any other articles which may from time to time be notified in the *Gazette* by order of the Governor.

(2) Personal baggage may be destroyed or disinfected at the discretion of the Port Health Officer. The value of such baggage as is destroyed, to be assessed by the Port Health Officer, shall be paid as compensation to the owner thereof.

(3) The articles mentioned in this subsection shall not be imported from any ports within or without the Colony, or exported from any ports within the Colony, when such ports have been declared by notification in the *Gazette* to be infected with cholera, and shall not be imported from any places, districts, or mukims, situate within the Colony of the Federated Malay States or any other Malay State declared by the Governor by notification in the *Gazette* to be infected with enteric fever or dysentery, that is to say, fruit (unless properly canned or bottled), vegetables (unless properly canned), milk (unless properly sterilised and sealed), fish (unless properly canned), shell fish, sweetmeats, fresh sausages, meat (unless salted or frozen), and any other foodstuff which may from time to time be notified in the *Gazette* by order of the Governor.

(4) If any articles the importation of which is prohibited under the provisions of this section are brought into any port or place in the Colony by sea, road, or rail, the master or chinchew of the ship, the guard of the railway train, or the driver of the vehicle bringing such articles, or the person conveying, or the importer of such articles, shall be liable to a fine not exceeding one hundred dollars, and the prohibited articles so imported shall be confiscated, disinfected or destroyed at the discretion of a Health Officer without compensation.

(5) If any articles the exportation of which is prohibited under the provisions of this section are exported from any port in the Colony, the master or chinchew of the ship in which such articles are exported or the exporter of such articles, shall be liable to a fine not exceeding one hundred dollars.

With regard to the danger accruing from the shipping of cargo of a nature specially dear to the soul of a rat, three cargoes will have to be considered:

(i.) Grain, such as wheat, rice, etc.
(ii.) Hardware or other material, usually wrapped in straw and packed in skeleton crates.
(iii.) Forage.

Here again, action will be dictated by different circumstances —*e.g.*, What were the plague conditions (human and rat) at the port of loading when the above cargo was shipped? Was it shipped alongside a wharf or in mid-stream? If alongside a wharf, what was the rat condition of the warehouses, and was the ship fendered off? These and other circumstances will determine what should be done in any special case. It is in this case, of course, a matter of possible fumigation, not of destruction. If plague was bad at the port of departure it may be advisable to fumigate the dangerous cargo, *in situ*, before discharge. In this way, without delay to the ship, the quarantine and sanitary inspections will mutually support each other.

With regard to the danger accruing from gaseous emanations from the cargo—as far as I know, such will only be likely to occur from the three following cargoes:

(i.) Recently cut vegetable matter.
(ii.) Benzene.
(iii.) Ferro-silicon.

The danger, of course, will only affect such of the crew or steerage passengers as may be occupying compartments which communicate with the holds containing the dangerous matter, or who may have occasion actually to enter such holds; and the result of such propinquity will be the ordinary symptoms of poisoning due to inhalation of the different gases which are in each case evolved.

Recently cut **vegetable matter** evolves a large amount of CO_2. This was recently (1914) well demonstrated in America, where four men were fatally asphyxiated in a silo, which had been filled the day before to about six feet from the top with cut immature Indian corn.

(NOTE.—A silo is a pit for storing green crops for future use as fodder in the state called "ensilage.") The air in this silo showed on analysis a composition of—

CO_2	.. ..	38 per cent.
O	.. ..	13·5 ,,
N	.. ..	48·5 ,,

although a neighbouring silo, which had been filled for a week or more, had only 0·2 per cent. of CO_2, and 20 per cent. of oxygen.

From this, the possibility will be realised of a considerable and dangerous evolution of CO_2 from the vegetable cargoes I previously mentioned, if they should at any time be stored in the holds and not on deck. The *symptoms* of CO_2 asphyxia will be: Cyanosis, violent action of the heart and respiration, dilated and sluggish pupils, with speedy coma, asphyxia, and death. If seen in time, the *treatment* should be: Cold douches, ammonia to the nostrils, oxygen inhalations, warmth and stimulants, with steady artificial respiration.

A most interesting case of this CO_2 poisoning occurred in Singapore on 22 Dec., 1915. A Dutch ship—the s.s. *Jacob*—arrived from China after a seven days' voyage. She brought eighteen hundred coolie passengers in her for'ard and after 'tween decks. The passengers proved to be all well on inspection, and they were discharged on the arrival of the ship in the inner roads. Preparations were then made for the discharge of cargo. A hatch cover was partially removed and two of the Chinese compradore crew went down the ladders into the hold. They immediately fell insensible on to the top of the cargo bales. Several attempts were unsuccessfully made to rescue them, but it was found impossible to descend for about a quarter of an hour. On my arrival soon afterwards I found the two men on deck both dead—although artificial respiration was kept up for some time. A sample of air taken from the bottom of the hold was kindly analysed for me by the Government Analyst, and disclosed the extraordinary result:

CO_2	.. ..	22·55 per cent.
O	.. ..	1·86 ,,
N	.. ..	75·29 ,,
CH_4	.. ..	0·30 ,,

Subsequent investigation showed that the hold in question was only ventilated by a single mushroom-topped shaft which went through the 'tween deck to its termination about six feet above the main deck. This shaft, in the absence of any other ventilating openings, could, of course, act neither as

an uptake nor downdraught, and allowed stasis of the contained air (at a high temperature) during the voyage of seven days. The chief cargo in that hold consisted of over a thousand crates of oranges; and it must have been the so-called " respiration " of this fresh fruit which caused the astounding result. The ventilator was afterwards fitted with a double-action cowl (Fig. 8), which proved quite sufficient to keep the hold fresh.

With regard to **Benzene** cargoes, several accidents have occurred in Singapore at different times.

With regard to cargoes of **Ferro-Silicon,** fatal results have occurred during recent years in the following instances:

Date.	*Ship.*	*No.*	*No. Died.*
1905	*Vaderland*	50	11
1905	*Emily* (canal boat)	4	2
1906	*Caroline*	4	2
1907	*Olaf Wyjk.*	10	4
1908	*Uleaborg.*	7	2
1908	*Harry.*	4	2
1908	*Ashton.*	5	5

As a result of the last-named occurrence, which happened between Antwerp and Grimsby, an inquiry was held by the Local Government Board into the nature, uses, manufacture, and danger of the substance, and their report was published in 1909.

Ferro-silicon is an alloy of iron and silicon, in appearance rather like rough pig-iron. It is used as an admixture in the preparation of certain kinds of steel.

When the percentage of silicon is large, disintegration with evolution of gases is not uncommon *in the presence of moisture,* and each ton of the alloy may evolve anything from 1 cubic foot to 16 cubic feet of poisonous gases. These gases consist chiefly of *Phosphoretted Hydrogen* (PH_3), but they often contain as much as 5 per cent. or more of *Arseniuretted Hydrogen* (AsH_3); and traces of *Acetylene* (C_2H_2), *Sulphuretted Hydrogen* (H_2S), and *Siliciuretted Hydrogen* (SiH_4).

The preliminary *symptoms* are: Headache and giddiness;

but if the dose is continued vomiting and diarrhœa soon set in, followed by death.

The *post-mortem appearances* are: Pupils semi-dilated; rigor mortis well marked; skin and mucous membranes cyanosed; no shrivelling of the fingers or toes; blood thin and fluid; and the mucous membranes of stomach and intestines highly congested.

Very little can be done in the way of *treatment* unless seen early, when fresh air, oxygen, warmth, and stimulants should be tried.

It is well to keep in mind the resemblance to cholera—the absence of shrivelling and the general cyanosis will be of some diagnostic value.

Board of Trade Regulations *re* Cargo on Emigrant Ships : (1911.)

Reg. 51. *Cargo ; General.*—No emigrant ship may clear outwards if there is on board, either as cargo or ballast, any article or articles which, by reason of their nature, quantity, or mode of stowage, are either singly or collectively, in the opinion of the Emigration Officer, likely to endanger the health or lives of the steerage passengers or the safety of the ship.

54. *Offensive Cargoes.*—Vessels which have been engaged in the cattle trade, or in carrying any offensive cargo, must be completely cleansed to the entire satisfaction of the Emigration Officer before they are allowed to clear as emigrant ships.

55. *Creosoted Sleepers.*—Creosoted railway sleepers may only be carried in large steamships, in compartments which are separated from the steerage passengers' space by watertight bulkheads, or by the engine and boiler space, and on the condition that the Emigration Officer is satisfied that the steerage passengers will not be affected.

56. *Salted Hides.*—Salted hides should not be allowed unless they are packed in tight casks or in flowers of sulphur, or are stowed in a closed compartment away from the steerage passengers' space, to the satisfaction of the Emigration Officer.

57. *Rags.*—Cargoes of rags may only be carried if the following conditions are strictly complied with, viz.:

(i.) That there is an iron bulkhead on both the fore and after side of the hold in which the rags are stored with an iron or watertight deck over it;
(ii.) that the hatch over the hold is caulked and payed, and covered by tarpaulin;

(iii.) that the steerage passengers' luggage is not to be carried in this hold;
(iv.) that the hatches are not to be removed during the voyage;
(v.) that the rags are certified to have been disinfected, the certificate to be given either by the person who has disinfected them, or who has direct knowledge of the fact; and
(vi.) that the arrangements are carried out to the satisfaction of the Board's Officers.

58. *Cattle.*—The conditions under which cattle may be carried as cargo on emigrant ships are as follows:

(i.) For the purposes of these rules, the expression "cattle" includes both sexes of horned cattle, deer, horses, and asses; and four sheep of either sex or four female goats shall be equivalent to, and may, subject to the same conditions, be carried in lieu of, one head of cattle.
(ii.) In emigrant sailing ships there shall not be carried as cargo more than one head of cattle for every 200 tons of the ship's gross tonnage, nor more in all in any emigrant sailing ship than ten head of cattle.
(iii.) No cattle shall be carried below any deck on which steerage passengers are berthed.
(iv.) Cattle shall not be carried in any compartment in which steerage passengers are berthed; and cattle shall not be carried in any adjoining compartment, except in the case of ships built of iron or steel, where the compartment containing the passengers and the compartment containing the cattle are separated by an iron or steel bulkhead, which is proof against the passage of both water and effluvium, and is also sealed on the passenger side with a felt and wood lining.
(v.) Cattle shall not be carried on any deck next above a deck on which steerage passengers are berthed, unless the portion of deck occupied by the cattle is more than two feet distant longitudinally from that portion of the deck which forms the top of a steerage passengers' compartment.
(vi.) If cattle be carried on a weather deck, no portion of the deck abreast of the place where the cattle are carried shall be reckoned as air or promenade space for the steerage passengers, unless it is separated from such cattle by a deck-house or substantially built bulkhead; and the adjoining promenade space provided for the steerage passengers within fifty feet of the cattle shall be reckoned at the rate of eight superficial feet per statute adult.
(vii.) In the case of steamships having the machinery space dividing the vessel's hold and 'tween decks, and a bridge erection dividing the promenade decks, if passengers are carried only in one portion of the ship—that is, either before or abaft the machinery space—then, notwithstanding anything contained in these rules, as many cattle may be carried in the other portion of the ship as can be conveniently and properly housed therein, to the satisfaction of the Emigration Officer; provided that the promenade space allotted for the steerage passengers in a case of this kind shall be equal to five superficial feet per statute adult, and shall be situated entirely in that portion of the ship in which the passengers are berthed.

(viii.) Proper arrangements shall be made to the satisfaction of the Emigration Officer, for the housing, maintenance, and cleanliness of the animals, and for the stowage of their fodder.

(ix.) Not more than twelve dogs and no pigs or male goats shall be conveyed as cargo in any emigrant ship without the special permission of the Board of Trade.

In conclusion and with special regard to local coasting or home trade ships, in addition to such sanitary measures as may be required of the masters, the Health Officer making routine sanitary inspections should use his utmost efforts to secure the complete vaccination of all crews, and the periodical fumigation of each ship at least twice a year.

CHAPTER X

THE DISINFECTION OF SHIPS

"Bring sulphur, old nurse, that cleanses all pollution, and bring me fire, that I may purify the house with sulphur . . ."

Odyssey, xxii. (*Butcher* and *Lang*).

THERE are many extraordinary ideas current as to the disinfection of ships. You have the old-time skipper who looked on the burning of a small pot of sulphur as a cure-all for every sanitary woe; and I see in my note-book the following two extracts taken from responsible but unrecorded sources: "The disinfection of the ship itself is secured by wetting all available surfaces (except cargo)—*i.e.*, holds, saloon, fo'c'sle, decks, etc.—with a solution of corrosive sublimate." (!) And "Disinfection on ships is the same as elsewhere except that the disinfecting apparatus is small." (!)

I hope to show in this chapter that disinfection of ships is not such an airy jest as that.

As *Christian* says: "Disinfection is a complicated tool, its application necessitating not only practice but also intelligence—that is to say, a knowledge of the causes and methods of dissemination of infectious disease; and also familiarity with the method and sphere of action of the several kinds of disinfectants." Added to this will be required (for sea work) an intimate knowledge of the structure and peculiarities of ships, and a close familiarity with the habits and customs of life on board both amongst human beings and vermin.

Primitive Disinfection.

There is no doubt that as early man gradually abandoned a solitary and nomadic existence for a more gregarious one, the results of periodical epidemics of infectious disease must have become more noticeable and alarming.

The growing cult of the priesthood, as the interpreter and custodian of unseen forces, must slowly have evolved the primitive ideas of disinfection—obviously a mixture of religious ceremonial with dim strivings towards sanitary righteousness.

Apart from incantations and various esoteric rites, there seem to have been three material agents used from time immemorial: incense, sulphur, and fire.

The first object of incense was probably to mask offensive smells.

We have mention in Homer of the burning of sulphur to purify the air; Hippocrates, too, mentions it as an antidote to plague; while in Ovid we find it used for bleaching fleeces and purifying them from contagion.

Fire, also, as a means of cremation of articles supposed to be infected, is of immense antiquity.

It is a strange testimonial to empiricism that here, after a lapse of about three thousand years, and with every advantage of modern science at our disposal, sulphur and fire are either directly or indirectly still the most practically useful agents at our command; and incense in some form or other is still of great practical importance as a protection against the wiles of the dangerous mosquito, even though but little used as a deodorant.

Little, if any, disinfection was apparently done on ships in medieval or early modern times, with the exception of the desultory use of sulphur. Even as late as the time of Nelson disinfection was very primitive, as may be seen from John Masefield's excellent book on "Sea Life in Nelson's Time." The following were some of the Navy methods then in vogue: Fumigation was carried out by soaking gunpowder in vinegar and burning it in iron pans. If badly infected—when in dock, tobacco was burnt in big pans about the gun decks, with ports and hatches closed, with the men standing at quarters "as long as they can bear it."(!)

Kit-bags were disinfected by being suspended over pots of burning sulphur.

When at sea the Surgeon was supposed to ask the Captain,

periodically, to have iron fire-buckets lowered into the hold. These contained burning charcoal; and, when in position, vinegar and brimstone were thrown on them, with the idea of providing both a drying and a disinfecting agent.

In the sick-bay, mattresses ("donkeys' breakfasts") were served out to each man. If the compartment was at all crowded, red-hot irons ("loggerheads") were plunged into buckets of tar placed on deck, with the idea of disinfecting the air—which probably needed it very badly!

After action, the bloodstained decks were first washed and then sprinkled with hot vinegar.

Rather later than this, and for some time after Nelson's death, the usual method of fumigation was to pour sulphuric acid and powdered nitre on buckets of hot sand.

Origin and Principles of Modern Disinfection.

By "disinfection" we mean the destruction by chemical or physical means of pathogenic organisms, and incidentally of non-pathogenic organisms also.

Modern disinfection may therefore be considered to have originated with the recognition of micro-organisms as being causal factors of infectious disease. The gradual evolution of this conclusion is full of historical interest.

The first compelling "streaks of dawn" were in the middle of the eighteenth century, when *Pringle* in France wrote his historic memoir on septic and antiseptic substances. This interesting brochure described forty-eight experiments, showing the antiseptic effect of different chemicals on pieces of fresh meat. Moreover, for the first time, standardisation was attempted; the investigator taking as his control the action of 60 grs. of salt on 2 grs. of meat in 2 oz. of water, and testing the relative efficiency of many other chemicals, such as ammonium chloride, ammonium acetate, potassium acetate, nitre, borax, alum, camphor, etc.

At about the same time two valuable experiments were made by *Redi*. He first showed that the moulds which grow on jam must have come from the air, because, if air is only

allowed to reach to jam through cottonwool, no moulds will grow. Further, by a gauze observation cage, he showed that maggots in meats were only miniature flies.

Not long after this, bacteria had begun to be recognised, and in 1773 *Müller* had described several forms.

In 1777 *Spallanzani* showed that heating would prevent the appearance of organisms.

Although the above observations form a comprehensive nucleus for the development of bacteriology, yet it was not until nearly a century later that the next real advance in bacteriology was made when, in 1850, *Davaine* found the anthrax bacillus in the blood of certain dead animals.

From that time, progress has been more or less uninterrupted.

In 1822 the great *Pasteur* had been born. He early turned his attention to chemistry. In 1852 he was appointed professor of chemistry at Strasburg, where his early work on tartrates was done. He isolated two tartaric acids from wine-lees; and showed that one of these was inert to polarised light—the inactivity being due to a binary structure.

As a proof of this he grew the mould *penicillium glaucum* on the inactive tartaric acid and found that the dextro-rotatory element was thereby destroyed, leaving only the lævo-rotatory component.

In 1854 he was appointed Professor of Chemistry at Lille. There he continued his researches into the diseases of beer and wine, and in 1857 showed that vinous, acetous, and lactic fermentations were due to the growth of small organisms or ferments. The question arose, Were these in the air, or were they (as was generally thought at that time) spontaneously formed in the liquid? By a series of elaborate experiments (on the lines of what *Redi* had done a century before) he showed with wounded grapes, etc., that fermentative or putrefactive changes did not take place if air was excluded, but always occurred if it was not—an observation which was carried to its practical application by *Lister* and others.

In 1870 he showed a disease of silkworms to be due to a bacterium.

The number of species of discovered micro-organisms had

by now reached a considerable total. An excellent classification of them was, for the first time, made by *Cohn* in 1872. In 1871 the leprosy bacillus had been discovered by *Hansen*.

The work of the bacteriological giant—*Robert Koch* (1843-1910)—now began to be published. In 1876 he definitely proved the causal relationship of *Davaine's* anthrax bacillus to splenic fever, and demonstrated its spore formation. Four years later *Pasteur* showed that this bacillus lost its virulence after a few sub-cultures in chicken broth, and that this attenuated culture when inoculated conferred a protective result against subsequent inoculations with virulent culture.

Koch continued steadily to improve bacteriological methods, and in 1882 discovered the tubercle bacillus, and during the following year in Egypt found the vibrio of cholera.

Such is a brief outline of bacteriological development up to the discovery of some of the organisms causing infectious disease.

Modern work has demonstrated many of such organisms; while investigation has shown the method of spread in most cases, and consequently given us the means to combat and control the diseases. This is our justification for adopting measures of disinfection and fumigation.

It has been sometimes objected that the term " fumigation " is unscientific. Such an objection is founded on the lax use of the term. Fumigation (the production of a smoky or gaseous agent) is, generally speaking, undertaken only with a view to killing incriminated vermin (disinfestation), or sweetening foul areas.

As a disinfectant, we only use gas-fumigation in the single instance of smallpox, and that merely on an empirical theory of an airborne origin. Sulphur dioxide and formaldehyde are both extremely valuable bactericidal agents in the presence of moisture; but, as practical disinfection deals almost entirely with " surfaces," we use liquid agents for preference, as being of easier and quicker application than gases.

Either disinfection or fumigation is undertaken on board ship for the following reasons·

(i.) After known or suspected human infection on board.
(ii.) After known or suspected rat infection on board.
(iii.) Owing to the presence of contaminated food, water, or cargo.
(iv.) As a precautionary measure for the extermination of rats or mosquitoes.
(v.) As a routine adjunct to general measures of sanitation and cleanliness on board.

For the proper disinfection of ships, special apparatus is necessary, and specially chosen agents; and the details of application will demand close vigilance and much ingenuity on the part of the officer who conducts the disinfection. Make-shifts will never do; and personal skilled control is essential for successful work—in fact, it had otherwise far better be left undone, as it would be liable to give a false sense of security.

Apparatus and Agents for Ship Disinfection.

To enumerate and discuss a full list of the different disinfecting agents which are used for disinfecting ships would uselessly occupy space in a small work of this kind.

I propose, therefore, only to consider a few agents which, while comprising all that is necessary for ship disinfection, have been proved by practical experience to answer the purposes required of them.

In practice, we shall want to know what to use for the disinfection or treatment of the following:

(i.) Ship's surfaces.
(ii.) Compartment fixtures and bugs.
(iii.) Air in compartments.
(iv.) Cargo and rats.
(v.) Ship's water-supply.
(vi.) Foodstuffs on board.
(vii.) Movable articles, such as clothing, utensils, mails, etc.

We shall see that to treat the above properly, the only agents needed are:

(*a*) One liquid disinfectant,
(*b*) One gas (preferably, two),
(*c*) One deodorant,
(*d*) One insecticide,

and as a questionable (*e*), a water-disinfectant.

I will begin by saying that a steam installation on board is quite unnecessary. Its only necessary or advisable use (in connection with ships) is for purposes of disinfecting the effects of emigrants or steerage passengers. Such disinfection should never take place on board ship. It is a matter which should be dealt with at a properly equipped inspection or quarantine station after the passengers have been removed thither from the ship. The discussion of steam machines will therefore be found in Chapter XI.

Another remark which should be made here is, By whom and when are the measures of disinfection to be undertaken?

The answer is, By the Health Authorities when the infected ship gets into port. It should be remembered that the port staff are experts in the job, while the Ship's Surgeon or crew are not, nor have they the proper apparatus or facilities. An infected ship often reaches the port, and the Surgeon on board informs us that he has completed the disinfection. It is often a shock to him to find that disinfection is ordered to be carried out again.

Not that the Surgeon cannot help, and very materially help, in the treatment and control of disease on board. *His* point of view and action are dealt with in Chapter VIII. The secret of his success will be the immediate **isolation** of each case of infectious disease *at the earliest possible moment* after it has occurred. All the disinfecting agents which need be used by him are—one liquid disinfectant, and the materials for generating formaldehyde gas. The measures he takes will be at the original site of infection, and should be continued by him *at the source of infection* all the time it remains on board. His disinfection, if conscientiously done, may be very valuable indeed, but is at best only a makeshift until expert treatment with proper appliances can be obtained at a port.

We now come to our consideration of disinfecting agents.

A Liquid Disinfectant.—The disinfectants that will be found in the store-rooms of most ships are—crude commercial carbolic, some roll sulphur, and perhaps a coal-tar disinfectant of the Jeyes' fluid type.

The liquids used by many Port Health departments will

usually be either a solution of perchloride or else one of the Jeyes' fluid type.

Now in choosing a liquid disinfectant for ship use, it is important to secure one that (in normal dilution) will meet the following requirements:

(i.) It should be of powerful germicidal value.
(ii.) It should be equally efficacious when mixed with sea water.
(iii.) It should be sufficiently cheap to cause no concern if large quantities are expended.
(iv.) It should have a minimum of corrosive or poisonous action.
(v.) It should be available for a maximum number of situations in which a liquid disinfectant is required (*e.g.*, it should be just as much available for the surface disinfection of a large hold as it would be for the disinfection of a surgical instrument or a teacup).
(vi.) It should not precipitate albumen.

Unless a disinfectant is chosen which will meet these six requirements, it will mean that several different agents must be used for several different purposes. If, on the other hand, a single agent will answer every purpose, it stands to reason that such disinfectant will be an ideal one for use on ships.

To take liquids in ordinary use: *Perchloride of Mercury Solution* is at once seen to be outside the pale, for it only meets with our requirements Nos. (i.) and (ii.).

Jeyes' Fluid type is also useless, for that only meets our requirements Nos. (iii.), (iv.), (v.), and (vi.), since they are mixtures of cresols and tar-oils of which the white emulsion in water breaks down and ceases action in the presence of urine, fæces, sea water, etc.

Formalin Solution only meets our requirements (i.), (ii.), (iv.), and (vi.).

Carbolic Acid Solution only answers to Nos. (i.), (ii.), and (vi.).

Chinosol Solution only answers to Nos. (i.), (iv.), and (vi.).

The *Lysol* type has the same limitations as Chinosol.

We thus see that, out of those agents most frequently in use, none are ideal for our needs.

There have been as far as I know, until recently, only two

liquids which fulfil all our six requirements. These are: *Sanitas Okol*—a liquid composed of cresols and tar-oils already emulsified with dextrine; having a mean carbolic acid coefficient of about 9; mixing readily with sea water without destroying the emulsion, and only losing about 1° of coefficiency thereby. It is made by the Sanitas Company, of Locksley Street, Limehouse, London, E., and is used in a working strength of 1: 1000, or 1: 500 for infectious disease, the cost of a gallon (as diluted) being about $\frac{1}{13}$d.

The other liquid disinfectant is *Izal*—a liquid composed of cresols and tar-oils already emulsified with gelatine; having a mean carbolic acid coefficient of about 8; mixing readily with sea water without destroying the emulsion, and only losing about 1° of coefficiency thereby. It is made by Messrs. Newton, Chambers and Co., Ltd., and is used in a working strength of 1: 800, or 1: 400 for infectious disease, the cost of a gallon (as diluted) being about $\frac{1}{10}$d.

There is very little to choose between these two admirable disinfectants. Okol I prefer and always use as being slightly more powerful and initially cheaper; but Izal is a rather more elegant emulsion.

I believe that other makers have recently followed suit, and put similar kinds of emulsion on the market, but I find no advantage over the two older and established products.

So much for the liquids themselves. With regard to apparatus necessary for their use: On board ship, they will either be used in a barrel for soaking linen, etc., or in a bucket for throwing over infected portions of deck, bunks, etc.; or they will be used in the form of a spray for treating the surfaces in cabins, crew's quarters, etc. For this latter purpose I recommend the use of a "*Mackenzie Spray.*" This excellent instrument is very efficient and portable, and is not a toy like the majority of portable sprays. It was devised by Dr. Leslie Mackenzie, Inspector of the Local Government Board, Scotland, and is sold by the Thresh Disinfector Co., Ltd., of 10, Walbrook, London, E.C. The most suitable size is the "A," which costs £2 2s.

For port work, the disinfecting launch should be fitted with

a tank of solution which is discharged under good pressure by means of a donkey pump and lengths of armoured hose—sufficiently long to reach the lower hold of a large ship.

We now come to *gaseous disinfection and fumigation.*

In choosing a gas for fumigation it is important to secure one that will meet the following requirements:

(*a*) That it shall kill rats effectually and quickly.
(*b*) That it shall readily kill vermin such as cockroaches, bugs, and fleas, etc.
(*c*) That it shall readily kill flying insects such as mosquitoes, house-flies, etc.
(*d*) That it has a minimum prejudicial effect on cargo or foodstuffs.
(*e*) That its production in large quantities can be effected cheaply.
(*f*) That its production can be effected quickly.
(*g*) That it has sufficient colour or irritating smell to warn human beings of its presence.
(*h*) That it is heavier than air.
(*i*) That it is not inflammable.
(*j*) That its penetration of cargo is slow.

If, in addition to these requisites we have

(*k*) That it has a good germicidal value,

then we shall have an ideal gas for use on ships.

Now there are very few gases that are capable of practical application in fumigation. We can at once exclude such gases as chlorine, oxides of nitrogen, etc., which have recently been put to so unsportsmanlike a use in human warfare.

The gases capable of application are:

(i.) CO (carbon monoxide).
(ii.) CO_2 (carbonic acid gas).
(iii.) Flue-gas (Harker process).
(iv.) Producer-gas (Nocht and Giemsa process).
(v.) SO_2 (sulphur dioxide).
(vi) Clayton gas ($SO_2 + SO_3$, etc.).
(vii) Formaldehyde (CHOH).

If we test these by our list of ideal requirements, *CO* is at once ruled out of court by the great expense of producing it *pure,* by the absence of effect on insects, by its danger to human beings, and by the fact that it is lighter than air.

CO_2 cannot be used in its pure state, because not only does it not kill insects, but a strength of at least 30 per cent. is necessary to kill rats, and such strength it is almost impossible to obtain in a ship's hold in practice.

Flue-Gas.—The application of the gas produced by ordinary furnace combustion in marine flues was originated by Dr. Harker, of Sydney, N.S.W. The idea is to utilise this gas by a special machine which has a motor-driven "blower," and a

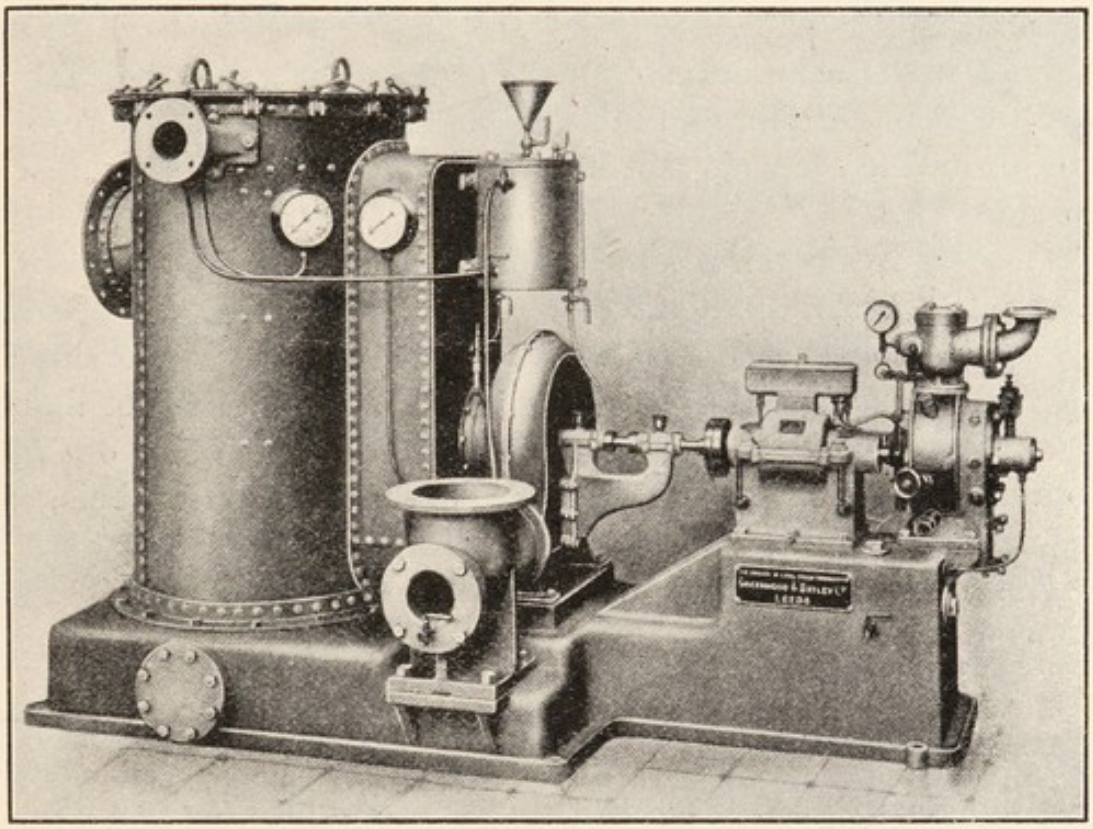


FIG. 21.—THE HARKER FLUE-GAS APPARATUS.

"washer" for cooling the gas and purifying it from soot, etc.

The accompanying illustration (Fig. 21) will give some idea of the machine which is made by the Harker Co. (Offices: 6, Bligh Street, Sydney, and 113, St. Vincent Street, Glasgow). Each ton of coal burnt in a ship's furnace is calculated to produce 400,000 cubic feet of gas. The Harker machine will supply about 1,000 cubic feet of gas per minute. Experiments

by the Government Analyst in Sydney show the analysis to be approximately as follows:

Nitrogen	79 to 81 per cent.
Carbon dioxide	8 to 11 ,,
Oxygen	8 to 10 ,,
Carbon monoxide	1 to 1·5 ,,

The gas produced is rather sooty and is too hot for cargo work (above 120° F. at discharge).

Moreover, it was found to kill neither micro-organisms nor insects.

Even with the addition of 0·7 per cent. CS_2 it was found that rats were not dead for four minutes, and that all their fleas were not even then killed. Cockroaches took fourteen minutes to die.

This gas is therefore too far from our ideal requirements to warrant its general adoption.

Producer-Gas.—This gas, which is produced in a machine devised by *Nocht* and *Giemsa*, is somewhat on the lines of the Harker process; but, instead of using ordinary gas of open combustion, coke is burnt in a special producer, air entry being regulated.

The resulting gas has a composition of:

Nitrogen	77 per cent.
Carbon dioxide	18 ,,
Carbon monoxide	5 ,,

Although this gas is cheap to make and kills rats readily, yet its composition, as well as the absence of colour and smell, make it even more deadly than Harker gas.

It is in use in the ports of Hamburg and Stettin, but as the initial cost is high (£5,000 for barge and engine), and the cost of supervision is high, and as, moreover, the gas has no bactericidal or insecticidal properties, its general adoption can scarcely be advised.

Sulphur Dioxide.—SO_2 is produced by burning sulphur in air.

Sulphur will burn in moist oxygen at 260° C. (488° F.), but it will distil without burning at 440° C. (824° F.).

When burnt in an open pot 1 lb. of sulphur will produce

approximately 11·7 cubic feet of SO_2 (*i.e.*, about 1 per cent. SO_2 in a space of 1,000 cubic feet).

The gas which is given off has the following analysis:

Sulphur dioxide (SO_2), 4 per cent.
Sulphuric anhydride (SO_3), $\frac{1}{10}$ m.g. per litre.

This gas is nearly invisible—not cloudy like the Clayton gas.

It is, moreover, almost non-toxic. *Hankin* (1896) found by experiment that its bactericidal action was nil; and even after obtaining the necessary humidity (4 fl. oz. water to saturate the gas from 1 lb. sulphur burned), the gas had merely an inhibitory and not a toxic effect.

It has been said that 5 per cent. of SO_2 is the maximum theoretical amount of gas obtainable in a confined space by burning sulphur by the open method; but even though no more can be produced, it is not under any pressure at all. Further production ceases because that strength (5 per cent.) of gas will inhibit further combustion of the sulphur.

Owing to the complete lack of pressure, or penetration, or bactericidal action, it will be seen that the old-fashioned idea of burning sulphur in a pot should be promptly jettisoned !

There are several machines which in use produce a gas of similar composition to that obtained by burning sulphur in the open. A type of such is *Halle's Apparatus*, as used in Amsterdam. It consists of a barge fitted with a dynamo and a fan propeller which pumps the SO_2 into a ship. Cylinders of liquid SO_2 form the source of gas.

It is not only costly and needing very skilled supervision, but it is also very liable to leak and freeze up.

The gas, moreover, has scarcely any germicidal value at all, and, as in the open method, is very liable to damage cargo. It scarcely will enter the domain of practical politics, therefore.

We now come to what is called *Clayton Gas*.

This also is the product of the combustion of sulphur, but as the process takes place in a closed chamber with regulation

of the air-inlet, the resulting gas has a rather different composition, which is as follows:

Sulphur dioxide (SO_2)	up to 18 per cent.
Sulphuric anhydride (SO_3) ..	$6\frac{2}{10}$ m.g. per litre.
Higher oxides (unstable)	traces.

The machine is made by the Clayton Co., Ltd., of 22, Craven Street, W.C., in several different types capable both of fire-extinguishing and disinfection.

Type " B " is the most suitable for port health work (*vide* illustration, Fig. 22).

This machine develops a furnace temperature up to 1,800° F., and is capable of producing over 48,000 cubic feet of Clayton gas per hour. Two and a half of sulphur are used for each 1,000 cubic feet to be fumigated. The rationale of the operation is merely the combustion of roll sulphur in a chamber, cooling the gas so produced by a water service of 1,500 gals. of water per hour, forcing the gas through armoured hose into the required space by means of a blower, and at the same time feeding the sulphur chamber with exhaust air drawn from the required space through a second set of armoured hose pipes—thus causing a continuous circulation of gas and air.

The following is the method of using the machine " B " in actual practice (*vide* Fig. 23):

1. Open valves H and C (*i.e.*, suction to generator).
2. Open valve A (generator to cooler).
3. Charge generator with 250 lbs. sulphur.
4. Start circulating water through cooler by valve E.
5. Start engine running at 350 revolutions p.m.
6. Throw some kerosene, or preferably methylated spirit over the sulphur. Light with torch and close door of generator.
7. Look through the mica sights. The sulphur shows blue flame at first. If burning sluggishly before melting completely, open the door and insert some burning waste.
8. As the strength of gas increases the flame changes from blue to yellow. If you wish to get a high percentage quickly, you may stir up the burning sulphur, but do not do so until it is thoroughly melted and well alight.
9. After running for fifteen minutes test the gas (method described later), and repeat each fifteen minutes until a test of *exhaust* gas shows three per cent.

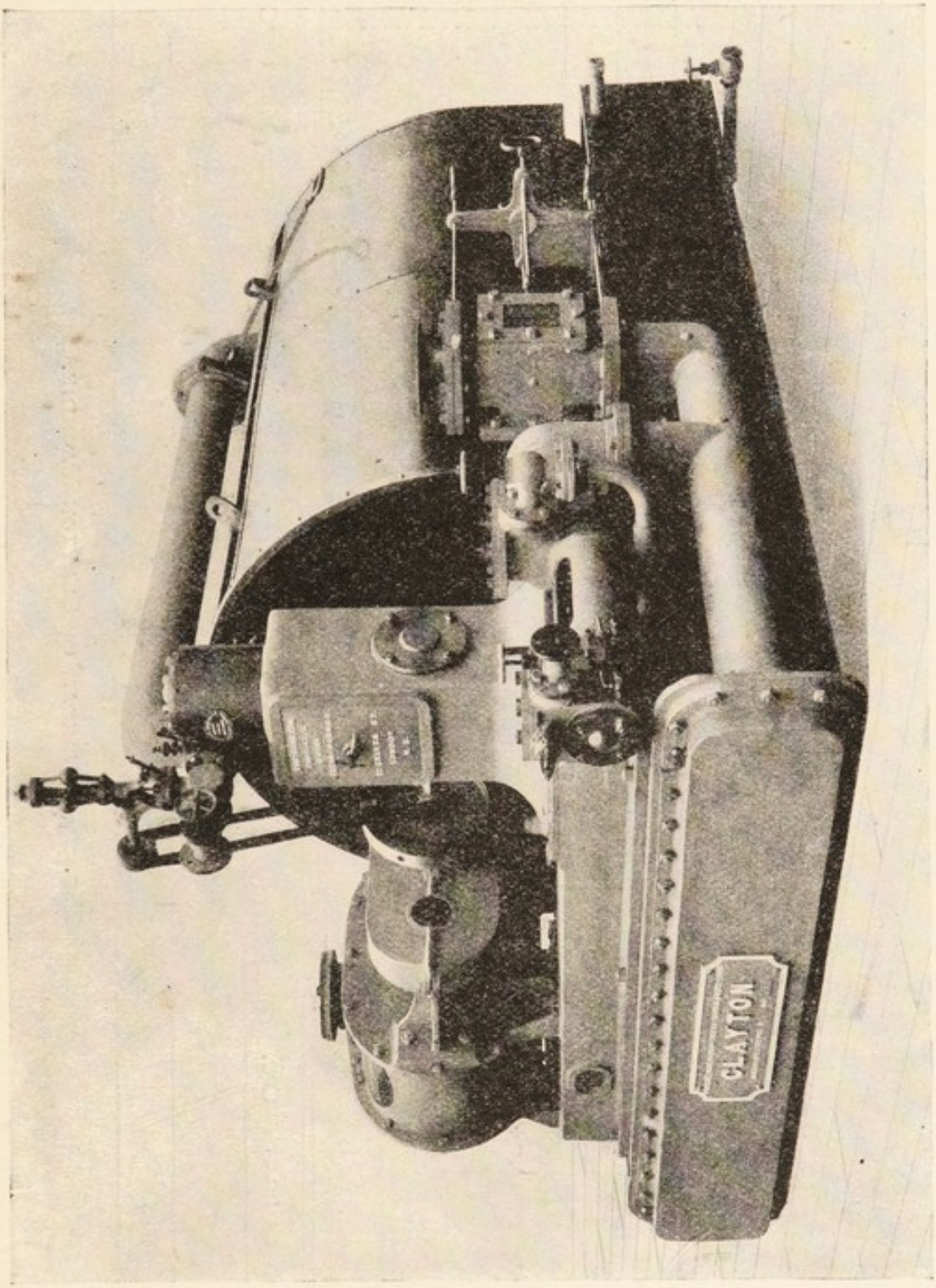


FIG. 22.—CLAYTON FIRE EXTINGUISHING AND DISINFECTING MACHINE.

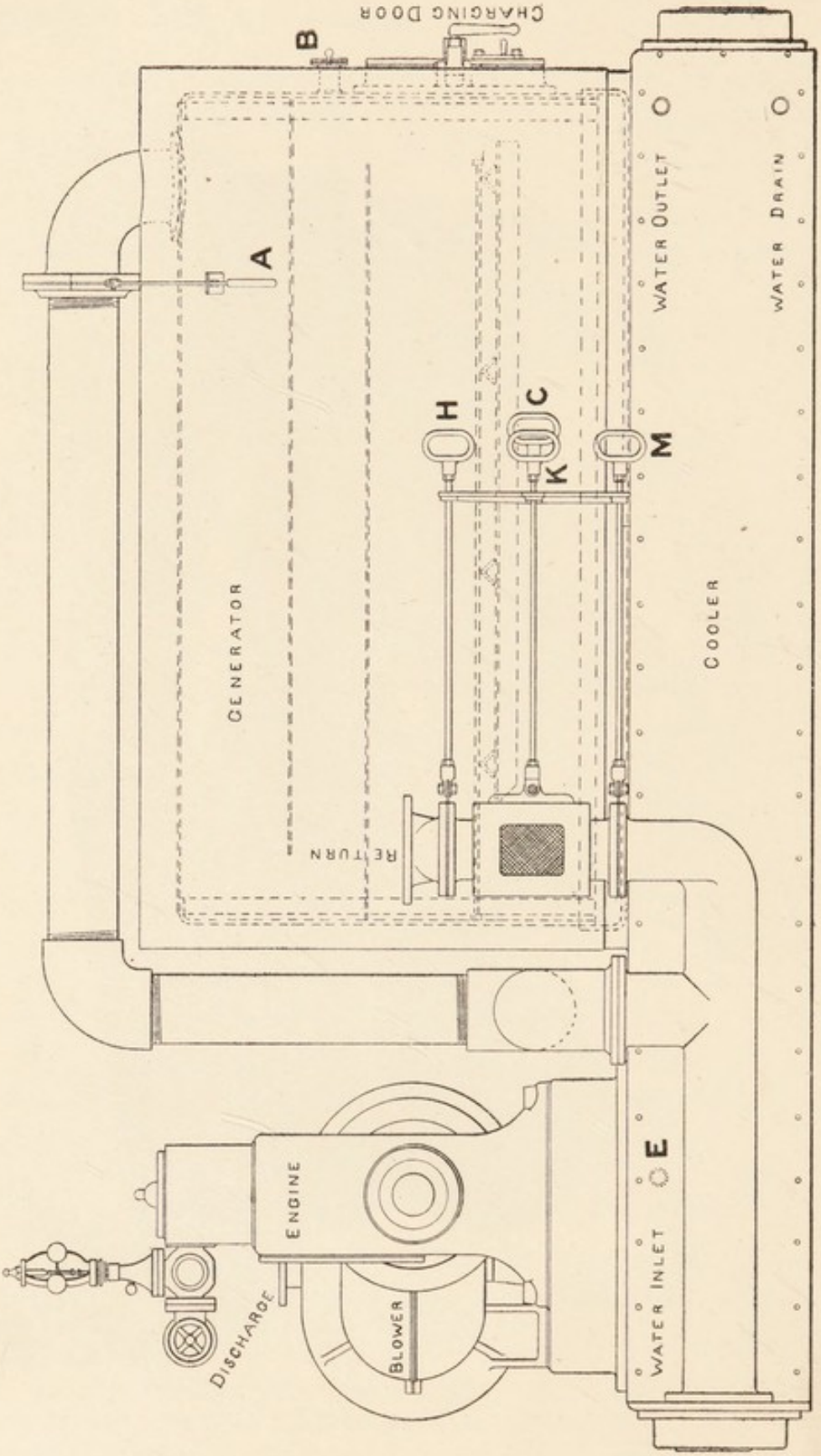


FIG. 23.—DIAGRAM OF CLAYTON MACHINE.

10. When that stage is reached, open air inlet valve K, and close exhaust suction valve H.

(NOTE.—This means that circulation in the hold or required space has stopped. Gas is now continuing to enter, but no air or gas is leaving the space by the exhaust pipe. Thus a pressure of strong gas is being added all the time to air in which a uniform 3 per cent. of gas had been diffused. The sulphur in the generator now gets its combustion air from the atmosphere direct, and not from the air of the hold or space being treated.)

11. Continue thus to pump in gas for a length of time equal to that which had been occupied in bringing the exhaust test up to 3 per cent. (Thus if it took one hour of circulation to bring exhaust gas up to 3 per cent., then continue to pump in gas for one more hour after closing the exhaust suction valve.)

12. During these operations, sufficient sulphur should be added from time to time to keep about one inch molten on the bottom of the generator. Towards the end of the run this should be burnt right out.

13. When it is desired to stop generating, slow down the engine and close all valves on the generator. The door should not then be opened until the sulphur has cooled below ignition point, and the gas within has been withdrawn by opening the necessary connections, and running the blower for a short time.

14. The hold into which a 9 per cent. gas has been introduced should be kept closed from three to six hours after completion, according to the size of the ship. If the holds were empty, one to two hours' closure are quite enough, according to the size of the ship.

The object of testing the gas is twofold. We want to know first when a uniform strength of 3 per cent. has been reached in the ship's hold, because, if it is more than that amount, it will be liable to stop combustion (of the sulphur in the generator) as it returns by the exhaust suction pip .

We further want to know that the gas at discharge does not reach the strength at which sublimation will occur. The volume of SO_2 is the same as that of the oxygen from which it is generated. As, therefore, the atmosphere contains about 20 per cent. of oxygen, the greatest strength of SO_2 is 20 per cent. of the total atmosphere passing through the machine. When 20 per cent. is reached, uncombined and vaporised sulphur commences to pass from the generator and will be deposited in the cooler and delivery pipe. To obviate this, an air-inlet valve *B* is fitted so that, if the test shows an approach to 20 per cent. in the delivery pipe, extra air may be admitted to prevent the formation and deposit of uncombined sulphur.

For purposes of testing, two stopcocks are provided, one on the delivery pipe and one on the exhaust pipe. A glass gas-pump, a special glass burette (Fig. 24), and a yard or two of rubber tubing, are all that is necessary in the shape of apparatus.

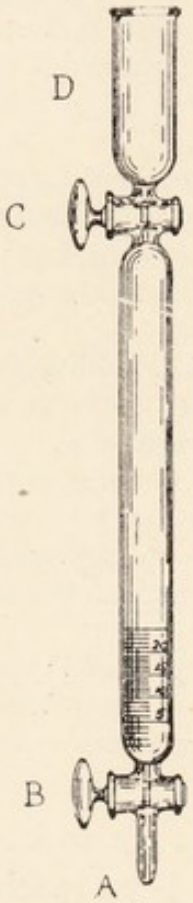


FIG. 24.—CLAYTON BURETTE FOR GAS TESTING.

In testing the gas from the delivery stopcock on the engine, all that need be done (because the gas is already at a pressure) is to connect the stopcock with the burette nozzle *A* by means of a piece of rubber tubing. The burette cocks *B* and *C* and the engine stopcock are then all opened, and a current of gas passes steadily through the burette. After a few seconds close burette cock *B* and then quickly close *C* also. (*Note.*—If the cocks are closed in the reverse order, a pressure will occur in the burette which will nullify correct readings.)

You then fill the burette reservoir *D* with fresh water. Open the cock *C* very slightly and allow some trickle of water to enter the burette. Close the cock, put your hand over the reservoir to close it, and shake the burette up and down smartly.

Repeat this process until no more water will enter the burette on opening cock *C*. (*Note.*—Do not grasp the burette with your hot hand; hold it by the reservoir at the top. Then hold up the burette and read off the level of the top of the water therein. The reading will give you the percentage of SO_2 in the gas.)

PRINCIPLE OF TEST.

Cold fresh water will absorb many times its own volume of sulphur dioxide (SO_2). It therefore follows that when the body of the burette contains a certain percentage of SO_2 at atmospheric pressure, and the cup at the cop of the burette contains cold fresh water, if the water be admitted to the body of the burette by means of the glass cock beneath the cup, then all the SO_2 contained in the burette will be gradually absorbed by the water. This will produce a partial vacuum which will

draw into the burette a volume of water equal to the volume of SO_2 absorbed; and as the burette is marked in hundredth parts of the original space occupied by the sample of gases, the height of the water indicates the percentage of SO_2 originally contained in the burette.

This test is quite accurate enough for practical purposes.

If it is required to do a chemical test, it will be done by means of an iodine solution:

$$\underset{81{\cdot}46}{H_2SO_3} + H_2O + \underset{251{\cdot}8}{I_2} = 2HI + H_2SO_4$$

A standard iodine solution is made by dissolving 12·59 grams of I and 18 grams of KI in a little water and diluting to 1 litre.

(1 c.c. = ·00407 H_2SO_3 = ·00318 SO_2.)

Take 0·5 c.c. of the H_2SO_3 solution in the burette, add 9·5 c.c. distilled water, add a little starch mucilage.

Titrate with above iodine solution until there is a permanent trace of free iodine, and make calculation.

Having thus discussed Clayton gas and its production, it remains to be seen to what extent it fulfils those ideal requirements of a fumigating gas which we have laid down for ourselves.

This is best seen by enumerating, seriatim, the findings of four different expert authorities who have carried out experiments under practical conditions.

1. Clayton gas at 10 to 12 per cent. saturation is a toxic gas.*
2. Eight per cent. of the gas readily kills rats and insects.†
3. Four hours' exposure at 10 per cent. is fatal to rats, cockroaches, bugs, fleas, mosquitoes, and their larvæ and pupæ.*
4. Two hours' exposure at 0·5 per cent. is fatal to rats and insects in an empty hold or interspaces of cargo; but owing to absorption it is necessary to circulate 3 per cent. for twelve hours in order to secure the 0·5 per cent. in all the air spaces of a full hold.§
5. Four hours' exposure at 10 per cent. will kill plague, cholera, and enteric organisms, but not anthrax spores.*
6. Eight per cent. will kill cholera, enteric, and plague organisms.†
7. Pathogenic bacteria are destroyed by two hours' exposure to 0·5 per cent. of the gas.§
8. Up to a strength of 20 per cent. the gas has no effect at all on dry fabrics.‡‡

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* *Hewlett* and *Simpson*, in London (s.s. *Manora*), 1903.
† *Calmette*, Marseilles.
‡‡ *Prof. Dunstan, F.R.S.*
§ *Dr. Wade, D.Sc.*, for Local Government Board.

9. Merchandise such as silks, prints, books, photos, etc., are unaffected by the gas, if dry.*

10. Jute cargoes are not affected by the gas.§

11. Textile fibres and fabrics are not damaged by the gas, as they are by open-method SO_2.§

12. Coloured materials are not damaged unless wet; and even then the bleaching will depend on the nature of the dye.‡

13. Coloured silks, cottons, and flannels have been kept for five hours in an atmosphere of 15 per cent. Clayton gas without damage.‡

14. The gas does not affect leather or skins.†

15. Petroleum will only slightly absorb Clayton gas if it is bubbled through it. Even then it is unaffected thereby.‡

16. Vegetable oils if exposed to a Clayton atmosphere will absorb the gas, becoming brown and showing black deposits.‡

17. A 3 per cent. circulation for twelve hours with subsequent closure of hold for twelve hours will ensure the disinfection of the interior of cargo.§

18. Machinery is merely tarnished by the gas and can be readily repolished.*

19. Foodstuffs generally are not damaged by the gas.‡

20. The gas is a preservative of meat, and will not injure foodstuffs except fruit and some kinds of vegetables.*

21. Tea and coffee if dry are not damaged by the gas.*

22. Cereals, sugar, and meats are not affected.†

23. Wheat in bags may be damaged, but not if in bulk.§

24. Barley and maize are unaffected.§

With such evidence before us, I think we can safely say that Clayton gas furnishes us with a gas that meets all our requirements for ship purposes—that is to say, when used by port health authorities. In addition, I might say that we have continually disinfected the full holds of ships in the port of Singapore for about ten years, by the Clayton process, and have, so far, had no single complaint of damaged cargo. If I know the shipping firms at all, this means that no cargo has been damaged!

The secret of excellence of the gas is, I think, that it is properly cooled before introduction, and thus avoids condensation.

The great bone of contention with regard to Clayton fumigation lies in the cargo. You will actually often see it stated that the gas may kill rats, but should never be used when the

* † ‡ § For reference see p. 281.

holds are full because it penetrates cargo so slowly that it will not disinfect it!

We don't want it to penetrate cargo quickly. That is one of its most valuable characteristics. Cargo is practically never infected.

If we introduce the Clayton gas at high strength and as rapidly as possible, and only leave it shut up for the time I suggest, we shall effect our main purpose—the killing of rats in holds or open crates, etc.—while at the same time the penetration of cargo by the gas will not be sufficient to cause any possible damage.

Do not fear cargo, therefore; and, whatever you do, do not recommend fumigation of an *empty* ship. That is the most illogical thing you can do. In rat fumigation you either want to prevent infected rats from entering your port, or else you want to prevent them from leaving your port for other countries. If, therefore, in the first case you wait until the cargo has been discharged before fumigating, you have very likely allowed infected rats to get ashore with such cargo—you are locking the stable door after the steed has fled.

In the second case, you will be disinfecting the ship and then allowing possibly infected rats or rat-infected cargo to be put on board—in which case you might just as well have saved the time and money spent in fumigating.

There is one other point, in connection with rat-fumigation, which I should like to bring up:

Don't imagine for a moment that, because a ship has been fumigated to kill rats, such ship is less liable to develop a case of plague on board during that voyage. As I have elsewhere insisted on, cases of plague on board ship have almost invariably been contracted ashore and the person has come aboard during the incubation stage.

Scarcely one in a thousand cases will have been contracted through the agency of infected rats on the ship.

The object of the rat killing is *not* to protect the *ship*, but to protect other ports at which infected rats might escape.

Before leaving the subject of SO_2, I might mention that there are other apparatus in use for generating a similar gas to that of the Clayton machine.

The *Kinyoun-Francis* furnace is a United States machine, which has had some vogue. It is a double-ended sulphur generator, from which the gas is also removed by a blower and hose. It has, however, two disadvantages: There is no cooler, and there is no suction exhaust, so that no satisfactory circulation of gas can be established in any hold or compartment. The machine is, therefore, not of practical value.

The other form is the "*Ritchie Duplex Fumigator,*" which has superseded the Clayton in some cases. Their Type 1 is a much larger machin—13 feet 9 inches by 9 feet by 6 feet 4 inches. Weight, 8 tons. It has a steel generator with a water-jacket, and air is drawn through by a double set of Root's blowers. It is capable of delivering as much as 95,000 cubic feet of gas per hour. Combustion of 3 lb. of sulphur gives 1,000 cubic feet of SO_2 with complete consumption of all the sulphur, and the gas is cooled by a water service of 3,000 gals. per hour. It can pump gas into the area up to the pressure of a 30-oz. gauge.

The initial cost of this large and fine machine is less than that of the Clayton. Thus it should have a good future. Three smaller types are on the market—the smallest being air-cooled.

Formaldehyde Gas (HCOH).—This gas, in the presence of moisture, especially if nascent and hot, is one of the best germicides we have. Unfortunately, it is not an insecticide nor a verminicide, and therefore its use on board ship is very limited. I, personally, only use it for the disinfection of cabins or hospitals in which smallpox cases have been living, such spaces being often very awkwardly situated or constructed for disinfection by a large and rather cumbersome Clayton plant.

Formaldehyde gas is also very useful for disinfecting cabin passengers' or crews' effects, and occasionally mails.

As the proper disinfection of most parts of a ship cannot be

undertaken without the disinfecting facilities of a port, it is as well that every ship should carry (in addition to a large stock of a good liquid disinfectant) some form of apparatus for carrying out interim disinfections of smaller compartments, etc.

There are many methods of producing formaldehyde gas. The gas itself was accidentally discovered in 1868 by Professor A. W. Hoffman, as a product evolved in the heating of a platinum spiral over the flame of a lamp burning methyl alcohol.

On the market, we find it in two forms—a liquid and a solid. The liquid is known as *Formalin* and is nominally a 40 per cent. solution of the gas in water. As a matter of fact the average is more like 35 per cent., and the solution has generally an acid reaction due to the presence of some free formic acid. Some samples contain as much as 10 per cent. methyl alcohol —added to increase the stability.

Hot formalin solution will attack iron and steel, but not other metals.

A 5 per cent. solution=1: 1000 $HgCl_2$ in germicidal value.

The solid form is known as *Paraform*—a white solid.

In practice, formaldehyde gas is always obtained either from formalin or from paraform.

The following are the chief methods:

(*a*) Boiling formalin solution.
(This is the principle of *Thresh's Portable Disinfector*.)

(*b*) Heating paraform tablets in a vessel by means of a spirit flame beneath.
(This is the principle of an apparatus known as "*Alformant A*.")

(*c*) Paraform 29 per cent. and barium peroxide 71 per cent. mixed with water.
(This was the first non-apparatus method introduced by Bayer and Co., and known by the trade name of *Autan*. The two chemicals are in two divisions of a sealed tin. The addition of water causes much evolution of heat, a dense cloud of steam and formaldehyde gas being given off in a couple of minutes. I have found in practice that the chemicals deteriorate with keeping, that the amount of gas released is insufficient, and that the distribution is not uniform. I believe that the receptacles have recently been improved and that soda bicarb. has been added to delay reaction and to prolong the stage of ebullition.)

(*d*) The action of formalin solution on quicklime.

(This is the method of *Henry V. Walker*, a New York Sanitary Inspector.) The idea is to slake quicklime with formalin solution which will absorb the water and release the formaldehyde gas.

Dissolve 20 lb. of commercial alum in 5 gals. of hot water. Then mix with 15 gals. of formalin. The alum is added to prevent reaction between $Ca(OH)_2$ and the HCOH with formation of akrose, formose, etc. For use, for each 1,000 cubic feet, take 8 oz. of the stock solution and arrange for multiple drips on to a pound of quicklime spread out in a pan.

(*e*) Adding formalin solution to crystals of potassium permanganate.

(This is the idea of *Evans* and *Russell*.)

The reaction is:

$$2K_2Mn_2O_8 + 3HCOH = 4KOH + 4MnO_2 + 3CO_2 + H_2O.$$

The process is one of the most widely used and most simple methods of any.

Lockemann and *Kroner* have made considerable investigations but not increased our knowledge.

Only the small amount of 4 per cent. of formalin is destroyed by the reaction which produces such a large amount of heat that 56 per cent. of the dissolved formaldehyde gas is quickly discharged from the remaining solution.

Any bucket or similar vessel can be used for the operation.

The Marine Board of Health devised a container, consisting of a metal cylinder of 10-inch diameter, with a funnel-shaped top having an opening of 18-inch diameter. The height of the whole container is 8 inches.

The capacity of the lower part should be 10 pints. It should be made of copper, with a double bottom of $\frac{1}{4}$-inch air space.

Most Health Authorities use $3\frac{1}{2}$ oz. of permanganate to 1 pint formalin.

This does not give the best result. I recommend for each 1,000 cubic feet:

One pint formalin, $\frac{1}{2}$ pint water, $\frac{1}{2}$ lb. permanganate.

NOTE.—Do not forget that the formalin should be poured over the crystals. If the crystals are added to the formalin the result is not as good.

(*f*) By some form of generating machine.

A. *The Kuhn Generator.*—Conversion of methyl alcohol. Takes one hour to generate from the $1\frac{1}{2}$ pints necessary for 1,000 cubic feet. Expensive.

B. *Trillat's Autoclave.*—Ten oz. formalin for each 1,000 cubic feet. To avoid polymerisation, NaCl is added to extent of 20 per cent. in order to raise boiling point and facilitate discharge of gas. Gas enters compartment via keyhole.

Apparatus cumbersome; needs much attention; diffusion slow; distribution uneven.

C. *Czarplewsky's "Colonia."*—Water is evaporated and steam blown out of narrow orifice over a nozzle from which the formalin issues and mixes with the steam.

Has but one exit.

D. *Proskaner's "Berolina."*—A vertical formalin chamber (containing a coiled steampipe), fitted into a small boiler. Steam is blown through the pre-heated formalin, and becomes impregnated with formaldehyde gas. Has but one exit.

E. *Flügge's "Breslau."*—A closed container, enclosing lamp and wide pan with 8 per cent. solution of formalin. Gives 8 per cent. formaldehyde gas and steam. One exit only.

F. *Demuth's Vaporiser.*—Is on somewhat same lines as G, but has only a keyhole vent so that diffusion is slow and distribution uneven.

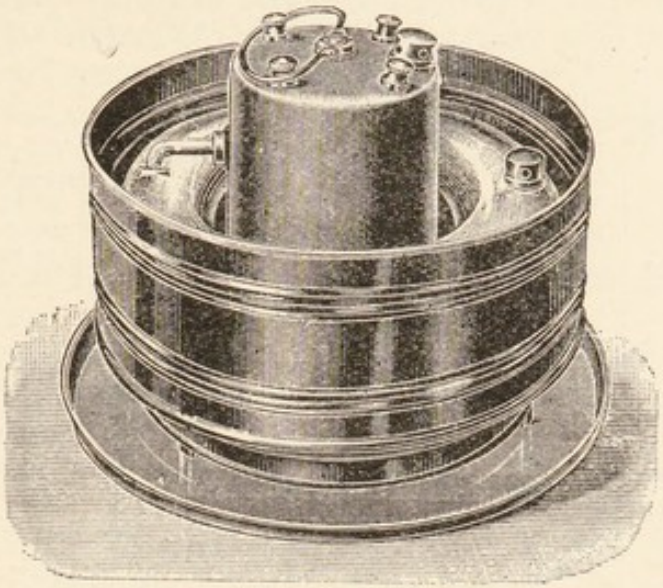


FIG. 25.—LINGNER'S DISINFECTING APPARATUS.

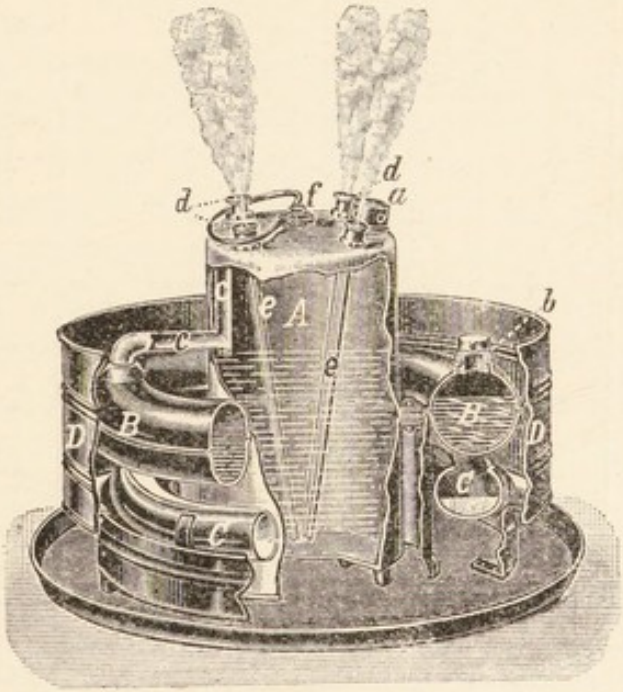


FIG. 26.—SECTIONAL VIEW OF THE APPARATUS.

G. *Lingner's Apparatus* (Chemical Works, Southwark Bridge Buildings, 60, Park Street, S.E.).

This is by far the best machine on the market. It is placed in the middle of the space to be disinfected. It has four jets ensuring quick diffusion and good distribution.

The annexed illustration will give a good idea of the construction of the apparatus, and the table will show the amounts of formalin, water, and methylated spirit to be used. I can recommend this machine for ship use.

TABLE SHOWING QUANTITIES OF FORMALDEHYDE (40 PER CENT.), WATER, AND METHYLATED SPIRIT TO BE USED WITH LINGNER'S APPARATUS.

Area, in Cubic Feet, of Rooms to be Disinfected.		Number of Apparatus to be used.	Quantity of Formaldehyde 40% strength to be used in each apparatus—in pints.	Area, in Cubic Feet, of Rooms to be Disinfected.		Number of Apparatus to be used.	Quantity of Formaldehyde 40% strength to be used in each apparatus—in pints.
Furnished Rooms.	Empty Rooms or Stables.			Furnished Rooms.	Empty Rooms or Stables.		
1,050	1,600	1	1⅛	5,950	8,900	2	3⅛
1,400	2,100	1	1½	6,300	9,450	2	3¼
1,750	2,600	1	1¾	6,650	10,000	2	3⅜
2,100	3,150	1	2⅛	7,000	10,500	2	3½
2,450	3,700	1	2½	7,700	11,550	3	2½
2,800	4,200	1	3	8,400	12,600	3	2¾
3,150	4,700	1	3¼	9,100	13,650	3	3
3,500	5,250	1	3½	9,800	14,700	3	3⅛
3,850	5,800	2	2	10,500	15,750	3	3¼
4,200	6,300	2	2⅛	11,200	16,800	3	3¼
4,550	6,800	2	2¼	11,900	17,850	3	3¾
4,900	7,350	2	2½	12,600	18,900	3	3⅜
5,250	7,900	2	2¾	13,300	19,950	3	3½
5,600	8,400	2	3	14,000	21,000	3	3½

For rooms, the area of which is between any two sizes given in the above list, the quantity of formaldehyde prescribed for the larger size should be used—*i.e.*, a room of, say, 2,200 or 2,300 cubic feet requires one apparatus with 2½ pints of formaldehyde; and for a stable of 13,000 or 13,500 cubic feet, three apparatus, each using 3 pints of formaldehyde, are required.

The same quantity of *water* and *methylated spirit* is always to be used. In *every case* 3½ pints of water are to be placed in the circular boiler, and ⅞ pint of methylated spirit (85 per cent.) in the heating vessel whether more or less of formaldehyde is used.

So much for some characteristic methods by which formaldehyde gas can be obtained. To obtain the best germicidal results, the following essential points should be carefully noted:

(i.) The space should be properly closed.
(ii.) A *large* evolution of gas is necessary.
(iii.) A *rapid evolution is essential.*
(iv.) The temperature should be above 60° F. or polymerisation may occur.
(v.) The relative humidity must be above 60 per cent. or polymerisation may occur.
(vi.) The contents of the space should be exposed as much as possible.
(vii.) The space should be kept closed for five hours from the commencement of the operation.

Practical Application of Disinfection.

The amount and character of the disinfection which will be required on a ship will vary so very much with the circumstances of each case that a uniform procedure cannot be laid down.

It should be understood that a vessel is but rarely so badly infected that disinfection is needed *throughout.*

The transmission of disease may often be a complicated chain. For instance, one of the crew in the fo'c'sle may be suffering from cholera. The Surgeon when visiting him gets some infected vomit off the deck on to his boot. He goes away and, in ascending to the promenade deck, some of the infected material is left behind on one of the guards of the ladder treads. A fly settles on this with joy, and soon afterwards, attracted by the smell of the galley, enters and deposits some cholera vibrios on the freshly made salad. Thirty-six hours later one of the saloon passengers develops the disease.

It is thus obvious that a preliminary to all disinfection should be: a careful investigation of the circumstances by a trained and expert Health Officer.

The special measures necessary in each case will depend on:

(*a*) Where the disease was contracted (ashore or on board).
(*b*) The location of the case on board.
(*c*) The germ-exit of election for that special disease.

(*d*) The possible transmission (on board) of germs from the original focus, by natural, mechanical, or biological means.
(*e*) The viability of the causal organism.
(*f*) The presence of "carriers."

It is, of course, a useful rule to disinfect "if in doubt."

Another point is that it is always advisable to enlist the sympathies of the ship's officers. Very valuable assistance can be rendered by them, and a little tact will go a long way towards establishing cordial relations.

Whatever else may be necessary, as a rule no treatment is required for:

1. Lamp-room.
2. Paint-locker.
3. Sail-locker.
4. Chain-locker.
5. Carpenter's shop.
6. Chart-room.
7. Engine-room.
8. Stokehold.
9. Bunkers.

The barber's shop on board is a detail which should receive the frequent attention of the Ship's Surgeon. Brushes are best kept clean and sweet by a 2 per cent. formalin solution. A fresh, clean, and dry towel should be provided for each person.

For disinfection of the hands and person, a solution of Chinosol 1 : 5000 is as good a disinfectant as can be required.

Disinfection after Bubonic Plague.—If one, or perhaps two, cases of bubonic plague have occurred on board amongst the crew or deck passengers within five days after a ship has left a port known, or suspected, to be infected with plague; and if there has been no special mortality amongst the rats on board—then it may safely be assumed that the case was contracted ashore before sailing, and was not due to infection by any rats on board. In such an instance, the case would be removed to hospital at the quarantine station ashore; the deck passengers would also be removed for the proper disinfection of their effects. Disinfection on the ship would consist in fumigating the several compartments in which the sick

man had lived or been detained, with a view to destroying any chance plague organisms which might have been there discharged, and to killing any possibly infected fleas which might be about.

If the case amongst crew or deck passengers did not occur until more than five days after departure from the port; or if no case at all had occurred, but a special mortality had occurrde amongst the rats on board—then, in addition to the procedure mentioned above, the whole of the 'tween decks, crew's quarters, and holds should be properly fumigated with Clayton gas.

If more than two cases occurred after the lapse of five days from departure, then arrangements should be made to fumigate the whole ship from end to end.

Cabins are usually sufficiently far removed from regular rat runs to render them quite safe from the visits of infected rat fleas. Plague amongst cabin passengers may be said to be always contracted ashore. In such case, therefore, no disinfection at all need be carried out in the ship, except the treatment of the cabin and contents after the patient has been removed.

In the SO_2 fumigation of compartments (except the holds), it is an advantage to give a preliminary wash down of decks, etc., with a liquid disinfectant.

Every box, locker, drawer, cupboard, etc., should then be opened and the contents exposed. Every ventilator should be closed with a canvas cover; every door and port hole and other opening shut, except the two ports required for the entry of the armoured gas hose-pipes. The gas pipe and the exhaust pipe should be put as far apart from each other as possible, care being taken that they are sufficiently free to admit of easy withdrawal from the outside, after the fumigation is finished.

The space (in the port holes) surrounding the hose pipes should be stuffed with gunny bags.

Some stout twine should be fixed to the hasp of the port scuttle, in order that, when the hose pipes have been withdrawn, the port may be closed from the outside.

Disinfestation.—In fumigating a ship to get rid of the rats we have to tackle all the holds, all the 'tween-decks, and the crew's quarters. If that is done properly, 75 per cent. of the rat population will be annihilated, and there is no need whatever to consider any other parts of the ship, such as engine-room, etc.

It has sometimes been said that all parts of the ship should be treated simultaneously. This, however, is not at all necessary, although a certain amount of method is essential to success.

In the first place, you should *begin with a hold which is nearest to the engine-room*—either for'ard or aft, it is immaterial which. That has the effect of cutting the rat population of the ship into two parts. You then continue the contiguous holds in sequence until you have reached the end of the ship. Next turn your attention to the hold next to the other side of the engine-room, and work from there towards *that* end of the ship.

By adopting this method you prevent an invasion of the engine-room, and obtain a maximum bag.

The method of introducing the gas has already been dealt with.

You should see that all hatches, ventilators, etc., are tightly closed, and that the compartments are kept closed for the requisite time thereafter.

Disinfection after Cholera.—Cholera being neither air-borne nor insect-borne (if we exclude house flies, which are comparatively rare on ships at sea), disinfection is resolved into treatment of such surfaces as may be directly or indirectly contaminated.

The preliminary investigation will have excluded (or otherwise) the possible but rare infection of the ship's food or water supply.

Cholera is very apt to spread with lightning rapidity from person to person, especially in the crowded conditions of an emigrant, coolie, or other similar ship.

Owing to the sudden onset of the disease, it often escapes notice for some time, and a large amount of infected material is apt to be scattered about promiscuously.

The importance of the earliest recognition and isolation of each case by the Ship's Surgeon is incalculable, and the deck or bunk space occupied or used by the sick person should be as promptly scrubbed with liquid disinfectant.

If the case occurs amongst the cabin passengers, suitable isolation and careful measures of cabin disinfection will be all that is necessary. The case will be removed to the quarantine hospital on reaching port, and the cabin or hospital re-disinfected.

If the case be amongst deck passengers it will be necessary thoroughly to disinfect the 'tween decks or other quarters occupied by them, after the people have been removed to a quarantine station. Such disinfection will consist of thorough washing of lower surfaces with a liquid disinfectant. In such a large space as a 'tween deck, the washing cannot be satisfactorily carried out by manual effort—a donkey pump and hose are needed.

If amongst the crew, similar treatment will be indicated.

Care and discrimination will be necessary in the disinfection of clothing and other effects which have had a reasonable chance of becoming infected, and also in the condemnation of possibly infected foodstuffs.

Disinfection after Smallpox.—As far as we know at present, the infection of smallpox is conveyed by the air and by fomites.

Any scheme of disinfection which we adopt must take this conclusion as a working hypothesis.

Although, owing to the long incubation period, and to the ease of control, the disease on a ship does not give the same cause for anxiety as do some other diseases, yet the facility with which bedding, clothing, rags, books, etc., may become contaminated emphasises the need for especial care in matters of disinfection.

There is no need to disinfect any part of the ship except such compartments as have been used or occupied by a patient at any time after the appearance of his eruption.

In the case, however, of cabins which have free ventilating communication with other cabins on one or more sides, it is

advisable to include such contiguous cabins in the processes of disinfection.

Similarly, if a case occurs amongst firemen whose compartment has free ventilating communication with the quarters of the sailors, then both compartments should be disinfected.

Nothing should be removed from the infected apartment. All contents, lockers, kit-bags, boxes, scran-bags, etc., should be opened up, and Clayton fumigation proceeded with in a similar manner to that which is outlined above in the case of plague infections.

Disinfection after Yellow Fever.—The organism of this disease is known (by inference) to circulate in the blood, and is therefore almost certain to be discharged with the urine, etc. This fortunately is a matter of indifference, since the disease is solely insect-borne. Neither air fumigation nor surface disinfection will therefore be needed as a germicidal precaution.

The essential foci of danger are: the patient himself (for the first three days of his fever) and the *Stegomyia fasciata* mosquito (for an indefinite period, beginning twelve days after her infected meal). Our only action need therefore be to isolate the patient by means of a mosquito net during his danger period, and to make sure that the ship harbours no stegomyiæ either in the stage of adult, larva, or egg.

In order to compass the latter, it is necessary to fumigate the ship either with Clayton or similar gas. This fumigation will be on rather different lines from that done as an anti-rat measure. It depends on the different habits of the mosquito and the rat. The rat prefers the hold as a domicile, where he can nest beneath the flooring, between frames, or occasionally in favourable cargo. He only visits the 'tween decks or crew's quarters, etc., as an excursion in search of food.

The mosquito, on the other hand, prefers upper cabins of passengers or crew, where hanging clothing, etc., will afford dark resting-places by day, and the human occupants will provide food by night. They will also be found to some extent in 'tween decks, especially when those compartments are occupied by passengers. In the holds of the modern steamer mosquitoes will very rarely be found, and then only if the

steamer is working cargo at different ports every day or two. The atmosphere, and the lack of food and water, do not tempt them except by chance exploration. It may be safely reckoned that holds which have been closed for a week will contain no live adult mosquitoes.

As has been seen in Chapter VIII., mosquitoes in the more open parts of a ship have generally disappeared within two days after leaving port. Twenty days is the longest recorded time—and that was probably due to a breeding out on board.

For mosquito fumigation of *incoming* suspected or infected ships, therefore, it will be necessary to do the 'tween decks, passengers' cabins, crew's quarters, saloons, and sometimes the engine-room. The holds need never be touched unless they have been opened in an infected or suspected port during the preceding seven days, or unless they had been opened during the preceding seven days at a time when a case of yellow fever was present on board.

If mosquito-fumigation is required for an *outgoing* ship, which will call at the next port within the following seven days, then fumigation will be required for the holds as well as for the other parts of the ship. In such cases it may be pointed out that, to be of any real and effective use, the fumigation should be carried out:

(*a*) *Immediately* before her departure.
(*b*) At a quarantine anchorage at least two miles from the shore.

An accompaniment to fumigation will in every and any case be required. I refer to a thorough survey of the ship for uncovered collections of water which should be at once discharged. Likely situations for such collections will be: ship's boats, fire-buckets, choked scuppers, etc.

Disinfection after Minor Infections.—Disinfection will, in this case, be only a matter of restricted and local application.

The nature of the disinfectant required will depend on the method of exit of the special organism of each disease—whether by respiratory passages, discharges excreta, or insects—demanding either aerial or surface disinfection according to circumstances. In their recent influenza epidemic,

Australia considered that disinfection was unnecessary except in defective hygienic surroundings.* Such remark would equally apply to cerebro-spinal meningitis.

Disinfection of Decks.—In ordinary ship routine the main and other upper deck are daily sluiced by the ship's crew, unless deck cargo is being carried. In most steamers (except the many-decked liners) the main or else the upper deck will also be open to the action of fresh air, rain, and sunshine.

It may be taken as an axiom of ship health work that decks will not usually require special disinfection.

The only exceptions to this rule will be:

(i.) 'Tween decks or decks of inhabited compartments in which infectious disease has occurred. (Action in these cases has already been considered.)
(ii.) Decks or 'tween decks after the transport of horses, cattle, sheep, pigs, or poultry.

The carriage of animals is an important trade in many parts of the world. With full cargoes on a voyage of some duration, the sanitary conditions are often very bad, especially with pigs and poultry, and if in the tropics. Pigs are usually carried in open wicker or rattan crates like torpedo tubes, and these crates are packed one above each other, three or four tiers deep. Poultry are likewise packed in wicker baskets piled one above the other. The consequence of this is that there is no possible means of properly cleaning the decks or scuppers until the voyage is over, and the wooden decks soon get soaked and foul. It is a great pity that responsible authorities do not regulate this traffic better. The stacking of live-stock as mentioned above should never be allowed unless an expanded metal (or wooden) grating had been previously fixed on the deck. There should be a 6-inch clearance between such grating and the deck beneath. This would allow of proper daily sluicing both of deck and scuppers.

Cattle and horses are generally better looked after, on the principle, I suppose, that the more valuable a thing the better will be the care taken of it.

Amongst cattle, foot-and-mouth disease is spread by personal

* *Quar. Serv. Public, No.* 18. Melbourne, 1919.

contacts and attendants; and rinderpest in the same way—the discharges being highly infectious.

In horses, glanders is a somewhat more uncommon and chronic disease, which seems to be air-borne like smallpox is.

Routine disinfection and sanitary cleansing of decks, pens, etc., should always be carried out after live-stock has been carried. If the animals have suffered from infectious disease during the voyage, the disinfection should be especially thorough. As the matter is of interest and importance to Port Health Officers as well as to Veterinary Officers, I take the opportunity of quoting extracts from two different types of regulations dealing with disinfection in connection with animals.

ORDER BY BOARD OF AGRICULTURE (1910).

DISINFECTION OF VESSELS, MOVABLE GANGWAYS, AND OTHER APPARATUS.

Disinfection of Vessels.

25.—(1) In the case of a vessel from which animals carried from a foreign country have been landed in Great Britain, each compartment of the vessel shall, after the landing of the animals therefrom, and before any animal or cargo is placed in that compartment, be cleansed and disinfected as follows:

(i.) All parts of the compartment with which the animals or their dung have come in contact shall be scraped and swept, and then thoroughly washed or scrubbed or scoured with water, and subsequently disinfected in the manner prescribed by this Order;

(ii.) All fittings, pens, hurdles, or utensils used for or about the animals shall, if not removed from the vessel, be scraped, and then cleansed and disinfected in the same manner.

(2) Each part of the vessel with which the animals or their dung have come in contact, and all fittings, pens, hurdles, and utensils, used for or about animals, shall be cleansed and disinfected in accordance with the provisions of this Article before any other animal or any cargo is allowed to come in contact therewith.

(3) The scrapings and sweepings of the vessel shall not be landed unless they have been well mixed with quicklime, and when landed they shall be effectually removed from contact with animals.

Disinfection of Movable Gangways and other Apparatus.

26.—(1) A movable gangway, passage-way, cage, or other apparatus used or intended for the loading or unloading on or from a vessel of animals carried from a foreign country, or otherwise used in connection with the transit of such animals, shall, so soon as practicable after

being so used, be scraped and swept, and then thoroughly washed or scrubbed or scoured with water and subsequently disinfected in the manner prescribed by this Article.

(2) The scrapings and sweepings, and all dung, litter, and other matter so removed shall forthwith be well mixed with quicklime, and be effectually removed from contact with animals.

Disinfection of Vessels ariving in Great Britain after Discharge of Animals.

27.—In the case of a vessel from which animals carried from a foreign country have been landed elsewhere than in Great Britain, this Chapter shall apply when the vessel arrives in a port in Great Britain, if and so far as its requirements have not already been complied with.

. . . . .

MISCELLANEOUS.

Prescribed Manner of Disinfection.

41.—The prescribed manner of disinfection to be adopted under this Order shall be as follows:

(i.) The place or thing, or the part thereof required to be disinfected, shall be thoroughly washed with—
  (*a*) a 1 per cent. (minimum) solution of chloride of lime containing not less than 30 per cent. of available chlorine; or
  (*b*) a five per cent. (minimum) solution of carbolic acid (containing not less than 95 per cent. of actual carbolic acid), followed by a thorough sprinkling with limewash; or
  (*c*) a disinfectant equal in disinfective efficiency to the above-mentioned solution of carbolic acid, followed by a thorough sprinkling with limewash.

(ii.) The application of limewash shall not be compulsory as regards such parts of a vessel as are used for passengers or the crew.

The following are extracts from *Australian regulations :*

The Disinfection of Fittings, etc., used in connection with any Imported Animal.

91. The following solutions and mixtures are prescribed as disinfectant solutions for disinfection in connection with the quarantine of animals:

(*a*) Chlorinated lime wash prepared by mixing, immediately prior to use, six ounces of fresh chlorinated lime containing not less than 25 per cent. of available chlorine in one gallon of clean cold water.

(*b*) A cresol and lime wash prepared by mixing two (2) ounces of a cresol preparation having a carbolic coefficient of not less than 10, in one (1) gallon of clean water, and afterwards adding one and one-half (1½) lb. of fresh lime, and stirring well before use.

(*c*) A soapy cresol solution prepared by mixing two (2) ounces of a cresol preparation having a carbolic coefficient of not less than 10, and one (1) lb. of soft (potash) soap in one (1) gallon of clean water.

92. Any vehicle used to transport any animal ordered into quarantine shall be disinfected by the following means and in the following manner: the floor, sides, and other parts of the vehicle shall be saturated or thoroughly painted with an approved disinfectant solution or mixture.

93. Rugs or other clothing and similar articles shall, if steam under pressure is available, be subjected to moist steam at a pressure of not less than 10 lb. to the square inch for twenty minutes after expulsion of air from the disinfecting chamber. If steam under pressure is not available, rugs, clothing, and similar articles shall be soaked in a hot soapy disinfectant solution as prescribed for not less than one hour.

94. All unstuffed harness and saddlery shall be disinfected by thorough washing with the approved soapy disinfectant solution. Stuffed harness shall, unless the Chief Quarantine Officer otherwise directs, be stripped of all lining and stuffing, and, after saturation with a soapy disinfectant solution, may be relined and restuffed with new clean material. The old lining and stuffing shall be burned.

95. Utensils, manger, feeding troughs, pens, hurdles may be disinfected by scrubbing with a hot soapy disinfectant solution as prescribed, or may be painted thoroughly and completely with the chlorinated lime wash as prescribed.

96. The floor of any stable shall be disinfected by saturation with a hot soapy disinfectant solution as prescribed, followed after three hours by a coating of chlorinated lime wash as prescribed.

97. The litter used in connection with and the manure of any animal in quarantine shall, if disinfection is ordered, be burned, or shall be saturated with a disinfectant solution as prescribed.

The Disinfection (External) of Animals.

98. The following solutions, mixtures, dips, or washes are prescribed for use as directed by the Chief Quarantine Officer:

(*a*) An aqueous mixture of lime and sulphur, at a temperature of 110° F., and prepared in the proportions of four (4) ounces of flowers of sulphur and two (2) ounces of lime to each gallon of water.

(*b*) Arsenical dip, prepared by the mixture of—

White arsenic	8 lb.
Caustic soda	4 ,,
Stockholm tar	1 gallon.
Tallow	8 lb.
Water	400 gallons.

(*c*) Any of the alkaline cresol preparations known as non-poisonous dips, as approved for use by the Board of Agriculture of Great Britain.

It will be noticed that, in both these sets of regulations, considerable emphasis is laid on the chlorinated lime.

This substance, obtained by passing chlorine through slightly damp slaked lime, was first prepared by Tennant and Knox of Glasgow in 1799. It is similar to the *Calx chlorinata* of the B.P. and has an approximate formula of CaClOCl. It should have 37 per cent. of available chlorine.

Unfortunately, it is of limited application, since its use in the tropics is impossible owing to deterioration by rapid loss of the available chlorine.

In my opinion, the single liquid disinfectant (either Sanitas Okol or Izal) which I have recommended for use on shipboard is quite sufficient and efficacious for this or any other surface disinfection which may be required.

In certain cases, however, where woodwork has got badly soaked and foul, a *deodorant* is required. For this I recommend, as far and away the best, *Doty's Method :*

(*a*) Dissolve 1 lb. of copper sulphate in 5 gals. of water.
(*b*) Dissolve 1 lb. of quicklime in 5 gals. of water.
Then mix (*a*) and (*b*) together.
The reaction is:

$$CuSO_4 + Ca(OH)_2 = \underset{\text{Precipitate insoluble in excess.}}{Cu(OH)_2} + \underset{\text{Plaster of Paris nearly insoluble.}}{CaSO_4}.$$

The whole should be well stirred whilst mixing in order to distribute the thick precipitate. The solution should be applied to the foul woodwork, etc., and allowed to soak in for some time. Then the whole area should be washed with an Okol solution (1: 1000).

Doty's method is highly effective, and the solution can be added to *bilges*, etc., after pumping out any foul contents, or used in any cases where a really effective deodorant is indicated.

Disinfection of Water-Tanks.—It has been pointed out that a cholera infection of the ship's water tanks is almost unheard of nowadays. Such a calamity would give rise to a great number of cases on board, nearly all occurring at about the same time.

Notwithstanding this, insufficient attention is often paid to

the ship's water-supply, which is ordered and received without any reference to the Ship's Surgeon, who is (or ought to be) the sanitary expert for the ship, and who should diligently find out everything there is to be known about the water-supply of every port touched at.

Water at many ports is not beyond reproach; and dysentery and enteric might be the result of too childlike a faith.

Tanks should be emptied and cleaned at the end of every voyage, or at intervals of six months.

If at any time water in any tank is suspected, one of two things may be done:

(*a*) The tank may be pumped out and, when empty, a steam connection (with a hose-pipe) made by the Chief Engineer. The interior should then be thoroughly steamed, and the tank left empty for a short time.

(*b*) Thresh's method:
(i.) Pure chlorinated lime in ¼ lb. hermetically sealed tins.
(ii.) Equal number of sealed tins containing each ½ lb. ordinary "hypo."

When it is required to disinfect a tankful of water, you should (for each 8,000 gallons) dissolve one tin of No. i. in one gallon of water, and add this to the 8,000 gallons to be disinfected.

In fifteen minutes the whole will be properly sterilised. Then, to remove the excess of chlorine, add to your 8,000 gallons one gallon of water in which you have previously dissolved contents of a tin of No. ii. In fifteen minutes the water will be disinfected, tasteless, and fit to drink.

Treatment of Cabins for Bugs, etc.—Bedbugs frequently get into cabins and, once entrenched, are very hard to dislodge. They get into the crevices of bunks, mattresses, and even behind the matchboarding of the bulkheads. Generations breed and flourish, and expert treatment is needed for their extermination.

Many cimicides have been recommended. I have experimented with petrol, benzene, phenyle, Sanitas Okol, etc., on the lines of work by *Saigol, Somerville, Hossack*, etc., sometimes with medium results and often with disappointment.

I have followed reams of correspondence in the Indian medical press on this subject. One person recommends paraffin. Another says it is quite useless, but that turpentine and soapsuds are infallible!

But I still looked for a good contact insecticide.

At last I began to experiment with *sypol*, which is an alkaline soapy product (of the Sanitas Company), practically identical with the well-known Lysol, and containing 50 per cent. cresols. I found that it made a fair mixture, in certain proportions, with various substances such as turpentine, petrol, kerosene, etc.; and that these clear mixtures made milky emulsions of varying stability on the addition of water.

After many trials I found what I think is the best contact insecticide so far experimented with. In a 10 per cent. solution it is immediately lethal when sprayed on bugs, fleas, lice, and ticks, and will also kill their eggs. Solution as weak as 2½ per cent. will generally be effective in under a minute.

The composition is as follows:

Stock solution { Kerosene 20 / Sypol 7

This stock solution should be kept in a well-corked bottle, and made up for use just before being required.

If the ingredients are impure the resulting mixture will not make a clear stock mixture. The addition of a dram or two of "Liq. Petroxylin" (Extr. Pharm.) will correct this.

It is not inflammable, but will light when hot.

For use make a 10 per cent. solution in water, and use with a pressure hand-sprayer. (Paper soaked in this dilution will not even light when a match is applied.)

The "sprayer" that I use is a very handy copper machine holding 1 pint, which will exhaust the whole contents at considerable pressure after pumping it up. It is made by *R. Sumner and Co., Ltd.*, Manufacturing Chemists, of Liverpool, at the suggestion of Dr. Melville-Davison, Medical Superintendent of the Booth Steamship Co.

When treating a cabin for bug invasion, infinite care should be expended on the spraying of every nook and crevice of bunks, boarding, drawers, mattresses, etc. If badly infected, all mattresses, pillows, and cushions should be thrown overboard, and the wood and ironwork then treated. To do a cabin properly will take an hour or two. It may be necessary

to bore a hole in the matchboarding of the bulkhead and spray behind it by the use of a special nozzle. Unless the treatment is thorough it is not worth doing it at all. On completion, the cabin should be washed out, dried, and repainted.

Treatment of Mail-Bags and Boxes.—Article 17 of the Paris Convention of 1912 exempts all mail material from any disinfection, with the exception of parcels.

This action must be due to the fact that the signatories either thought that letters could not carry infection, or else that mail-bags on an infected ship were not likely to become infected, or, perhaps, both such suppositions.

I am quite of the opinion that the bags in the mail-room of a ship, however much infected such ship may be, are not in the least likely to get infected as a result of their voyage, whatever may be the type of infection that has occurred. They should not therefore be detained *for that reason.*

It is otherwise with the letters themselves.

Admitted that the percentage of infected letters may be very small indeed, it is, nevertheless, a fact that smallpox is carried by this means—and very possibly is so carried much more often than is suspected. As stated in Chapter VIII., an epidemic was caused in that way, in Michigan, in 1906, resulting in the deaths of thirty-four people.

Cholera could certainly be carried for some distance in the same way, and very probably scarlet fever also.

When it *is* necessary to disinfect mails, there is no necessity to open envelopes and covers. It is sufficient to put all the letters in a disinfecting chamber, and, after getting a preliminary vacuum, to admit warm formaldehyde gas into the chamber, leaving it closed for half an hour.

Disinfection Certificates.

After the disinfection of a ship, the Captain or Agents may wish to have a written record of what has been done, for the information of subsequent ports.

The forms which this document takes are various.

I give a sample of the one used in the port of Shanghai

No.

Ship ——————————————

Agents——————————————

Tons ——————————————

RECEIPTS:

	$	cts.
——per 100 tons register Rate ½ @ tons		
¾ or ¼ @ tons		
¾ @ tons		
Certificate		
TOTAL BILL $		

Date of Disinfection——————————
19 .

No.



OPTIONAL CERTIFICATE OF DISINFECTION.

S.S. —————————— Date of arrival ——————————

Tons —————————— From what port ——————————

No. of European Crew———— Infected with / Free from Plague, Cholera, Smallpox.

No. of Native Crew————

No. of 1st Class Passengers————
,, 2nd and 3rd Class Passengers———— } on departure.
,, Deck Passengers————

Sails for———————————on————————19

REMARKS:

Mean gas strength:

On delivery ———— %

By exhaust ———— %

EXPENSES:

	Amount Used.	*Cost* $ Cts.
Disinfectant ..		
Sulphur		
Coal		
Kerosene oil ..		
Extra wages ..		
TOTAL EXPENSES $		

Initials of Officer issuing Certificate

DETAILS OF DISINFECTION.

Portion of Ship dealt with.	*Liquid Disinfectant= Sanitas Okol 1 : 500.*	*Formaldehyde Gas Fumigation Strength Per Cent.*	*SO_2 Fumigation (Clayton).*				*Special Procedure.*
			Hours of Application.	*Approximate Mean Strength on Delivery.*	*Approximate Mean Strength by Exhaust.*	*Hours Closed after Completion.*	

I hereby certify that s.s. ———— has been efficiently disinfected to my satisfaction, as per above details, in the Port of———— and that the Ship is now in a satisfactory Sanitary State.

Given under my hand and Seal at———this———day of———19 .

Port Health Officer.

(page 306). It is short and to the point, but does not really convey very much of the information which a neighbouring Health Officer would like to have.

CERTIFICATE OF FUMIGATION.

I hereby certify that the———————————————
s.s. "———————————" reg. tonnage———————
under deck tonnage———————————————
has been thoroughly fumigated in accordance with Article No. 9 of the Port Sanitary Regulations (Paragraphs I. to V.).

All crew's quarters with———————————————
All holds and cargo spaces with———————————————
All store-rooms with———————————————
and ———————————————

———————————————

———————————————

the number of dead rats afterwards found being———————
FEE—at the rate of 2 Tael cents per ton of under deck tonnage as shown in Lloyd's Register————tons—Sh. Tls ————————

———————————————

Harbour Master.

Harbour Master's Office,
Custom House,
Shanghai,————————19

———————————————

Deputy Port Medical Officer.

I also give another example, see pp. 304, 305, the form which has been in use in the Port of Singapore for the past eight or nine years.

Disinfection of an infected ship is compulsory in Singapore and is paid for by the Agents. But the certificate stating what has been done is optional, and an extra fee is charged for the issue of it.

CHAPTER XI.

QUARANTINE ORGANISATION.

"But I kept watch to fence his life from harm."
(*Tecmessa, in Aias.*)

THE word "quarantine" comes from the Italian word *quarante.* = forty.

It originally referred to the forty days' detention of ships, first used by Venice as a measure against plague in 1348. Other Hanseatic cities followed suit, and established a procedure which lasted until quite modern times. The idea was to form an effective dam, as it were, to absolutely exclude infectious disease.

It may hardly be believed, but even as late as the eighteenth century ships from infected ports were sometimes actually *sunk* (!) as a measure of quarantine precaution.

In those days, even though commerce was a matter of considerable and growing importance, the fear of contagion was of even more paramount interest.

Everyone was groping in the dark. But evolution was at work in this, as in all mundane matters. The importance of maintaining the health of those on board and of improving the general sanitary conditions became more and more recognised, until the era of Pasteur and Koch enabled us to replace theory by fact, and showed us the true use of weapons which we long had wielded in the dark.

Specialised modern quarantine may be considered as a complex of measures adopted for the purpose of preventing the introduction or spread or transmission of infectious disease, whether by sea or land.

The old word "quarantine" is still retained, but that is all. The dominating principle at the present day is not that of a

"dam" as in olden times, but rather that of a "sieve" or "filter" which lets through passengers and merchandise, with such minimum hindrance to travel or trade as may be compatible with the reasonable control of infectious agencies amongst persons or animals or goods.

But your "sieve" should not have too big a mesh! There is, in some places, an unfortunate tendency to do away with quarantine and to leave measures to be carried out by the Ship's Surgeon! Where infectious disease is concerned, a ship has to be treated as a whole just as a town is treated as a whole. A private practitioner who comes across a case of cholera in his practice has to report it to the M.H.O. of his town, and rightly so. The practitioner is not in a position to gauge the relative bearings of the case with regard to the town as a whole, nor has he, as a rule, the necessary skill or experience or facilities to trace the case to its source, or to undertake the most effective measures for its control. *That* is the function and sphere of the Health Officer, who makes the expert study of that, and of kindred subjects, his life-work.

In the same way on board a ship. The Ship's Surgeon is probably not an expert in infectious disease, and he certainly is not so in the details of ship structure. He goes to sea for one voyage or perhaps for one year. He has in most cases never seen a case of major infectious disease. He has probably done no public health work, and cares but little for the subject. He has, moreover, probably hardly ever been on board a ship. And such is the man it is proposed to entrust with the quarantine treatment of a ship, in preference to the expert knowledge of a port authority!

Until the Ship's Surgeon undergoes a course of preliminary training and obtains a proper qualification for his work, the Port Health Officer would never be justified in relying on the average Ship's Surgeon in matters connected with public health or infectious disease on board.

The most modern measures of quarantine are, if tactfully and expeditiously applied, seldom very irksome to passengers or onerous to agents.

Whatever regulations may be adopted, however (even the

most stringent), it is not always possible to ensure that absolutely no loophole is left in our defences; and, when we consider that modern practice very reasonably admits of discretionary latitude by considering quarantine a sieve rather than a dam, this point becomes even more emphasised, though it is often overlooked. *Doty* very admirably sums up this situation when he says, "Reasonable and practical quarantine regulations cannot ensure *complete* protection against imported infectious disease, and attempts to obtain this result not only seriously injure commerce, but defeat the end in view. While there are many times when the most stringent regulations are justified in dealing with incoming vessels, passengers, and crew, at quarantine, there is under ordinary conditions a limit in the enforcement of regulations, beyond which a Quarantine Officer cannot go without being subject to deserved criticism."

We have now to consider the application and needs of modern quarantine.

Perrin Norris has propounded two fundamental points in this connection, the first being that quarantine is peculiarly a measure adopted by countries free from or relatively free from the diseases against which quarantine is aimed; and the second being that the diseases against which quarantine is directed will naturally vary in different countries according to the nature of the communicable diseases which have established themselves as local diseases.

With existing modern conditions and organisation there is, in my opinion, no justification for imposing any general measures of quarantine against any but the four major diseases: plague, cholera, smallpox, and yellow fever, unless we exclude influenza and cerebro-spinal meningitis, diseases which may require limited action in special circumstances.

As a matter of national policy, which may or may not be justified, it is always open to any country to permanently exclude any pathological condition which they deem advisable, such as leprosy, syphilis, trachoma, or to require vaccination of all intending immigrants; but that is a different matter to quarantine.

The application of quarantine to an infected or suspected ship may comprise some or any of the following measures:

(*a*) Refusal of entry to the ship.
(*b*) Inspection at a quarantine anchorage.
(*c*) Allowing ship to leave in quarantine after landing an infectious case, without further, or only limited, action or treatment.
(*d*) Giving pratique on a clean "entry declaration" by Master and Surgeon, without inspection, except of the disembarking passengers.
(*e*) Removal of infectious cases.
(*f*) Retention of infectious cases on board.
(*g*) Quarantine detention of cabin passengers as contacts or suspects.
(*h*) Release of cabin passengers on "undertaking."
(*i*) Unconditional release of cabin passengers after inspection.
(*j*) Quarantine detention of deck or steerage passengers as contacts or suspects.
(*k*) Release of deck passengers on an "undertaking."
(*l*) Unconditional release of deck or steerage passengers after inspection.
(*m*) Quarantine detention of crew.
(*n*) Daily observation of crew on board.
(*o*) Vaccination of ship's officers.
(*p*) Vaccination of crew.
(*q*) Vaccination of cabin passengers.
(*r*) Vaccination of deck passengers.
(*s*) Disinfection of luggage and effects.
(*t*) Disinfection of ship and cargo or portions of same.
(*u*) Fumigation of ship or portions thereof.
(*v*) Discharge or treatment of water-supply.
(*w*) Destruction or jettison of infected articles on board.
(*x*) Issue of pratique.
(*y*) Issue of exemption permit from quarantine restrictions at certain subsequent ports.
(*z*) Telegraphic notification *re* infected ship to her next port of call.

The practical details of quarantine inspection of ships were dealt with in Chapter VII. I am here approaching the subject on the lines of principle, and of theoretical policy.

Refusal of entry, to a ship, would be justified in cases of an infected or suspected ship which (when boarded) refused to

submit to the local quarantine rules and regulations. No quarantine enactments would be complete which omitted to insert a clause allowing such ship to proceed on her voyage without penalty, if she so wished.

In certain cases, such as that of an infected mail steamer on contract schedule, it is often advisable for the sake of greater despatch to allow her to land the case, discharge some cargo, mails, and passengers at the quarantine anchorage, and to depart in quarantine without being disinfected or otherwise treated. Such action, which is against the best modern practice of letting no ship leave a port unless she has been rendered danger-proof, is only justified if telegraphic approval has been received from the authorities at her next port of call.

The issue of pratique to a ship from an infected or suspected port, merely on the strength of a clean "entry declaration" signed by Surgeon and Master, and without personal inspection of crew and passengers, is a highly dangerous proceeding, and is only justified in exceptional circumstances born of a personal and intimate knowledge of that actual ship and its officers. It is even then wiser to inspect personally, at least, all the disembarking passengers. With clean ships from a clean port, the practice might be justified.

With regard to the retention of infectious cases on board instead of landing them. This naturally refers only to transit passengers. The proceeding is not recommended, but is only justified amongst cabin passengers when the case is:

(*a*) A minor infection.
(*b*) Yellow fever.
(*c*) Plague (of the bubonic variety).

Amongst deck passengers (transit) the sick should always be removed in the case of major infections; but minor infections could be left on board.

Quarantine detention of cabin passengers as contacts or suspects is never justifiable except in the case of *immediate* contacts such as parents or cabin mates, etc., of a major infectious case, and even then only in the case of transit passengers, and at the discretion of the Health Officer.

Cabin passengers who have been exposed to infection on board should invariably be required to sign an "undertaking" to report to or submit to surveillance by a municipal health authority before they are allowed to disembark from an *infected* ship. If the ship be not infected, and the cabin passengers prove healthy on inspection, there is no reason why they should not be allowed to disembark unconditionally even though the ship has come from an infected port—a dictum arrived at by long observation of results.

The problem of steerage and deck passengers, pilgrims, coolies, etc., is a big thing. They form the *raison d'être* of the modern quarantine stations. If we had not to deal with such classes, the diffusion of sea-borne disease would sink to a very low ebb; it would be justifiable to reduce the time of quarantine periods to that of actual incubation periods; and the need for quarantine stations for contacts would have departed. The unconditional release of deck or steerage passengers from an *infected port* is never justified unless the full quarantine period for that disease has duly elapsed since leaving the infected port. In the case of an *infected ship*, the quarantine detention of deck passengers is advisable until a period equal to the incubation period of the disease has duly elapsed since the removal or proper isolation of the case, and until their clothes and effects have been disinfected as necessary. The only exception to this will be in the case of smallpox infection, when native or immigrant deck passengers should be removed for disinfection and vaccination, and, if vaccination prove successful (as ascertained on the fourth day after the operation), they should be discharged without further detention. In the case of more responsible and disciplined bodies such as troops, who have been revaccinated after smallpox has occurred on board, there is no need for further detention; but the barracks or centres to which the men are going should be duly notified of the circumstances.

The release, on "undertaking," of native deck passengers from an infected ship is seldom justifiable unless a bond for their individual appearance is signed by a responsible merchant or householder.

The quarantine detention of a crew amongst whom infectious disease has occurred is never justifiable, unless the disease be cholera or pneumonic plague—and even then it would only be necessary to remove the crew if *several* cases had occurred; and only those in the same compartment as the sick man would have to be dealt with as a rule.

On a ship infected with smallpox, vaccination has to be thought of. Should everyone on board be vaccinated? It is, of course, on general principles desirable to have as many of the population as possible protected by vaccination. If we consider the matter only from the point of view of the ship, and the possible danger of spread from a case on board, then the necessity for vaccination will depend on the situation of the case. With disease amongst the first, second, or third class cabin passengers, it will only be necessary to vaccinate the respective class concerned, and the stewards of that class should also be done; even then it would be quite reasonable to excuse any of the above who would give a personal assurance of successful vaccination within the previous five years.

If the disease has occurred amongst the ship's officers, either executive or engineer, one or other branch should all be vaccinated, subject to the above exemption.

If amongst a native crew, whose word or memory is not so reliable, I should advise vaccination of them *all*, whether they purport to have been recently done or not—the only exception should be if the Surgeon can certify to his personal vaccination of any; or if any of them can produce a personal certificate or "medical history sheet" such as I have suggested in Chapter I.

With smallpox amongst native deck passengers or illiterate immigrants, they should all, of course, be removed to a quarantine station where they would be disinfected and vaccinated. I think that this limited vaccination action, which I have outlined above, is as reasonable as is the limited disinfection now generally adopted. Every case should be more or less judged on its own merits.

Such action does not, of course, preclude the enactment of

any legislation which may require general vaccination of all intending immigrants.

The destruction or jettison of infected articles on board is not, as a rule, justified except in the following cases:

(i.) Food stores which are reasonably suspected of infection with cholera organisms.
(ii.) Decomposed food stores.
(iii.) Deck cargoes of fruit or vegetables brought from a cholera-infected port, contrary to any existing regulations.
(iv.) Similar deck cargoes if in a decomposed state, or if they have been exposed during the voyage to contamination by micturition of deck passengers, urine in the scuppers, etc.
(v.) Pillows, mattresses, and blankets used by cholera cases.
(vi.) Pillows and pillow cases, mattresses, blankets, and sheets used by smallpox cases.
(vii.) Mattresses, pillows, and settee-cushions in any cabin that is badly infected with bedbugs.

Where a country or colony has a certain number of ports within its territories, to several of which, we will say, a visit is intended by a ship from an infected port, it is neither fair nor reasonable to load such ship with burdensome quarantine restrictions at all the ports she touches at.

Proper inspection and treatment at her first port (if clean) in the country or colony should admit her to reasonable facilities of pratique at the subsequent ports. Such dispensation, however, should not be an unconditional one. In my opinion the presence of deck passengers from the infected port should be the criterion. On p. 315 is a copy of the form which I adopted for the Straits Settlements. It is now generally called a "T.S. Permit" for short (T.S. being the International Code Signal for "pratique").

When, after infection and subsequent quarantine action, a ship is about to sail for another port, I think that a cable giving short particulars might with advantage always be sent to the Port Health Officer of the subsequent port, who would thus be on the qui vive, and would be able to make any necessary arrangements before the arrival of the ship.

SHIPPING EXEMPTION PERMIT.

PORT HEALTH OFFICE,

———————

———————19———

To the Master of s.s.———————which arrived in the Colony *in a clean condition* from the " Infected Port " of———————— and leaves here *having on board no deck passengers from the " Infected Port," no Chinese or Indian Immigrants, and no Pilgrims.*

NOTICE.

If no case, or suspicious case, of infectious disease breaks out on board your ship in the meanwhile, you are hereby AUTHORISED, during the current voyage, to enter any other port of the Straits Settlements without flying the Quarantine Flag, and without proceeding to the Quarantine Anchorage for inspection.

You should, however, fly the Code Signal T. S. when approaching such port, in order that your possession of the permit may be known.

———————

Port Health Officer.

National Quarantine Organisation.

In tabloid form, the two ideas of quarantine are: the examination and treatment of ships, and the station or depot detention of passengers. It is most interesting to see what national provision is made in the shape of staff and accommodation to meet these two requirements.

A comparative table (see p. 316) will perhaps show this with less weariness to the flesh than would be occasioned by the perusal of lengthy written remarks.

On looking into the various organisations there are two things that strike one. Firstly, that Great Britain and her colonies tend to follow rather than lead other nations in quarantine matters; secondly, that the quarantine organisation of the United States and her dependencies is better conceived and administered than that of any other nation.

I fear that in quarantine, as in so many other matters, we do not take things sufficiently seriously. Commercial

interests should never be allowed to prevent the imposition of quarantine restrictions. Again, very few countries would be so ingenuous as to practically entrust unskilled Customs Officials with the first line of quarantine defence—which the British practice amounts to! Nor will you often find such systems as are in vogue in some British colonies, where there is no independent health organisation; where a constant

TABULAR COMPARISON OF ORGANISATION AT CERTAIN PORTS.

Port.	*Port Health Officers.*	*Assistant P.H.O.'s*	*Quarantine Station Resident Medical Officer.*	*Quarantine Hospital Beds.*	*Accommodation for Suspects or Contacts, etc.*	
					Cabin.	*Deck or Crew.*
Suez (including El-Tor)	1	6	6*	500	100	16,500
Singapore	1	2	1	150	nil	5,000
New York (Quarantine)	1	5	3	100	100	850
New York (Immigration)	1	20	—	250	—	2,000
London	1	5	1	40	—	—
Hamburg	1	3	—	16	20	150
Liverpool	1†	3	—	50	—	—
Marseilles	1	6	—	60	300	
Kobe	1	3	1	50	60	600
Manila	1	3	—	25	150	1,000
Port Said	1	6	—	200	—	500
Honolulu	1	5	—	45	400	600

stream of untrained and unwilling House Surgeons is poured into uncongenial sanitary billets, only to be diverted again into medicine or surgery long before their partial and wasted training has had time to have any effect; or where disinfection or fumigation is carried out by an unskilled Customs or Marine Department.

From such a depressing outlook it is refreshing to turn to the U.S.A. They approach the subject from the point of view

* Increased to 26 in the pilgrim season.
† Is City Health Officer in addition.

that, if quarantine has any value at all, it is worthy of being treated seriously. Their organisation comprises:

(*a*) A Federal Bureau of Public Health and Marine Hospital Service at Washington, in charge of a Surgeon-General.
(*b*) A fully trained whole-time staff under the above Bureau, of ample numerical strength for all federal health and quarantine work throughout the country and its dependencies.
(*c*) Inspection and examination at all ports of entry, by the above staff.
(*d*) Large and well-equipped quarantine stations on all seaboards.
(*e*) Sanitary supervision by members of the above staff (attached to the U.S.A. consulates) of all ships and passengers leaving important infected ports in foreign countries for ports in the United States.

This outpost branch of their work (*e*) is a very valuable asset to the country. The duties of these consulate attachés in foreign parts are as follows:

(i.) Investigation of previous itinerary and present sanitary history of all vessels bound for U.S.A. ports or dependencies.
(ii.) Inspection of vessels and their contents, and rejection or certification of freight.
(iii.) Fumigation and, when necessary, disinfection of ships.
(iv.) Observation, disinfection, rejection, detention, or isolation of intending passengers for U.S.A. ports.
(v.) Forwarding of weekly reports to the Bureau, as to the health and sanitary condition of his port and its neighbourhood.
(vi.) Certification of U.S.A. Consular Bills of Health.

The Marine Quarantine of *Germany* is dictated by her geographical position. Compulsory vaccination and revaccination throughout the country has caused her to fear smallpox as little as Australia does much. Cholera is chiefly for her a matter of land-frontiers; and plague-infected places are so distant that her main quarantine outlook is towards the exclusion of rats only.

The main oversea ports are Hamburg and Bremen. Vessels

for the former port have first to call at Cuxhaven (which is at the mouth of the river), if they have come from a port notified as infected or if they have infectious disease on board. There is a quarantine hospital here with 314 beds, but admissions only total two or three a year. They then proceed to Hamburg, where they are fumigated. The Cuxhaven inspection is only carried out at night if there is a properly qualified German Surgeon on board.

The quarantine organisation of other countries does not, I think, call for any detailed notice—with the exception of Egypt, whose service is the outcome of International Sanitary Conventions, and whose organisation is under international control in the shape of the Maritime Sanitary and Quarantine Council at Alexandria, and the personnel of which is also international in character. In the Suez section there is a Director, six medical assistants (one a woman), and ten Sanitary Guards who accompany the vessels through the Canal. In the Port Said section there is a Director, five medical assistants (one a woman), and a bacteriologist. Detention and isolation of disembarking passengers whose voyage from an infected port has been of shorter duration than the incubation period of the disease, or the similar detention of passengers from an infected ship, constitute the routine line of action.

An extraordinary amount of rubbish has been written about Egypt being "the quarantine outpost of Europe," "the advance sentinel of the quarantine guards defending Europe from the pestilences rife in the countries to the South" (*i.e.*, Asia), and so on. Reflection will show that it is nothing of the kind. The diseases to which attention is paid are two: plague and cholera. The latter disease follows the lines of human migration, being carried by human "carriers," or actual cases, or infected food, etc. A case of the former disease (unless of the pneumonic type) is now admitted to be of very little danger as a focus for spread of the disease; in fact, it could be safely treated in the wards of a general hospital. The danger of sea-borne plague lies almost entirely at the feet of infected rats.

Putting apart the pilgrim ports of the Red Sea, Egypt lies

far beyond the incubation period of either disease, in distance from any infected ports of the East.

What then is the situation? Eastern Europe has for several years been ravaged with cholera, which has even extended as far as Italy and Marseilles.

Why did not Egypt, as the outpost of Europe, prevent this incursion of one of the two diseases she takes quarantine cognisance of? Simply because she is not *the* gateway to the East. Through Turkestan, through Persia, through Asia Minor, is a constant stream of emigration from the infected East to Europe; and now the heart of Europe is only some dozen days or less by rail from the heart of China.

Plague might have followed similar routes to Europe? No, for we have seen that human beings are not the epidemiological factors in plague. That factor is the rat, and rats fortunately travel but little by rail, and not at all by caravan. Their tourist excursions are practically all by steamer.

So we see that Egypt, as a protection to Europe against cholera, is of very little use at all. As a protection to Europe against plague she might be a very valuable outpost indeed But what do we find? A large staff examining human beings (who matter very little where plague is concerned), and neglecting entirely all thought of cargo and rats, which is the chief work which should justify the existence of their service!

If every ship from the East which could not produce a certificate of fumigation performed just before her departure trom her last port were detained at Suez for a 12-hour fumigation of her holds and cargo, an almost incalculable service would be rendered to Europe thereby.

The quarantine service of Egypt has, however, one very important function—namely, the protection of herself, of the North African littoral, and to some extent of Asia Minor from the introduction of infection by the pilgrim traffic. Of the nine or ten thousand pilgrims who return annually to Singapore by some dozen or more ships, it is very rare indeed to find a single shipload which is not infected with smallpox. Occasionally a ship will have cholera or plague in addition. Owing to the very much greater numbers with which Egypt has to

deal, the conditions will be proportionately more serious. The large and admirable quarantine station of El Tor is well fitted for this purpose, and remarks on the station will be found later in this chapter.

Quarantine Stations.

U.S.A. Regulation 55 defines the requirements of an equipped quarantine station:

(*a*) Adequate provision for boarding (launches) and inspection (one or more Quarantine Officers and assistants).
(*b*) Apparatus for the mechanical cleansing of vessels.
(*c*) Apparatus for disinfection by means of steam, sulphur, formaldehyde, disinfecting solutions, or any other prescribed means.
(*d*) A clinical laboratory (for bacteriological investigation).
(*e*) Hospital for contagious diseases (isolation wards).
(*f*) Hospital for doubtful cases (observation wards).
(*g*) Detention buildings for suspects.
(*h*) A steam laundry.
(*i*) Bathing facilities for a number of persons.
(*j*) A crematory.
(*k*) A sufficient supply of good water.
(*l*) A proper system for the disposal of sewage.

If one were permitted to criticise this comprehensive summary, I would suggest for (*e*): Separate hospital buildings for each of the four major infectious diseases ("contagious" is hardly a suitable word in modern parlance).

I would suggest also that (*j*) be deleted, for the custom would offend the religious prejudice of a great majority of peoples.

For it might be substituted: "An inspection depot for emigrants."

The trend of modern ideas, however, is to substitute "surveillance" for "detention," except in the case of irresponsible and unreliable people, such as deck or steerage passengers, pilgrims, etc., whose very numbers (apart from their irresponsibility) would tax the resources of a shore organisation beyond all practical limits. The principle receives its imprimatur in an article of the Paris Convention of 1912.

In my visits to the quarantine stations of Australia and other parts of the world, it was borne in on me that most places are not yet imbued with the spirit of modernity. Cabin passengers from infected ships are still detained for observation in Australia, Japan, Egypt, Germany, etc.

This is quite unnecessary. In fact, I would go so far as to say that even a quarantine station is quite unnecessary in any port whose deck immigrants (as opposed to first, second, or third class cabin passengers) do not exceed fifty per week. In such cases an infectious diseases hospital with a disinfecting plant is all that is required.

Any deck immigration over that amount, however, puts a different complexion on the case, and the provision of a proper quarantine station becomes imperative.

There is no need to give a detailed description of many quarantine stations. The details of structure, staff, etc., will, of course, depend on whether a temperate or tropical climate is concerned, and what numbers and types of persons are to be catered for.

The three great quarantine stations of the world, for native deck passengers, are: El Tor, Camaran, and Singapore.

El Tor is on the Eastern side of the gulf, about 120 miles south of Suez, and is the largest in the world. It is surrounded by a high fence three miles long, and has desert on three sides of it. There is one exit wharf, and three landing wharves, each of which leads to the courtyard of a separate bathing and disinfection block, so that three ships can be handled at a time. There are twenty sections of isolated detention blocks, each of which has permanent buildings for 300 persons, and temporary accommodation for an additional 500—thus being capable of receiving 16,000 suspects or contacts. There are also six separate hospital enclosures, with total provision for over 500 patients. A central kitchen block serves all the hospitals. A large laundry equipped with modern appliances serves the needs of the station, and is divided into two parts for the staff and for the quarantinés.

There are: an administrative block, large storehouses, dispensary, laboratory, mortuary, and other buildings. A

light railway with engine, open carriages, and luggage trucks runs through the station and communicates with every section. The main use of the station is for the pilgrim season, which only lasts for a few months each year. The nucleus staff consists of 1 R.M.O., 5 assistant medical officers, a laboratory assistant, 24 attendants, 3 sanitary guards, and 13 other assistants. In the pilgrim season the staff is increased to 26 medical officers, 9 nurses, 44 male hospital attendants, 6 female hospital attendants, 23 additional general attendants, 160 sanitary guards, 60 porters, and 200 labourers, in addition to pharmacists, engineers, cooks, and others.

The *Camaran Station* is on an island in the Red Sea, off the coast of Arabia, about 500 miles south of Jeddah. It is the international station which deals with the pilgrims coming from the south—*i.e.*, from India and the Malay Peninsula and Archipelago. It takes notice of pilgrims who are making their journey, not of those who are returning. Every ship from south must make a first call at Camaran for inspection, disinfection, etc., during a certain number of days. When the ship is returning from Jeddah to her own country, it is immaterial to the authorities whether she is infected or not. Thus Camaran acts as a protection to the Arabian pilgrimage, but not to the outside world. Though international in its personnel, it is not international in its scope.

The station is closed except during the pilgrim season. There are the usual administrative blocks, disinfectors, hospitals, etc. The detention area is divided up into sections to accommodate pilgrims from a number of different ships. The sheds are of a very primitive thatched type, as will be seen in the accompanying photo (Fig. 27).

The *Singapore Station* has rather different functions. It is not an immigrant depot for detaining people for inspection, disinfection, and observation, whether infected or not.

It is a station for disinfection and detention of deck passengers removed from actually infected vessels. The immigration of coolies from China is over a quarter of a million per annum. Of these, some 25,000 to 30,000 annually pass through the station as removals from infected ships. Many pilgrims are

also dealt with, and occasionally large batches of Indian coolies from the north. There is separate isolated hospital accommodation for each of the major infectious diseases. There is also a five-ward hospital where infected cabin passengers are treated, though there is no accommodation for cabin passenger contacts—none of whom are ever detained in quarantin .

The station is situated on an island (St. John's) about four



FIG. 27.—TYPE OF PILGRIM WARDS, CAMARAN QUARANTINE STATION, RED SEA. (Photo by author, 1907.)

miles to the south of the town. The island is about a mile long by $\frac{3}{4}$ to $\frac{1}{4}$ mile broad.

There is a large installation for distilling sea water, the distilled water being then pumped up to a reservoir on a hill, and distributed by gravity mains to every building on the station. There is a luggage shed connected by trolly lines with the landing jetty and with the disinfecting section. This shed can hold the luggage of about 5,000 people.

The disinfecting section has three large steam machines, a formalin machine, and a sulphur chamber.

The hospital compound constitutes one end of the island, being entirely cut off from the remainder, where the contacts and suspects are housed. The accommodation for the latter consists of twenty-two large wards with concrete floors and verandas. The total maximum accommodation is for 6,000. The burial ground is on an adjacent island, to which access is obtained by boat from a separate jetty near the mortuary.

The station is under the general direction of the Port Health Officer, assisted by the following staff:

1 Resident medical officer.
1 Lay superintendent.
1 European nurse.
2 Chinese amahs.
4 Dressers.
2 Campmasters.
1 Clerk and interpreter.
7 Hospital attendants.
1 Engineer.
10 Engineer's staff.
20 Gardeners.
10 Sweepers.
10 Luggage coolies.
1 Washerman.
23 Sikh constables. (Changed monthly from town police force, and augmented if required.)

In considering these quarantine stations for native deck passengers it seems to me that next to a proper water-supply and disinfecting facilities, the question of housing is the most important question in a tropical country. And the secret of success in housing of natives lies chiefly in the *floor*. Have a good floor of concrete with cement facing, and let it extend for some distance around the building, and then sanitary conditions become possible.

It is not necessary to dilate upon quarantine stations in other countries.

Australia, for instance, has large stations at Sydney and Melbourne, and smaller ones at other ports. The problem is practically all European and they have to deal with scarcely

any natives. All the buildings are of European type, and intended for the reception of cabin passengers from infected ships, who are detained instead of being released on surveillance as in most places. In any case most of these stations could be done away with, for they are scarcely ever used. The infected arrivals for the *whole continent of Australia* during 1910 were only two; during 1911, six; and during 1912, eight! Total, sixteen. During the same three years the infected arrivals in Singapore totalled 202; not a single cabin passenger was detained, and no adverse effects followed.

In seventeen years of very heavy shipping work in Singapore, out of many thousands of cabin passengers from infected ports *and from infected ships*, not a single one has ever manifested the disease during their quarantine surveillance. Even if they had so developed the disease, the surveillance by the shore health authorities would immediately nip it in the bud, and the resulting action would render the danger to the general community practically nil.

The Quarantine (State) and Immigration (Federal) Services at *New York* are situated on four islands: Staten, Hoffman, Swinburne, and Ellis.

The administrative offices, quarters for Staff, laboratory, etc., are on *Staten Island*, which is a kind of boarding depôt where live the Chief Quarantine Officer, 3 assistant P.H.O's., 4 bacteriologists, and 2 Federal Health Officers.

On *Hoffman Island* there are 3 R.M.O's., and accommodation for 100 saloon and 850 steerage passengers or crew; disinfecting and bathing blocks are also provided.

On *Swinburne Island* there are 2 R.M.O's., and 4 isolation hospital blocks holding 100 patients altogether.

On *Ellis Island*, which is the Federal Immigration Depôt, there is 1 Chief Medical Officer, and 20 whole-time assistant Health Officers—some for boarding, others for depôt work. This depôt has room for 2,000 immigrants; and there is also a hospital of 250 beds, but infectious cases are removed to Hoffman or Swinburne Island.

There is only one other organisation which need be commented on: that of *Hamburg*. Here, in addition to the

quarantine service already mentioned, there is a large emigration service, which ranks after New York as one of the great European steerage depôts. It was built and is maintained by the Hamburg-American line, which has taken thousands of immigrants yearly, collected from the remotest parts of Eastern Europe. The depôt is really a small town on the outskirts of Hamburg, composed of numerous blocks for the separation of nationality, etc., and capable of accommodating six or seven thousand people. There is a complete disinfecting station with two current steam machines, and one formalin at 80° C. The people are boarded at 2s. or 3s. 6d. daily. There are churches, shops, a market, a post-office, and an hotel. Waste water is all disinfected with chloride of lime before discharge into the Elbe. The State provided the ground, but only supervises the organisation, which is conceived and administered by the company as a safeguard to itself.

With such a large and complicated subject as that of quarantine organisation, it is impossible to give more than a sketchy outline of some of the principles and practice. However, I hope that enough has been said to call attention to the importance of the subject.

If we wish to recover our place in the van of progress and endeavour, wholehearted and earnest action will be necessary.

What is wanted is a Minister of Public Health* in the Cabinet. Under him would be a Public Health Service of Imperial scope, comprising the direction and organisation of all county, municipal, and port health work both in Great Britain and in all the Crown Colonies. There should also be a division of the service containing Health Officers who would be stationed at the chief ports of our self-governing Colonies and of foreign countries, as well as at the great coolie, pilgrim, and emigrant ports of the world.

In this way we should have a dignified, unified, and cohesive service, worthy of our country. It would be independent of local parsimony or prejudice, and would offer a continuity of policy and breadth of outlook not otherwise obtainable.

* A Ministry of Health has just come into being as this volume is in the press.

CHAPTER XII.

THE PORT HEALTH OFFICER

" With great things charged he shall not hold
Aloof till great occasion rise,
But serve, full-harnessed, as of old,
The days that are the destinies."

KIPLING.

THE office of a P.H.O. in a large port is a busy spot. Besides the control of boarding, quarantine station, and inspection work, there will be a ceaseless flow of correspondence, telephoning, issue of documents, interviewing, etc., which will demand a sufficient and efficient staff.

An undermanned or untrained staff will entail irritating delays and heavy demurrage expenses to the shipping and general public; will bring opprobrium on a job which is (perhaps naturally) more thankless and better disliked than any other in the public service; and, what is most important of all, will quite possibly cause the admission of infectious cases the exclusion of which is the chief *raison d'être* of port sanitary work. Municipal, Local, or Government Authorities, too often do not recognise this point.

The Port Health Officer Abroad.

In the smaller ports of the Empire one Health Officer can usually manage the boarding of ships, marine health work, and office work, by himself. It is very unwise, however, to combine town and port health work. If the P.H.O. has too little shipping work to occupy his time he could look after a hospital for infectious cases or a bacteriological laboratory in addition.

In the somewhat larger ports, with several arrivals daily, he should have an assistant to share the work with him.

In the world's great ports the P.H.O.'s duties should be administrative, not executive. He will need anything from three to six or more assistants, according to the size of the port. His time will be fully occupied in supervision of his various departments of quarantine, boarding, disinfecting, etc. During the usual office hours he should be available in his own office to the public, and for control of correspondence, laboratory work, etc.

It should be a *sine qua non* in all such higher posts that the P.H.O. shall have himself gone through the mill. He should hold a diploma in public health, he should, if possible, have had experience as a Ship's Surgeon, and he should have had considerable experience as an Assistant P.H.O. in a large port.

In the matter of his staff, there is one essential—that it should be comparatively permanent. Port health work is a highly technical matter, and I have no hesitation in saying that a year is the shortest possible time in which an assistant in a large port can learn enough of his work to carry on. If, therefore, the department is fed from a general medical service, as is sometimes done in some places—as, for example, one case I know where a P.H.O. had twenty-one assistants in eight years—it will mean that the P.H.O.'s whole time will be wasted, to the detriment of the public, in partially training a succession of men who do not care for the work and have no intention of carrying it on.

It is a source of regret that we cannot take quarantine seriously and have an Imperial Quarantine Service for the whole Empire, the cost of upkeep being contributed to by Imperial funds, by the self-governing Colonies, by India, and by the Crown Colonies.

Before touching on the subject of Assistant Port Health Officers and their training, there is one word of advice I would give to Port Health Officers, and that is: Don't sleep at the wheel. There are so many lines along which our interesting and useful life-work can be expanded. There is so much research work wanting years of careful attention. To outline only a few of the points to be elucidated:

1. The percentage and migration of rats in different kinds of cargo.
2. Classification and census of ship rats and fleas in various parts of the world.
3. Improvements in ship ventilation.
4. Improvements in ship disinfection.
5. Improvements in crew accommodation.
6. Investigation into the breeding and transport of mosquitoes on ships at sea.
7. Investigation of ship and lighthouse beri-beri.
8. Fly prevention on quarantine stations.
9. The control of cholera epidemics on quarantine stations and ships.

Many other lines will doubtless suggest themselves, especially in connection with tropical work.

Assistant Port Health Officers.

To those who mean to take up this work seriously my advice is: Put in at least a year as a Ship's Surgeon. During that time get to know every inch of your ships, from the stern to the taffrail, from the shaft-tunnel to the chain-locker. Find out where every ventilator goes to, where every sounding pipe is, how the decks are caulked, what is behind the match-boarding of your cabin, what they mean by a cross-bunker, a box-keelson, limberholes, sheerstrakes, how much water your tanks hold and how to steam them, and so on. Never rest till you can diddle the Mate. Try to get on a tropical run if you can, and go ashore at every port and see all the cases of plague, cholera, smallpox, and yellow fever that are possible. Try to see the P.H.O. at each port. Don't be shy. Get him to ask you to dinner, it will be worth your while.

When you've done all this, spend a year ashore and take your D.P.H. and put in a course at a school of tropical medicine. Then you will be properly equipped to start off. We will imagine you have got an appointment. The lines to work on will be:

1. Get up your infectious diseases thoroughly.
2. Learn how to disinfect every part of a ship.
3. Get thoroughly used to examination of deck passengers, immigrants, pilgrims, etc.

4. Learn up thoroughly all the local law dealing with your job.
5. Cabin passengers will worry you horribly. Keep smiling.
6. Get your chief to send you for a trip to neighbouring coolie emigration ports to see their local conditions and the way in which things are done. If he can't spare you, then begin your first "leave" in that way; for it will pay you to know all about the ports with which you have dealings.
7. It is a wise and sound practice, as a rule, to avoid sampling "strong waters" when boarding ships on duty. In a busy port the opportunities may be numerous and the invitations pressing; but the Health Officer's job is one which requires quick and crisp decisions, and an unsleeping alertness incompatible with sluggish or dimmed faculties.

Other detail will be picked up gradually—often at the cost of bitter experience.

The Ritual of Marine Hygiene.

There are many routine forms, in connection with Port Health work, about which a few remarks might not be out of place. The forms of "Entry Declaration," "Passenger's Undertaking," and "Pratique" have been already dealt with in Chapter VII. The only other forms used actually on board ship will probably be "Order to Land Passengers" when such is necessary for removal of passengers by agents to a quarantine station. Such a form calls for no comment.

"Order to Land a Dead Body for Burial."

Such an order should, of course, *always* be in the hands of the P.H.O., from whatever cause the death may have occurred. Unless this is done, infectious disease might easily occur without the knowledge of the Health Department. The P.H.O., after inspection of the body, will call in the Coroner if it be an inquest case; or, if infectious disease, he will be able to deal with it promptly. The points to note with regard to the form are: Infectious Disease, Inquest, Burial, and Registration. The annexed is the form used in the Straits Settlements.

With regard to the forms emanating from the Office itself,

No.———

Name ———

Nationality———

Sex———

Age ———

Date of Death ———

Place of Death ———

———

External Appearances:

———

———

———

P.M. Appearances:

———

———

———

By whom Examined.

———

No.———

PERMIT TO LAND A BODY FOR BURIAL.

———

I hereby certify that I have examined (*or* caused to be examined) the body of ———

who died on s.s.———on———19—, and have no reason to suspect that death was due to any infectious disease, or to any unlawful act or omission which might require an inquest under Section 315 of the Criminal Procedure Code.

I therefore hereby give permission for the said body to be brought ashore for burial provided that the requirements of Section 242 of "The Municipal Ordinance VIII of 1913" with regard to burials be duly carried out.

———

Port Health Officer.

To the Chief Police Officer.

Note.—A death report is attached hereto, which should be forwarded at once to the Registrar of Births and Deaths.

GENERAL PERMIT.

Name _____

Date _____

Extent _____

_____

_____

_____

_____

Officer issuing

_____

GENERAL PERMIT.

To all whom it may concern.

Whereas no person is allowed without written permission to enter or leave the Quarantine Station, or to communicate with any ship when in quarantine or displaying the quarantine flag or lights, or being a transit passenger on an infected or suspected ship to break his voyage, I give notice that I hereby accord to _____

permission to _____

_____

_____

Given under my hand at _____ this _____ day of _____, 19

_____

Port Health Officer.

they are legion. Certificates and Permits will be needed for all sorts of matters.

Sometimes several birds may be killed with one stone (*vide* p. 332).

Perhaps one of the most important routine forms, and the one taken least seriously is—the **Bill of Health.** I have not been able to discover when the first of such documents was promulgated, but I have a large collection of modern examples seized (at some personal risk) from the jealous jaws of Ship-masters' portfolios. I find that a Master will cling almost more tenaciously to his Bill of Health than to any other document. The reason for this affection is an enigma, for I cannot imagine an examining Health Officer ever wishing to see them, since nine-tenths or more are quite valueless.

The most primitive is that issued by the Medical Officers of the Chinese Imperial Maritime Customs in the treaty ports. This runs as follows:

"I certify that I have examined the crew and passengers of the s.s. ———— and that I find no signs of plague, cholera or other infectious disease amongst them.

"*Signed:*....."

This is appalling. There is not a single detail included, and the bare certificate is futile, for there might be a score of the passengers in the incubation stage, and, moreover, actual cases might embark after the certificate had been signed.

Not much better is the type used in the British Customs and Consular Service, which practically only gives two apposite facts—one being the presence or absence of infectious disease in the port (the amount being omitted) and the other being the total of persons on board (which I have generally found to be incorrect). Malta and several other places have an almost similar document, but embellished with superfluous phrases about the "Grace of GOD," etc.

The Bill of Health of the Commonwealth of Australia contains similar scanty information, as does also the form used in the great port of London, where the issue is left to the Custom House and not dealt with by the Port Health Authorities at

BILL OF HEALTH.

Issued at the Port of——————Fee——————paid.

Description of Ship.

Name ——————
Flag——————Reg. tonnage——
Surgeon——————
Captain ——————

Past History.

First Port of present voyage:——————
Date of leaving ditto:——————
Intermediate Ports touched at:——————
——————

Infectious disease on board during current voyage to date:

Plague	Cases:	——	deaths:	——
Cholera	,,	——	,,	——
Smallpox	,,	——	,,	——
Yellow Fever	,,	——	,,	——

Number and causes of any other deaths——————

Present History.

Arrived on ——————

Berthed at $\frac{\text{Wharf.}}{\text{Roads.}}$ (Not) fendered off and (no) rat-shields applied.

Cargo, nature of:——————

(Not) Disinfected in this port.

(No) Provisions } taken on board in this port.
(No) Water }

Number of crew (including Captain) on leaving this port——

Number of Passengers, on leaving this port: 1st class——
2nd and 3rd—— Deck——

Leaves on——————in a $\frac{\text{good}}{\text{indifferent}}$ sanitary state.

Destination——————

Health of this Port.

This Port and its immediate environs are at present (not) infected* with ——————

Non-prescribed Cases during week ending——19——		Total from 1st January to date.
Plague	——	——
Cholera	——	——
Smallpox	——	——
Yellow Fever	——	——

I certify that the above particulars are correct to the best of my knowledge and belief,

Dated, ——————19——

——————
Port Health Officer.

all! As well might one expect the Paymaster to make charts for the Naval Hydrographer!

Indian forms are better, in that they supplement the two above-mentioned items by specifying the nature of the cargo and the sanitary condition of the ship. But even in this case, other details have to be added by hand, or attached in the form of additional certificates.

Perhaps the most lucid and useful form is that used by the U.S.A., which is easy to grasp quickly, as it is in tabular and not in discursive style, and the information is very full, including the number of infectious cases and deaths for the previous two weeks in the port of issue. It lacks, however, several details which are valuable and includes several which are needless, and it has the great disadvantage of enormous size.

I suggest the form herein illustrated as a possible solution of the question. It is simple, easy to take in at a glance, and contains all the information (as to the condition of the ship and the state of the port from which she has come), which is of the greatest value to the examining Health Officer.

If uniformity could be secured by the general adoption of some such form by British and other countries, it would, I think, be a step in the right direction.

The matter mentioned in the footnote is dealt with later in this chapter.

BILL OF HEALTH (*Continued*).

* NOTE.—An epidemic is considered to begin whenever 25 or more infectious cases are first reported in any one week (excluding prescribed cases): and is considered to continue until the number of fresh cases reported, during each of 3 consecutive weeks, has fallen to 15 or under.

A *status sporadicus* is considered to begin when, for the first time, one or more cases (other than epidemic or prescribed cases) are reported in any one week: or when an epidemic has ceased, but cases are still being reported weekly. The disease is considered no longer sporadic when any two consecutive weeks have shown no reported case.

A "Prescribed Case" is defined as either:

(*a*) A case of infectious disease occurring amongst those incarcerated in a quarantine station, a gaol, an asylum, or a reformatory.

(*b*) A case imported by ship or train and promptly isolated.

(*c*) A case occurring in a passenger during his or her quarantine surveillance.

We have thus far dealt with a certain number of office forms in routine use.

The P.H.O. will also have advisory responsibility with regard to the imposition and removal of quarantine restrictions against other ports. This is a most important matter.

When I arrived in Singapore to take up my present post, I found that there was no method in force at all. Some neighbouring country would declare some port to be infected and we followed suit; they removed restrictions and we did the same! The actual conditions were not considered. A ship would arrive infected with one case of plague; the port from which she came was promptly declared an infected port!

The question was, where to begin, and what to do?

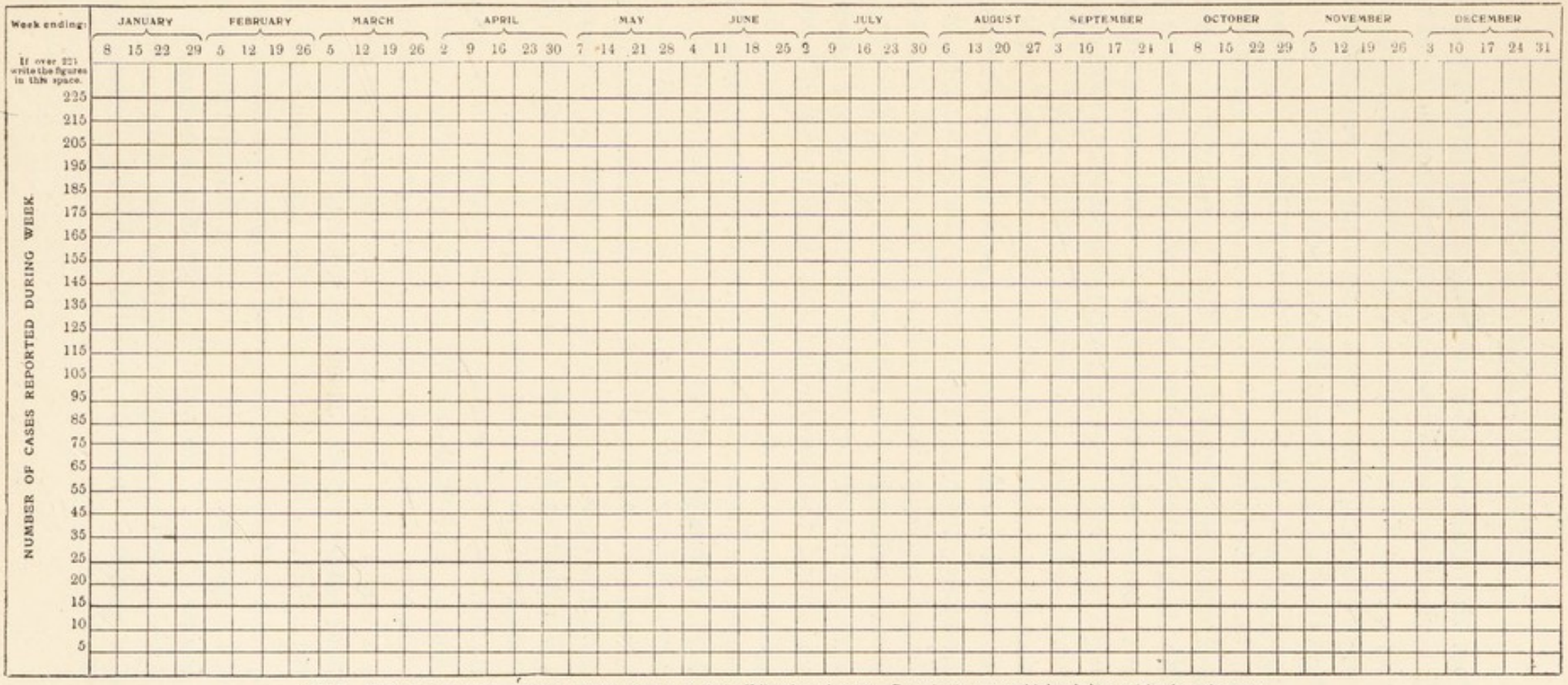
I made inquiries to find out what systems were adopted by neighbouring countries. I found chaos. Java would put Singapore in quarantine when only two cases of plague had occurred in a week, but she would ignore fifteen cases of cholera! Hong-Kong did not trouble much whatever the condition of Singapore. In India, the question as to whether a disease was epidemic or not was decided by a Board. Sometimes thirty cases in a week would not be considered epidemic. At other times when cases had fallen to five a week the disease was still pronounced epidemic. It was obvious that the whole matter required most careful consideration.

The first thing was to get regular weekly returns of infectious disease from all the chief Eastern ports. These returns were charted out for each port on a chart similar to the illustration herein.

On the charts I entered up the names of all infected ships coming from the respective ports, and continued for a few years to watch events.

Experience showed me that, not until the cases in a port had reached a total of twenty-five to thirty per week would an infected ship arrive from that port, and by no means always then. The charts had also showed me other things. A wonderful periodicity in plague curves in India and Hong-Kong occurred year after year, so that one could say within a few weeks when the curve would rise.

Port of..... Infectious $\frac{\text{Cases}}{\text{Deaths}}$ for the year..... Correspondence No.....



NOTE Plague Entries, in red, Smallpox, in blue, Cholera, in black, Yellow fever, in green. Enter in *situ* names of infected ships arriving from above port.
"Epidemic" begins at 25 cases in one week, and ends when three consecutive weeks shew 15 cases, or under 15, per week

FIG. 28.

From the date of onset in Hong-Kong it was possible to predict whether it would be a bad plague season, and so prepare for it; for, if fifteen cases a week are reached during March, it is nearly sure to be a bad year; but if that total is not reached till May, plague will have a low curve.

Ships infected with smallpox came every spring from Hong Kong, but this infection was independent of an infection of Hong-Kong itself, showing that, with coolie traffic, one must consider the hinterland from which the passengers are drawn, and get regular reports as far as possible from such sources.

The Java charts also had valuable lessons. Plague broke out inland at Malang. The seaport for Malang (with which it is connected by rail) is Sourabaia. The returns from the two places showed within what time a port may be infected from its hinterland, and what relative infections are likely to occur.

Having therefore gleaned some useful crumbs of knowledge, it seemed worth while to act upon them, and from that time forward I used a definite standard of epidemicity upon which to recommend the imposition and withdrawal of quarantine restrictions against the neighbouring and foreign ports. I considered the first occurrence of twenty cases in any one week as an indication (albeit arbitrary) of an epidemic status, and automatically put such port on the quarantine list.

The time for removal of quarantine restrictions was also based on the chart work, which had shown a port to be safe when the number of cases had dropped to ten cases (or less) per week for three consecutive weeks.

This method of automatic standardisation I have continued ever since. The only alteration, consequent on added experience, has been that I have altered the standard to twenty-five cases a week, and the time for removal to three consecutive weeks at fifteen or less cases per week.

I brought the idea forward at the first meeting of the Far Eastern Association of Tropical Medicine in Manila in 1910, when I suggested that the Association should define the words "epidemic" and "sporadic" for general adoption. "Sporadic" we defined as an occurrence of one or more non-prescribed or non-epidemic cases of infectious disease in any week; or

when an epidemic has ceased but cases are still being reported weekly. We considered that the sporadic state had concluded when any two consecutive weeks showed no reported case.

The Singapore procedure on these lines, and the definitions of the two conditions, have been incorporated for the first time in the consolidated Quarantine Ordinances of the Straits Settlements.

A year or two ago an early draft of these was circulated through the East for the favour of other people's opinions. In one or two quarters an objection to the arbitrary standard was put forward on the ground that flexibility should be introduced according to the size and population of a port; because twenty-five cases per week in a place A with 1,000,000 inhabitants did not mean at all the same thing as it would in B with only 100,000 inhabitants. This seemed reasonable, but yet the charts appeared to show an equal safety or danger on a uniform standard adopted for both such places.

A little thought, however, seems to show that the fixed uniform standard is the most logical method.

Neglecting the question of plague rats (which, with care, need not be a serious one), the transmission of infection to a port will be accomplished by human agency (generally sea-borne).

Now, emigration from different ports will generally be found to bear a proportional relationship to the number of their population. This would naturally be expected. Business and pleasure will naturally tend to call away more people from a large city than from a small one. Many factors are, of course, at work and the statement can only be a generalisation, but it seems nevertheless to be sufficiently accurate to call it a postulate for practical purposes.

Say that:

" A," with a population of 1,000,000, has a weekly emigration of $10x$.

" B " with a population of 100,000, has a weekly emigration of x.

Infectious cases=100 per week in both " A " and " B."

Then : Per head of the population, there will be ten times as many people ill in " B," as there will in " A "; for—

" A " will have 1 : 10,000 ill, and " B " 1 : 1,000.

If, therefore, an equal number of emigrants leave " A " and " B," the chances of an infected emigrant amongst the " B " lot will be ten times greater than amongst the " A " batch.

But : The number of emigrants leaving " A " is ten times as great as the number leaving " B."

Therefore : The chances of infection occurring amongst those who actually leave " A " will be the same as amongst those who actually leave " B."

That is : The danger of sea-borne disease transmission will vary directly with the disease incidence, irrespective of the number of the population and the incidence-rate.

With regard to the special standard adopted, observations have demonstrated its reasonable safety. There is, moreover, no doubt as to the great advantages which would accrue from the universal adoption of a single standard. The shipping world would know exactly where they stood, and it would be possible to adjust quarantine laws as a basis for reciprocal action and mutual recognition.

If any country were afraid of possible disease introduction from a place at which disease existed sporadically but was not yet epidemic, it would always be open to them to frame regulations (as in the Straits Settlements) which should ensure such inspection and disinfection as may be required, without imposing the stricter quarantine measures which would automatically come into operation on the port reaching the epidemic standard and being declared " infected."

The Port Health Officer in Europe.

The foregoing remarks, although having a certain wide and general application, are more especially concerned with the tropical ports of our outer Empire.

The problems of the tropics, especially in the East, are vivid and compelling. The major infections are endemic in wide areas; and, moreover, both religious and economic necessities result in continual migrations of enormous numbers of irresponsible pilgrims and coolies, for the observation and control of whom, ceaseless vigilance is required.

Europe, on the other hand, is far from the great centres of epidemic diseases, from which she is separated by voyages of many days' duration. Irresponsible native deck passengers are nearly as rare as are snakes in Iceland. And the chances of introduction of the major infections will consequently be equally rare. Even if such cases should be introduced, modern hygienic conditions and sanitary control are now of such excellence that little danger of spread by " contacts " is to be anticipated.

The European port problems are therefore resolved mainly on four lines: (*a*) Exclusion of the " minor " infections such as typhoid, diphtheria, etc.; (*b*) Inspection of European immigrants with a view to exclusion of physical undesirables and decrepits, such as: phthisis, trachoma, etc.; (*c*) Control of food-imports. The Foreign Meat Regulations of January 1, 1909, have considerably increased the work in this direction; (*d*) Rats.

The " Port Health Officer " is, in Great Britain, generally called " Medical Officer of Health to the Port," and is appointed by a Port Sanitary Authority. In smaller ports the M.O.H. seldom visits ships unless asked to do so by a Customs Officer who is supposed to report infectious disease. In the larger ports the M.O.H. does not usually board in person. The M.O.H. has legal power of entry. A large proportion of ships, however, are not usually inspected—*e.g.*, London inspections for the last ten years have been less than 25 per cent. of arrivals. There is, generally speaking, no definite method on which places are declared infected. Ships arriving from such places as happen to be on the current list would be medically inspected, otherwise an inspection would be dependent on a notification from the Customs Boarding Officer.

The following are the London Port Bye-laws:

> BYE-LAWS made by the Port Sanitary Authority of the Port of London, pursuant to the Public Health (London) Act, 1891, Section 66 (3), and confirmed by the Local Government Board, for the removal to Hospital of persons brought within the Port by any Vessel who are infected with a Dangerous Infectious Disease.

1. In these Bye-Laws the expression " The Port Sanitary Authority " means the Mayor, Commonalty, and Citizens of the City of London

acting as the Port Sanitary Authority of the Port of London; the expression " Dangerous infectious disease " means any one of the following diseases:

Smallpox,
Diphtheria,
Membranous Croup,
Erysipelas,
Scarlatina or Scarlet Fever,
Typhus Fever,
Typhoid Fever,
Enteric Fever,
Relapsing Fever,
Continued Fever,
Puerperal Fever,
Measles.

2. Every master or other person having charge of a vessel arriving in the Port of London, with any person on board, whether a passenger or belonging to the ship's crew, suffering from a dangerous infectious disease, shall stop on arrival off the Custom House at Gravesend, and forthwith send notice to the Medical Officer of the Port Sanitary Authority stationed at Gravesend, that there is a person on board suffering from such a disease.

3. The master or other person in charge of the vessel shall cause her to remain off the Custom House until the Medical Officer of Health has boarded her.

4. The Medical Officer of Health to whom notice is given as aforesaid shall as soon as practicable visit the vessel, and ascertain whether the person referred to in the notice is suffering from a dangerous infectious disease, and if in the opinion of the Medical Officer of Health he is, and can properly be removed, and proper accommodation can be provided for him in the Hospital of the Port Sanitary Authority at Gravesend, or in some other hospital to which the Port Sanitary Authority are entitled to remove patients, the master or other person having charge of the vessel shall forthwith cause such person to be removed to such hospital according to the directions of the Medical Officer of Health.

5. If any dangerous infectious disease shall break out on board any vessel arriving in the Port of London, and after she has passed Gravesend, the master or other person having charge of such vessel shall give notice to the Medical Officer of Health of the Port Sanitary Authority, at his Office at Greenwich, that there is on board a person suffering from such a disease, and if, upon examination, the Medical Officer of Health shall find that he is so suffering, the master or other person in charge of such vessel shall forthwith cause such person to be removed to a hospital to which the Port Sanitary Authority are entitled to remove patients, as directed by the Medical Officer of Health.

These bye-laws only confer power to remove certain cases of infectious disease to an isolation hospital.

The Local Government Board Regulations of 1907 cover the introduction of Cholera, Plague, and Yellow Fever, but seem to ignore Smallpox.

An *infected ship* is defined as a ship which has a case of the above diseases on board, or has had on board a case within seven days (yellow fever eighteen days) prior to arrival. A *suspected ship* is one which has had a case on board during the voyage, but not within the above periods. If the M.O.H. finds the ship infected or suspected (after it has been detained by the Customs Officer) he gives the Master a certificate to that effect, and then he *must* examine everyone on board. The case is removed to hospital and a suspected case merely detained for *two* days for observation. Otherwise no one on board may be detained at all unless he cannot satisfy the M.O.H. as to his name, destination, and address. The address of passengers may also be insisted on if they have come by a suspected ship or if their ship has called at an infected port. Articles 16, 18, and 19 make provision for disinfection. Articles 23 and 24 deal with rat-destruction and Article 25 with mosquito-destruction.

A survey of P.H. organisation in England was carried out in 1907 by the L.G.B., embracing 108 port districts. Very unsatisfactory contitions were found to obtain at many ports, although the larger seaports were mostly in Class "A."

There is certainly room for co-ordination of marine sanitary measures both at home and abroad. They should not be left in the hands of apathetic local authorities, with whom commercial interests might be likely to be paramount.

Quarantine Station and Staff organisation has already been dealt with in Chapter XI.

As a final word on Office aspects, may I counsel the following:

1. A well-equipped laboratory of a size commensurate with the work of the port. It is not only more convenient and fitting, but very much more expeditious to do as much as possible of your own laboratory work than to send it somewhere else.

2. A series of well-chosen framed maps and charts of neighbouring countries, ports, etc., should be hung in every office.

3. A comprehensive library is indispensable—dealing with all the possible medical and legal aspects of the marine health work. A good selection of relevant books of reference should also be included, such as: The International Code of Signals; a good modern atlas; the Navy List (quarterly); Lloyd's Register of Mercantile Shipping; Paasch's "Keel to Truck," etc.

Many valuable periodicals might also with advantage be taken, and bound annually for the library. Of especial use are: the "Public Health Reports" (weekly) of the U.S.A. Public Health Service; the "Bulletin" of the Tropical Diseases Bureau, Imperial Institute (fortnightly); the "Bulletin" (monthly) of the International Public Health Office in Paris; and the Quarantine Service Publications of the Australian Commonwealth.

Finally, it should not be forgotten that, more especially with the Mercantile Shipping Community, time is money; and every endeavour should be made at all times to facilitate prompt despatch in so far as may be compatible with the paramount requirements of that sanitary trust which is the *raison d'être* of the Port Health Officer's responsible calling.

APPENDIX I

LIGHTHOUSES AND LIGHTSHIPS

WHILE, in Europe, this subject is not of much interest to the Port Health Officer, in many parts of the world the Sanitary Authorities of a Colonial port are called on to supervise lighthouse sanitation in their colony or district, to report on disease amongst the crews, and to arrange the diet schedules, etc.

Lighthouses are divided into three classes:

(*a*) Lightships.
(*b*) Shore lighthouses.
(*c*) Sea lighthouses (*i.e.*, on rocks or banks or small islands).

In each case there is a light-keeper and a crew. In the tropics, the crew are usually recruited from native races.

The structure is usually sound, and of suitable though limited accommodation. Sanitation will depend on common sense and ordinary routine cleanliness. The crew are composed of picked men; and, owing to the isolation of their life, will be less liable to attacks of infectious disease than are other members of the public.

In tropical stations, however, three diseases are often very prevalent amongst them: Dysentery, beri-beri, and malaria, the latter disease being almost exclusively confined to shore lighthouses, owing to the propinquity of other inhabitants and the presence of anophelines.

Dysentery will usually result from the contamination of the water-supply or the infection of food by flies, which are often a great plague. One lighthouse at the Eastern end of the Malacca Straits—Horsburgh Lighthouse—is on an island in the centre of the narrow mouth of the Strait. All ships, bound east or west, make this light and pass close to it.

Many of these ships, especially those carrying coolies or cattle, have in addition a full cargo of flies; and from personal observation I can vouch for a muscid migration to the lighthouse. In such a confined area the dysentery is often hard to stop. In fact, in bad instances, it is better to disinfect the whole place, and change the crew *in toto*.

Beri-beri is sometimes less prevalent, but is even harder to control. A native rice-eating staff naturally reminds one of the modern dietetic theories of beri-beri etiology. But, as so often happens in the case of ships, you can change the rice, or omit it, or even change the crew—and yet cases crop up at intervals! As mentioned in Chapter V., I have a haunting conviction that the disease is of bacterial origin—the special organism being favoured by warmth and moisture, widely present in tropical air, rejoicing exceedingly in the atmosphere of the fo'c'sle or lighthouse quarters, and growing fat on its favourite food—white (over-milled) rice. There is no doubt that structural and aerial disinfection will frequently stop the disease in the two above-mentioned situations—which, as I have shown, is exactly what one would expect.

In lighthouse supervision, the Health Officer should first secure thorough cleanliness, and plenty of whitewash. The water-supply is usually collected rain water from the roof or other catchment area, and is frequently charged with sea-bird manure. It should be so arranged that the firstfruits of a shower be diverted from the receiving tank. The tank should be properly situated in as cool a spot as possible, and should be well ventilated, but at the same time screened from contamination by dirt, insects, etc.

The latrine arrangements should be planned to make the best use of nature's great drainage system—the sea. There is no need for any collections of night-soil to remain in the building or to be distributed on the rocks outside.

If the lighthouse is situated on shore, the question of malaria must be considered, and anopheles located and their breeding-grounds exterminated.

The mosquito inhabitants of tropical sea lighthouses are nearly all *Stegomyia fasciata*, with an occasional culex. The

danger is therefore nil in these cases, unless yellow fever be introduced into the area.

The food stores should be kept in a cool, dry, well-ventilated room, protected from rats and insects. Rice-bins, safes, boxes, etc., should all be raised on bricks, allowing a free circulation of air everywhere.

Diet scales will, of course, vary according to nationality and locality.

The *U.S.A. Lighthouse Service* require for the Lightship Service, for each man daily:

Pork	½ lb.	Biscuits	11½ oz.
Beef	½ ,,	Brown sugar ..	6 ,,
Flour	3½ oz.	Tea	4 drs.
Rice	1¾ ,,	Coffee	1⅛ oz.
Raisins	1¼ ,,	Butter	10 ,,

besides beans, vinegar, molasses, pickles, potatoes, and onions.

In the *Straits Settlements*, whose lighthouse crews are Malay —with a few Chinese—the following is the daily scale per head:

Rice	1½ lb.	Onions	½ oz.
Dhal	9 oz.	Yams	8 ,,
Salt fish	4 ,,	Ghee	2 ,,
Sugar	2 ,,	Biscuits	½ lb.
Coffee	2 ,,	Flour	5 oz.
Tamarind	1½ ,,	Tea	3 drs.

The diet also includes small quantities of salt, chillies, pepper, turmeric, coriander, cumin, and garlic—which are used in curry preparation. Fresh fish is, of course, always caught by the men; and, in special circumstances, more nitrogen is supplied.

The keeper—a European or Eurasian—has, in addition to the above, an extra monthly allowance consisting of:

Soup	15 tins.	Salt beef	15 lb.
Condensed milk ..	8 ,,	Flour	58 ,,
Butter	4 lb.	Beer	31 pts.
Potatoes	15 ,,		

APPENDIX II

DRUG SCHEDULES

VARIOUS scales of drugs and medical stores have been laid down.

I give here four standard scales which are typical of most.

The first is a scale for merchant ships on short voyages; the second, for similar ships on long voyages; and the third, for emigrant ships.

These three are all laid down by the Board of Trade in pursuance of the Merchant Shipping Act, 1894.

The fourth scale given here is that previously required by the Public Health Administration of the Turkish Empire, for pilgrim ships proceeding to Jeddah.

Throughout, medicines marked with one asterisk (*) must have a red "poison" label. Those with two asterisks (**) should, in addition, be in green fluted bottles, and labelled "External use only."

I. Board of Trade Emergency Scale.

For Merchant Ships making a voyage of under five days (M.S.A., 1894, Sect. 200):

Drugs:	*Per Ship.*
Spir. ammon. aromat.	2 oz.
*Tinct. chlorof. et morph. co.	1 ,,
Lin. calcis.	1 pint.
Oleum ricini	½ ,,
**Ac. carbol. liq.	2 oz.
Tinct. benzoin. co.	2 ,,
**Liq. plumbi subacet. fort.	2 ,,
*Tinct. opii	2 ,,
**Lin. opii	4 ,,
Pil. colocynth. co. (gr. iv.)	3 doz.
Vaseline	4 oz.

Medical Stores :	*Per Ship.*
Rubber plaster	1 yard.
Boric lint	½ lb.
Absorb. wool	½ ,,
Minim measure	1
2-oz. ,,	1
6-oz. bottles with corks	6
1 oz. ,, ,, ,,	6
Mustard leaves	1 tin.
Scissors	1 pair.
Lancet	1
Δ bandages, 48″ × 32″ × 32″	2
2″ ,,	3
3″ ,,	3
Calico	2 yds.
Splints	1 set.
Esmarch's tourniquet	1
Needles (in vaseline)	6
Safety pins	2 doz.
Suture silk (4 sizes)	1 tablet.
Higginson's syringe	1
Truss (36″ single reversible)	1
,, (38″ double)	1
"Ship Captain's Medical Guide" (as sanctioned by B. of T., Oct. 30, 1899)	1 copy.

NOTE.—Ships making voyages of less than twenty-four hours have the option of carrying the small "Ambulance Hamper" of the St. John Ambulance Association in lieu of the above scale.

II. Board of Trade Scale for Ordinary Merchant Ships.

(Prescribed March, 1903, under M.S.A., 1894, Sect. 200.)

	Crew Numbering :			
	Under 10.	*Under* 20.	*Under* 40.	*Above* 40.
Drugs (for twelve months):—				
Alum	2 oz.	4 oz.	6 oz.	8 oz.
Sp. ammon. arom.	4 ,,	6 ,,	8 ,,	12 ,,
Bals. copaiba	4 ,,	8 ,,	12 ,,	16 ,,
Pot. bicarb.	4 ,,	6 ,,	8 ,,	10 ,,
Sod. bicarb.	8 ,,	12 ,,	16 ,,	20 ,,
Mist. sennæ co.	2 pts.	4 pts.	6 pts.	8 pts.
Lotio nigra	1 ,,	2 ,,	2 ,,	3 ,,
**Liq. epispasticus	1 oz.	1 oz.	2 oz.	2 oz.
Ammon. brom.	2 ,,	4 ,,	6 ,,	8 ,,
*Calomel	1 ,,	1 ,,	1 ,,	1 ,,
Camphor	2 ,,	4 ,,	6 ,,	8 ,,
**Ac. carbol. liq.	4 ,,	6 ,,	8 ,,	12 ,,
Disinfectant (80 per cent. carbolic or cresol)	1 gal.	2 gals.	4 gals.	4 gals.
Lin. calcis	1 pt.	1 pt.	2 pts.	3 pts.

	Crew Numbering :			
	Under 10.	*Under* 20.	*Under* 40.	*Above* 40.
Drugs (for twelve months) *continued :—*				
Ol. ricini	2 lb.	4 lb.	6 lb.	8 lb.
*Argent. nit.	½ oz.	½ oz.	1 oz.	1 oz.
Tinct. chlorof. et morph. co.	1 ,,	2 ,,	3 ,,	4 ,,
Creosotum	½ ,,	1 ,,	1 ,,	1 ,,
**Condy's fluid	½ pt.	1 pt.	1 pt.	2 pts.
Acid. sulph. aromat. ..	2 oz.	4 oz.	6 oz.	8 oz.
Mag. sulph.	3lb.	6 lb.	10 lb.	12 lb.
Tinct. zingib. fort. (B.P. 85)	1 oz.	2 oz.	3 oz.	4 oz.
Ess. menth. pip. (B.P. 85)	1 ,,	2 ,,	3 ,,	4 ,,
Tinct. benzoin. co.	4 ,,	6 ,,	8 ,,	10 ,,
**Liq. plumbi sub acet. fort.	1 ,,	2 ,,	4 ,,	6 ,,
Pot. iod.	2 ,,	2 ,,	3 ,,	4 ,,
**Liq. iodi f rt.	1 ,,	2 ,,	3 ,,	4 ,,
**Iodoform	6 drs.	8 drs.	10 dr.	12 drs.
*Tinct. opii	4 oz.	6 oz.	8 oz.	10 oz.
Lini (plus 2 drs. camphor to the lb.)	7 lb.	14 lb.	21 lb.	28 lb.
Mustard leaves (in tins) ..	12	24	24	24
Pot. nit.	4 oz.	6 oz.	8 oz.	10 oz.
Olive oil	4 ,,	8 ,,	12 ,,	16 ,,
**Lin. opii	6 ,,	8 ,,	10 ,,	12 ,,
*Tinct. camph. co.	4 ,,	6 ,,	8 ,,	10 ,,
Pil. hydrarg. (gr. iv.) ..	4 doz.	6 doz.	8 doz.	10 doz.
Pil. ipecac. c̄ scillæ (gr. iv.)	4 ,,	4 ,,	6 ,,	8 ,,
Pil. saponis co. (gr. ii.) ..	2 ,,	2 ,,	3 ,,	4 ,,
Pil. colocynth. co. (gr. iv.) ..	6 ,,	12 ,,	16 ,,	20 ,,
*Pulv. ipecac. co.	1 oz.	2 oz.	3 oz.	4 oz.
Pulv. ipecac.	1 ,,	2 ,,	3 ,,	4 ,,
Quinine (treble quantity in tropics)	1 ,,	2 ,,	3 ,,	4 ,,
Sod. salicyl.	4 ,,	8 ,,	12 ,,	16 ,,
Spir. chlorof.	4 ,,	6 ,,	8 ,,	10 ,,
Zinci. sulphas	1 ,,	2 ,,	3 ,,	4 ,,
Sulphur (sublimed)	1 lb.	1 lb.	2 lb.	3 lb.
Spir. æth. nit.	6 oz.	6 oz.	8 oz.	10 oz.
Ac. tartaric...	4 ,,	6 ,,	8 ,,	10 ,,
Tinct. ferri perchlor. ..	4 ,,	4 ,,	6 ,,	8 ,,
**Lin. terebinth.	8 ,,	10 ,,	12 ,,	16 ,,
Extr. hamamelidis liq. ..	1 ,,	1 ,,	2 ,,	2 ,,
Ung. ac. bor.	4 ,,	6 ,,	8 ,,	10 ,,
Ung. gallæ c̄ opio	1 ,,	2 ,,	3 ,,	4 ,,
Ung. hydrarg.	2 ,,	2 ,,	,,	6 ,,
Ung. sulphur.	8 ,,	12 ,,	16 ,,	16 ,,
Ung. hydrarg. ammon. ..	2 ,,	2 ,,	4 ,,	6 ,,
Vaseline	12 ,,	12 ,,	16 ,,	24 ,,
Medical Stores :				
Scales	1 set.	1 set.	1 set.	1 set.
Rubber plaster	1 yd.	2 yds.	3 yds.	4 yds.
Boric lint	½ lb.	¾ lb.	1 lb.	1 lb.
Absorbent wool	½ ,,	¾ ,,	1 ,,	1 ,,
Double cyanide gauze ..	1 yd.	1 yd.	2 yds.	2 yds.

	Crew Numbering :			
	Under 10.	*Under* 20.	*Under* 40.	*Above* 40.
Medical Stores, continued :—				
Pasteur or similar filter (2 gals.)	1	1	1	1
Minim measure	1	1	1	1
2-oz. measure	1	1	1	1
6-oz. bottles	1 doz.	1 doz.	2 doz.	2 doz.
Corks	1 ,,	2 ,,	3 ,,	4 ,,
Pair of Scissors	1	1	1	1
Syringes, ½ oz.	2	2	4	4
Abscess knife (Paget's)	1	1	1	1
Eye spud	1	1	1	1
2″ bandages	1	3	3	4
3″ ,,	2	3	3	4
△ ,, (48″ × 33″ × 33″)	2	3	4	4
Flannel bandages (7 yds. × 6 ins.)	1	2	3	4
Calico	2 yds.	3 yds.	4 yds.	6 yds.
Flannel	2 ,,	3 ,,	4 ,,	6 ,,
Needles (in vaseline)	6	6	6	6
Suture silk spool (4 sizes)	1	1	1	1
Safety pins	3 doz.	3 doz.	3 doz.	3 doz.
Splints (common set)	1	1	1	1
Higginson's syringe	1	1	2	2
Esmarch's tourniquet	1	1	1	1
Soft catheters	3	3	3	3
Trusses (36″ single reversible)	1	2	3	3
,, (36″ double)	1	1	1	1
Sponges (aseptic bottles of 1 doz.)	1	1	1	1
Plaster of Paris bandages (in tins)	1 doz.	1 doz.	2 doz.	2 doz.
Clinical thermometers	1	1	1	1
Camels'-hair brushes	1	1	2	2
Bedpans	1	1	1	1
Oatmeal	4 lb.	8 lb.	16 lb.	24 lb.
Arrowroot	2 ,,	4 ,,	8 ,,	12 ,,
Pearl barley	4 ,,	8 ,,	16 ,,	24 ,,
Cornflour	4 ,,	8 ,,	16 ,,	24 ,,
Sago	4 ,,	8 ,,	16 ,,	24 ,,
Sugar	14 ,,	28 ,,	42 ,,	56 ,,
Tinned soup and bouilli	6 ,,	12 ,,	24 ,,	36 ,,
,, mutton	6 ,,	12 ,,	24 ,,	36 ,,
Quarter pints, meat essence (tins)	6	12	24	36
Desiccated soup	4 lb.	8 lb.	16 lb.	24 lb.
Dried vegetables	4 ,,	8 ,,	16 ,,	24 ,,
Potatoes (if not in prov. scale)	14 ,,	28 ,,	56 ,,	74 ,,
Port wine	3 bots.	6 bots.	12 bots.	18 bots
Brandy	2 ,,	4 ,,	6 ,,	8 ,,
"Ship Captain's Medical Guide" (as sanctioned by B. of T., Oct. 30, 1899)	1 copy.	1 copy.	1 copy.	1 copy.

III. Board of Trade Scale for Emigrant Ships.

(Prescribed in 1903, under M.S.A., 1894, Sect. 300.)

[N.B.—There is a separate B. of T. scale for *North Atlantic Emigrant Ships*. That scale is not quite so extended as this, and the amounts required are graduated for the needs of 100, 250, 500, and 750 emigrants.]

Drugs.	*Quantities Per 100 Emigrants.*		
	Pts. or Lb.	*Oz.*	*Drs.*
Acid. boric.	0	3	0
**Acid. carbol. liq.	0	4	0
Acid. citric.	0	1	0
*Acid. hydrocyan. dil.	0	0	2
*Acid. nitro-hydrochlor. dil.	0	4	0
*Acid. sulphuric. dil.	0	4	0
*Æther	0	6	0
Alumen	0	2	0
Ammon. brom.	0	4	0
Ammon. carb.	0	3	0
*Argent. nit.	0	0	2
Bism. carb.	0	2	0
Borax	0	2	0
Calc. hydras (for lime-water)	0	1	0
Camphor	0	3	0
*Chloroformum	0	6	0
*Collodium	0	0	4
Copaiba	0	4	0
Extr. cascara sagr. liq. (or tabloids) ..	0	2	0
Extra ergot. liq.	0	2	0
Extr. hamamelidis liq.	0	1	9
Ferri et ammon. cit.	0	1	0
Ferri et quin. cit.	0	1	0
Glycerine	0	8	0
Glycerinum acid. tannici	0	2	0
*Hydrarg. subchlor.	0	0	2
*Hyd. c̄ cret.	0	2	4
*Iodoformum	0	1	1
Linum contusum	6	0	0
**Lin. belladonnæ	0	8	0
**Lin. camph. ammon.	0	6	0
**Lin. opii	0	4	0
**Lin. saponis	0	12	0
Liq. ammon. acet.	0	8	0
*Liq. arsenicalis	0	0	4
*Liq. atrop. sulph.	0	0	2
Liq. calcis	0	8	0
**Liq. epispasticus	0	1	0
**Liq. ferri perchlor.	0	0	4
**Liq. hydrarg. perchlor.	0	6	0

Drugs.	Quantities Per 100 Emigrants.		
	Pts. or Lb.	Oz.	Drs.
**Liq. iodi fort.	0	1	0
*Liq. morph. hydrochlor.	0	1	0
**Liq. plumbi subacet. fort.	0	2	0
*Liq. strychninæ hydrochlor.	0	2	0
Mag. sulph.	3	0	0
Mist. sennæ co.	5	0	0
*Ol. crotonis	0	0	1
Ol. lini	1	0	0
Ol. olivæ	0	8	0
Ol. ricini	1	0	0
**Ol. terebinth.	0	6	0
Paraff. molle	0	12	0
*Phenacetin	0	0	4
Pil. colocynth. co., gr. iv.		4 doz.	
Pil. hydrarg., gr. iv.		4 ,,	
Pil. plumbi ō opio, gr. ii.		1 ,,	
Pil. rhei co., gr. iv.		4 ,,	
Pil. saponis co., gr. ii.		3 ,,	
Pil. scillæ co., gr. iv.		3 ,,	
Pot. bicarb.	0	4	0
Pot. chloras	0	4	0
Pot. iod.	0	4	0
Pot. nit.	0	1	0
Pot. permang.	0	4	0
Pulv. cret. aromat.	0	2	0
Pulv. glycerrhizæ co.	0	4	0
Pulv. ipecac.	0	1	0
Pulv. ipecac. co.	0	1	0
Pulv. jalap. co.	0	1	0
Quin. sulph.	0	2	0
Sodii bicarb.	0	6	0
Sodii salicyl.	0	3	0
Spir. æth. nit.	0	8	0
Spir. ammon. arom.	0	6	0
Spir. chlorof.	0	3	0
Spir. menth. pip.	0	1	0
Spir. rect.	0	6	0
*Sulphonal	0	0	4
*Syr. chloral	0	5	0
*Tabellæ trinitrini	0	1	0
*Tinct. arnicæ	0	1	0
*Tinct. belladon.	0	1	0
Tinct. benzoin. co.	0	2	0
*Tinct. camph. co.	0	4	0
Tinct. cardam. co.	0	6	0
Tinct. catechu	0	2	0
*Tinct. chlorof. et morph. co.	0	1	0
*Tinct. digitalis	0	1	0
*Tinct. ferri perchlor.	0	2	0
Tinct. gent. co.	0	6	0

Drugs.	Quantities Per 100 Emigrants.		
	Pts. or Lb.	Oz.	Drs.
Tinct. hyoscyami	0	2	0
*Tinct. opii	0	4	0
Tinct. scillæ	0	2	0
Tinct. senegæ	0	4	0
Tinct. zingib.	0	2	0
Ung. ac. bor.	0	8	0
Ung. gallæ c̄ opio	0	1	0
Ung. hydrarg.	0	2	0
Ung. hydrarg. ammon.	0	4	0
Ung. hydrarg. ox. flav.	0	2	0
Ung. sulphuris	0	10	0
Ung. zinci	0	8	0
*Vinum antimoniale	0	1	0
Vinum colchici	0	1	0
Vinum ipecac.	0	4	0
Zinci oxid.	0	4	0
Zinci sulph.	0	1	0

Medical Stores, etc.	Per 100 Passengers.
Hypodermic syringe and needles	1 case.
Tabl. hypoderm:	
Morph. tart., gr. $\frac{1}{4}$	2 doz.
Atrop. sulph., gr. $\frac{1}{100}$	1 ,,
Cocaine hydrochlor., gr. $\frac{1}{4}$	2 ,,
Apomorph. hydrochl., gr. $\frac{1}{20}$ .. .. *per ship*	1 ,,
Carbolic powder	1 cwt.
Commercial carbolic	2 gals.
Roll sulphur	5 lb.
Soloids of hyd. perchlor., gr. 8·75 .. .. *per ship*	100
Lint	8 oz.
Boric lint	8 ,,
Absorbent wool	1 lb.
Strapping	3 yds.
Tow	1 lb.
Sponges (aseptic sealed bots. of 1 doz.) ..	1 to 3 bots.
Bedpan	1
3″ bandages (6 yds. long)	2 doz.
6″ ,, (6 yds. flannel)	3
△ ,, (48″ × 33″ × 33″)	3
Calico	3 yds.
Flannel	3 ,,
Gamgee tissue	1 lb.
Double cyanide gauze	2 yds.
Oiled silk .. .. *per ship*	1 yd.
Waterproof sheeting .. .. ,,	4 yds.
Trusses (36″ double)	1
,, (30″ reversible)	1 single.
,, (36″ reversible)	1 ,,
Safety pins .. .. *per ship*	5 doz.

Medical Stores, etc. (*continued.*)	*Per* 100 *Passengers.*
Mustard leaves	,, 2 tins.
Plaster of Paris	1 lb.
Cline's sprints	*per ship* 1
MacIntyre's splint	,, 1
Perforated felt	4 sq. ft.
Minim measure	*per ship* 2
Ounce measure	,, 1
3 oz. measure	,, 2
Stomach tube and funnel	,, 1
Higginson's syringes	2 to 4
Glass syringe, ½ oz.	6
Scales	*per ship* 1 set.
Enamelled basin	,, 1
Mortar and pestle	,, 1
Enamelled △ tray	,, 1
Wedgwood funnels	,, 2
Spatulæ	,, 2
2-oz. bottles	2 doz.
8-oz. bottles	4 ,,
2-oz. bottles (fluted)	1 to 2 ,,
6-oz. ,, ,,	1 to 2 ,,
Pasteur filter (2-gallon)	*per ship* 1
Corks	6 doz.
Gallipots	6
Nested pill-boxes	1 set.
Labels	6 doz.
Poison labels	2 ,,
Dispensary paper (white)	*per ship* 1 quire.
Camel's-hair brushes	3
Æther inhaler	*per ship* 1
Urinometer	,, 1
Spirit lamp	,, 1
Litmus paper	,, 1 book.
Test-tubes	,, 12
Nitric acid	,, 2 oz.
Liq. potassæ	,, 2 ,,
Calf lymph (glycerinated)	24 to 48 tubes.
Pharmacopæia	*per ship* 1
"Ship Captain's Medical Guide"	,, 1

Instruments.	*Total Per Ship.*
Pocket case	1
Artery forceps 1	
Dressing forceps 1	
Finger knife 1	
Curved bistoury 1	
Ditto, blunt point 1	
Probes 2	
Silver director 1	
Caustic stick 1	
Scissors 1	
Spatula 1	
Lancets 2	
Gum lance 1	
Needles in vaseline	12
Suture silk (4 sizes)	1 reel.
Fergusson's small saw	1
Amputating saw	1
Amputating knives	2
Dissecting forceps (large)	1 pair.
Spencer Wells	2 pairs.

Instruments (continued).	*Total Per Ship.*
Trephine (¾-inch)	1
Elevator	1
Trephine brush	1
Eye spud	1
Scalpels	2
Hernia knife	1
Hernia director	1
Trocars and canulæ	2 sets.
Aneurism needle	1
Tooth forceps (in roll)	7 asstd.
Tracheotomy tubes (double)	3
Trachea dilator	1
Midw. forceps (long)	1 pair.
Esmarch's tourniquet	1
Bristle probang	1
Aspirator and two needles	1
Silver catheters (Nos. 4, 8 and prost. 12)	1 each.
Soft catheters	1 set.
Clinical thermometers	2
Stethoscope	1
Drainage tubing (No. 10)	1 ft.
Silkworm gut	1 spl.

Medical Comforts :	*Per 100 Passengers.*
Arrowroot	7 lb.
Pearl barley	5 ,,
Semolina	10 ,,
Condensed milk (1 lb. tins)	30
Beef extract (¼ lb. tins)	20
Brandy	1 gal.

IV. **Turkish Scale for Pilgrim Ships.**

As was approved by the Chief Board of Health at Constantinople, on May 27, 1913.

(*Note.*—This scale was irrespective of the number of pilgrims on board.)

LIST OF DRUGS AND DISINFECTANTS REQUIRED FOR PILGRIM-SHIPS GOING TO THE HAJI.

A. Drugs.

Acid. tannicum	½ lb.
Acid. lacticum	1 ,,
Acid. tartaricum	1 ,,
Antipyrina	½ ,,
Æther	1 pint.
Atropini sulphas	15 grs.
Argenti nitras	1 stick.
Bismuthi salicylas	½ lb.
Bismuthi subnitras	¼ ,,
Caffeina	¼ oz.

Chloroformum (pure)	½ pint.
Chloral. hydras	2 oz.
Collodium	½ pint.
Digitalinum	40 tabloids of $\frac{1}{250}$ grain.
Extract. belladonnæ	2 oz.
Glycerinum	½ pint.
Hydrarg. subchlor. (calomel)	¼ lb.
Iodoformum	¼ ,,
Liquor ammoniæ	½ pint.
Linum	8 lb.
Magnesia levis	½ lb.
Magnesii sulphas	6 lb.
Naphtholis benzoas	½ lb.
Oleum camphoratum	2½ oz.
Oleum ricini	5 pints.
Potassii bromidum	¼ lb.
Potassii chloras	½ ,,
Potassii iodidum	½ ,,
Phenacetinum	½ ,,
Pulv. ipecacuanhæ	½ ,,
Pulv. ipecac. co.	4 oz.
Pulv. opii	2 ,,
Quininæ hydrochlor. acid.	3 ,,
Quininæ sulphas	1 lb.
Santoninum	3 drs.
Senegæ radix	½ lb.
Sinapis	4 ,,
Sodii bicarbonas	1 ,,
Sodii salicylas	12 oz.
Sodii sulphas	6 lb.
Spiritus rectificatus (strength, 90 per cent. = sp. gr., 834)	1 gal.
Tinct. digitalis	6 oz.
Tinct. ergotæ ammon.	4 ,,
Tinct. iodi	8 ,,
Tinct. ferri perchlor.	½ pint.
Tinct. opii	6 oz.
Tinct. opii crocata (Sydenham's laudanum)	1 pint.
Unguentum hydrargyri	1 lb.
Vaseline	3 lb.

B. Serums and Vaccines.

	In flasks of 20 *c.c.*
Yersin's serum	5
Haffkine's vaccine (Plague)	1 (of 10 c.c.)
Kolle's vaccine (Cholera)	2
Antidysenteric serum (Polyvalent)	5
Smallpox lymph	20 tubes.

C. Disinfectants.

Carbolic acid (crystals)	¼ oz.
Carbolic acid (crude)	4 ,,
Sulphuric acid	2½ ,,
Corrosive sublimate	8 lb.
Chloride of lime	100 ,,

Permanganate of potash	10 lb.
Potassium carbonate (crude)	8 oz.
Formalin solution, 40 per cent.	3 pints.
Solution of chlorinated potash (Eau de Javelle)	10 ,,
Copper sulphate	6 lb.
Ferrous sulphate	6 ,,
Sponges, brushes, etc.	

D. INSTRUMENTS, DRESSINGS, ETC.

Scales (to ½ c. gr.)	1 pair.
Pestle and mortar (glass)	1 ,,
Pestle and mortar (stone)	1 ,,
Spatulæ	2 ,,
Measure glasses (assorted)	12 ,,
Catheters (gum elastic)	3 ,,
Irrigators	2 ,,
Syringes (glass, urethral)	5 ,,
Syringes (Pravaz)	3 ,,
Mustard plasters	50 ,,
Lead plaster	2 boxes.
Clinical thermometers	2
Plaster of Paris bandages	10
Absorbent bandages (2″)	20
,, ,, (4″)	20
Absorbent wool	11 lb.
Sterilised gauze	1 ,,
First-aid instruments	1 case.

These lists speak for themselves and very little comment is necessary.

From the allowance of clinical thermometers, it is obvious that the Board of Trade have never sailed the deep as a Ship's Surgeon! It will also be noticed that no other diagnostic impedimenta are included—not even microscope slides.

APPENDIX III

SIGNALLING CODES

At first sight it may seem strange that a flag alphabet and an appendix on signalling should find a place in a book on medical matters.

Reflection, however, will show that a certain knowledge of signalling, as well as a familiarity with details of ship construction, etc., are but integral parts of the many-sided technical education which should contribute to the making of a complete Marine Health Officer. In his work afloat such Health Officer will have to deal with ships flying innumerable national ensigns, house-flags, and flag signals. Some of the latter may be of urgent importance, and many of them may give indications of the necessity for his presence aboard, or for sanitary action. He should therefore have the subject at his fingers' ends.

People of British stock—a race so largely dowered with the curse of Reuben—are to be found all over the earth's surface. The marine aspects of the war have especially brought home to us the need of preparation for any emergencies in life; and no one can tell at what moment the lives of himself and party may not be dependent on his knowledge of signalling. Over trackless oceans, burning deserts, or polar snows, a sentence may spell salvation. This is one of its general applications, and for that reason a competent knowledge of the Morse code should be insisted on as part of the general education of every British boy, and kept up through life.

Three main types of signalling are employed: Morse, semaphore, and flag codes. The flag code is dealt with in the next section of this Appendix.

The semaphore has only a limited range of applicability and concerns the professional signaller only.

The Morse code is, however, of the utmost importance. It is easy to learn and has a wide range of usefulness. The principle is that of various combinations of "dots" and "dashes" to express the alphabet. These are used over the telegraph systems of the world, the signals being transmitted by a small hand-key. The Morse alphabet can also be used in many other ways. It can be heliographed over immense distances by day, and transmitted by lamp over long distances by night. Or it may be adapted to the hand dipping of a handkerchief or small flag on a stick, which can be read at a considerable distance by using a telescope.

The Morse Alphabet is as follows:

A	· —	N	— ·
B	— · · ·	O	— — —
C	— · — ·	P	· — — ·
CH	— — — —	Q	— — · —
D	— · ·	R	· — ·
E	·	S	· · ·
F	· · — ·	T	—
G	— — ·	U	· · —
H	· · · ·	V	· · · —
I	· ·	W	· — —
J	· — — —	X	— · · —
K	— · —	Y	— · — —
L	· — · ·	Z	— — · ·
M	— —		

Although much practice is needed to read and transmit the code fluently, yet its memorisation is not as difficult as would at first sight appear.

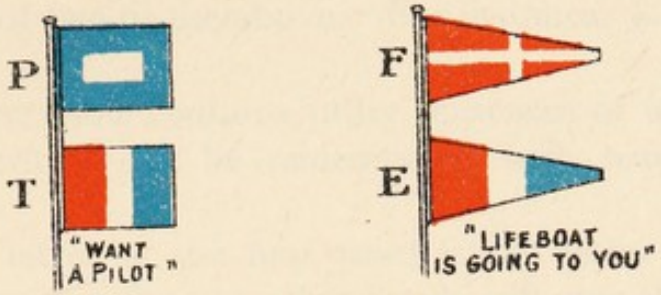
Cable employees have many mnemonic phrases to help the beginner—*e.g.*, "Earwigs infest summer houses." The initial letters give the ascending "dot" series, and so on.

The following appears to me, however, to be the simplest way to remember the alphabet:

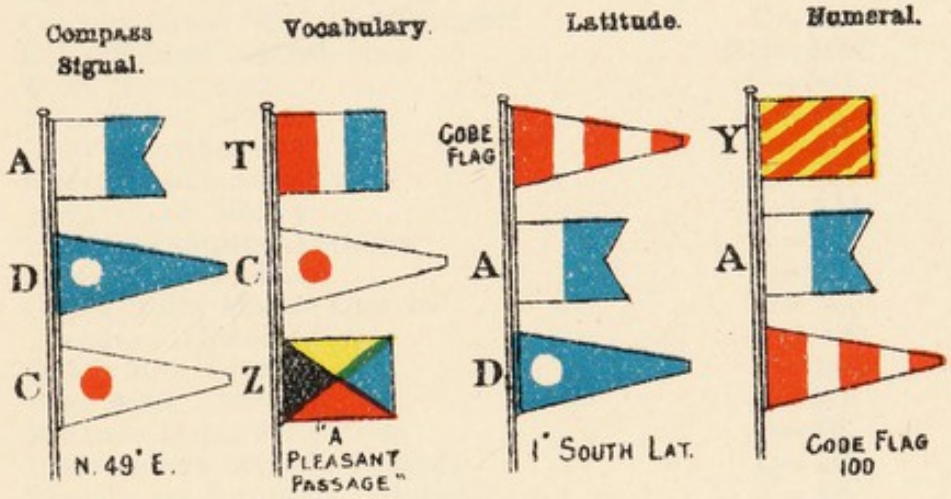
There are six letters which are represented by only two or less symbols. These can easily be learnt:

E	·	N	— ·
I	· ·	M	— —
A	· —	T	—

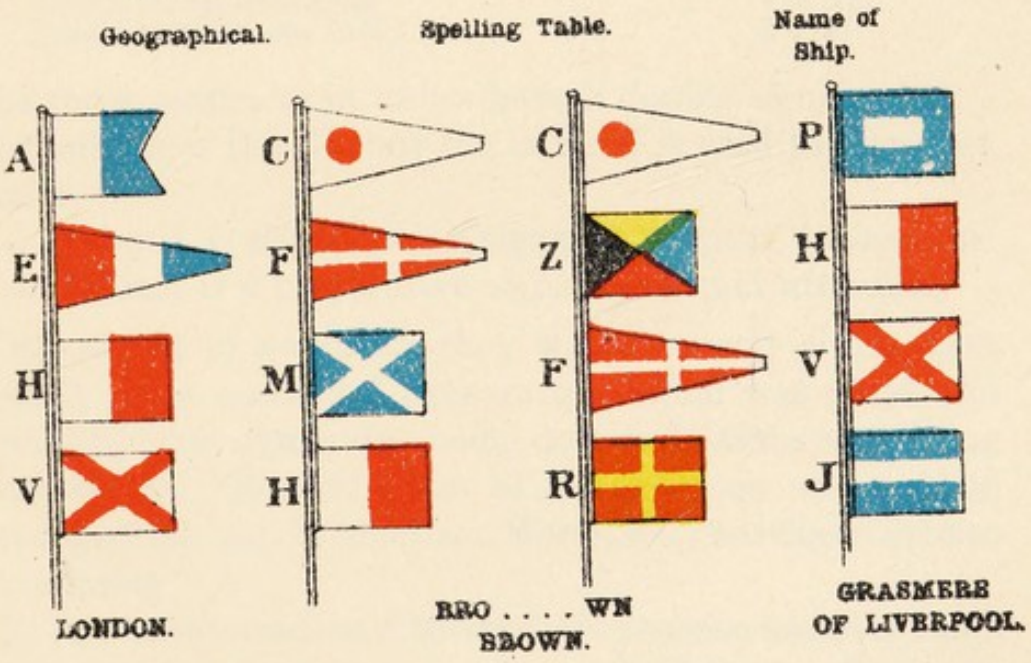
EXAMPLES OF TWO FLAG SIGNALS.



EXAMPLES OF THREE FLAG SIGNALS.



EXAMPLES OF FOUR FLAG SIGNALS.



All the other letters of the alphabet can be resolved into combinations of two of the above. For instance, J = AM and so on.

The following table contains pithy sentences of only three words each, which can be remembered with scarcely any effort.

The initial letter of the first word is the letter required. The initial letters of the two other words will give the symbol for the required letter.

Bankbook Negative Indication	B = NI
Consumptives Need Nourishment	C = NN
CHeerfulness Maketh Man	CH = MM
Duty Never Ends	D = NE
Fleas Infest Natives	F = IN
Gold Tarnishes Not	G = TN
Heat Induces Insomnia	H = II
Jews Amass Money	J = AM
Kissing Tempted Anthony	K = TA
Lost : Again Indicate	L = AI
Opportunity Makes Thieves	O = MT
Prepare : Alphabet Now	P = AN
Quick Men Advance	Q = MA
Rest After Exercise	R = AE
Solitude Induces Egotism	S = IE
Undertakers Intrude Terribly	U = IT
Ventilation Improves Atmospheres	V = IA
Watch Exemplary Men	W = EM
X Needs Answer	X = NA
Youth Needs Managing	Y = NM
Zenanas Missionise India	Z = MI

The three sentences in italics have a double significance.

Not only does B = NI, but the letter B is used to express a negative.

L = AI, but L is also used as a signal to " repeat " a message.

P = AN, and is a preparative signal to attract attention.

With regard to *numerals*, they were formerly either spelt at length, or a numerical preparatory signal was given and followed by code numerals—being dots and dashes resembling certain letters. Various codes of numerals are still used in Army Signalling and in American Morse, etc.; but these systems are confusing.

The recent International Morse Code revision has now made *each* of the ten digits into a *five-symbol* signal. Numerals can thus be introduced into an ordinary alphabetical message

without any preparatory signal, since they cannot be confused with letters, none of which have more than four elements.

The following are the International Morse numerals:

1	· — — — —	6	— · · · ·
2	· · — — —	7	— — · · ·
3	· · · — —	8	— — — · ·
4	· · · · —	9	— — — — ·
5	· · · · ·	0	— — — — —

Flag Signalling.

The special interest of the subject, as far as the scope of this book is concerned, will chiefly lie in the *flag alphabet*, and the combinations thereof, which go to make up what is known as the International Code of Signals.

Beyond a knowledge of the flag alphabet, little more can be mastered—it is necessary to consult the Code Book. But the Health Officer will frequently see signals flown during his rounds afloat, and, as he will not probably have the cumbersome Code Book with him, a selection of the more common signal combinations is here arranged alphabetically. All that is necessary, therefore, is to learn the flag alphabet, which is given as a frontispiece to this book, and then to consult the list in this section.

Before giving the abbreviated code list, it will be as well to remark on the principles of the scheme.

There are twenty-six different flags representing the twenty-six letters of the English alphabet.

There is also a *code flag* (or " answering pennant ") which is a tapering flag having three vertical red stripes separated by two vertical white ones.

The code flag flown over a single letter is descriptive or explanatory.

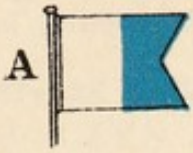
Two-flag signals are urgent messages.

The code flag *over* two flags, covers signals concerning latitude, longitude, time, barometer, and thermometer.

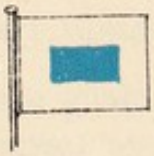
The code flag *under* two flags is an alternative method for numerals—little used.

SPECIAL FLAGS OF THE NEW INTERNATIONAL CODE

Which may be hoisted singly and which have special significance. Also Pilot Flags and Distant Signals, and Signals of Distress.



Burgee A.
Flown by vessels of H.M. Navy when on Full Speed Trials in the waters of the U.K.



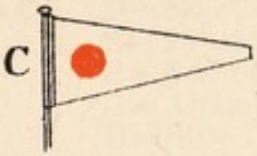
Flag S.
The International Pilot Signal, "I require a Pilot."



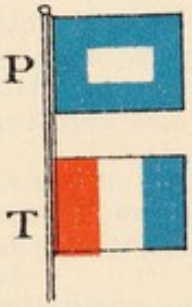
Burgee B.
Powder Flag.
Is always to be hoisted by a vessel when loading or discharging Gunpowder or Explosives



Pilot Jack, M.S. Act, 1894.
The Union Jack, with a White border one-fifth the width of the Flag.



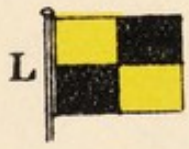
Pennant C.
"Yes."
Affirmative.



The International Code Pilotage Signal,
"I want a Pilot."



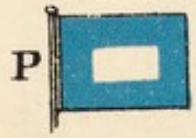
Pennant D.
"No."
Negative.



Flag L.
Cholera, Yellow Fever, or Plague Flag, or "I have (or had) some dangerous infectious disease on board."

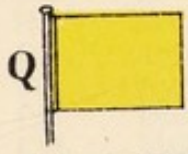


The Distant Signal for a Pilot,
"I want a Pilot."

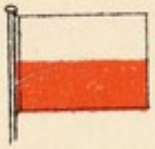


Flag P.
The Blue Peter, is the signal for all persons to repair on board, as the vessel hoisting it is about to sail.

Section 615 (3) of M.S. Act, 1894, provides, that if any Master of a vessel displays or permits any under his authority to display any of the Pilot Signals for any purpose than to call a Pilot, he shall be liable to a fine not exceeding twenty pounds.

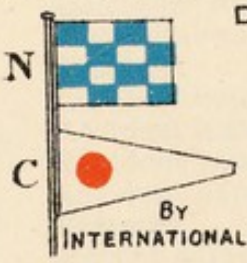


Flag Q.
Quarantine, Hospital, (used foreign).
In British waters it signifies, "I have a clean bill of health, but am liable to Quarantine.



Pilot Boat Flag, in British Pilotage waters, M.S. Act, 1894. A small flag of same colour is also shown on the rigging or about the bridge, when a Pilot is on board.

DISTRESS SIGNALS.



By International Code



By Distant Signal



By Distant Signal

Three-flag signals A—AST refer to compass bearings: ASU—BDZ refer to coinage and weights and measures; BEA—CWT comprise auxiliary phrases; *CXA—ZMR comprise a general vocabulary of all ordinary signals.*

Four-flag signals ABCD—BFAU are geographical signals; CBDF—CZYX comprise an alphabetical spelling table—an alternative method of spelling words.

Other four-flag signals are registered names of ships.

ABBREVIATED SIGNAL TABLE.

Code over C = Yes.
,, ,, D = No.
,, ,, E = Subsequent signals are alphabetical, not code.
,, ,, F = End of each word when signalling alphabetically.
,, ,, G = Alphabetical signals ended.
,, ,, H = Stop! Have something important to communicate.
,, ,, I = Unclean Bill of Health.
,, ,, L = Dangerous infectious disease on board.
,, ,, M = Subsequent signals numerical, not code.
,, ,, N = Decimal point in numerical signals.
,, ,, O = Numerical signals ended.
,, ,, Q = Clean Bill of Health but liable to quarantine.
,, ,, S = Want Pilot.

AL Accident. Dangerously wounded.
AM Accident. Want a surgeon.
AT Boiler burst. Men killed.
AU Boiler burst. Men killed. Wounded.
AX Boiler burst. Killed and wounded not yet known.
AY Boiler burst. Several killed.
AZ Boiler burst Several wounded.
BI Damaged rudder. Cannot steer.
BJ Engines broken. Disabled.
BN Seriously damaged.
BO All boats lost.
BR Man overboard.
BS Accident.
BZ Aground.
CE Aground. Send assistance.
CL Disabled. Communicate.
CM Drifting. Want assistance.
CX Assistance impossible. Do your best.
DB Immediate assistance wanted.
DCE **Accident.**
DCF Accident happened. Crushed.
DCG Accident happened. Cut. Stab.
DCH Accident happened. Drowned.
DCI Accident happened. Gunshot wound.
DJX Farewell.
DU Repeat name. Flags not made out.
DUZ Fever and ague.
DWR Alcohol.

DXV	All right.
DZE	Sanctioned.
DZL	Not allowed.
EDX	Ambulance.
EDY	Ambulance wanted to convey patient to hospital.
EOD	Antiseptic.
EON	Any cases of fever on board ?
EPT	None. Not any.
EQB	Anyone hurt or wounded?
EQY	Aperient.
ERC	Apoplexy.
ET	Boat coming to your assistance.
EVI	Arm broken.
EVJ	Arm dislocated.
FE	Life-boat going to you.
FGL	Want medical assistance.
FGP	Doctor wants assistance.
FI	Send boats suitable for landing passengers.
FM	Allow no communication.
FNM	Medical authorities.
FP	Bad weather expected.
FPB	Await official inspection outside.
FQW	Bad case.
FR	Bar impassable.
FT	Take care. Caution requisite.
FU	Channel dangerous.
GD	Prepare for hurricane.
GJ	Thick fog coming on.
GM	You are clear of danger.
GN	Your position is dangerous.
GPQ	Contagious disease on board.
GPR	Fever broken out on board.
HB	In want of coal.
HKB	Bronchitis.
HLQ	Cattle.
HO	Have you combustibles on board ?
HP	Loaded with combustibles.
HPZ	Goodbye.
HQ	No combustibles on board.
HWI	Captain is dead.
HWO	Captain is sick.
HYD	Carbolic acid.
HZG	Live cargo.
IC	Have you had communication with infected vessels ?
IDH	Many slight cases.
IDJ	Case is for hospital.
IDK	Case is infectious.
IDL	Case of dysentery.
IDM	Case of fever.
IDN	Case of smallpox.
IDP	Slight case.
IEP	Castor oil.
IG	I have had no communication with ——
IHR	Death certificate.
IOS	Chief officer.
IPK	Chloroform.
IPR	Cholera.
IO	Rendezvous in lat. ——, long. ——.

MERCHANT FLAGS.

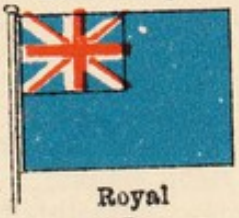
BRITISH.

White Ensign.



Man of War.

Blue Ensign.



Royal
Naval Reserve.

Red Ensign.



Mercantile
Marine.

FOREIGN.

France.



National.

Germany.



Merchant.

Sweden.



Merchant.

Norway.



Merchant.

Denmark.



Merchant.

Spain.



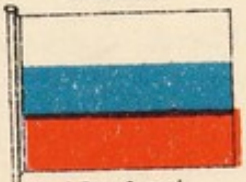
Merchant.

Italy.



Merchant.

Russia.



Merchant.

Japan.



Merchant

U.S.A.



National.

Greece.



Merchant.

Belgium.



Ensign. Man of
War & Merchant.

Brazil.



Ensign.

Austria-Hungary.



Merchant.

China.



Merchant.

JD	You are standing into danger.
JE	Beware of derelict.
JY	Will you take despatches ?
KCR	Crew healthy.
KCW	Crew sick.
KN	Get under way quickly.
KNX	To-day.
KOW	Death.
KQA	Deck passengers.
KZ	Anchor instantly.
LEG	Passengers must be disembarked.
LES	Disinfected.
LG	Go ahead.
LJ	Go astern.
MFE	Enteric fever.
ML	Stop.
MQ	Engines disabled.
MR	Main shaft broken.
MS	Screw disabled.
MWG	Fever.
MWK	Had yellow fever on board.
MWL	No yellow fever on board.
MWN	Intermittent fever.
MWO	Is there yellow fever at —— ?
MWP	Jungle fever.
MWQ	Malarial fever.
MWR	Scarlet fever.
MWS	Typhoid fever.
MWT	Yellow fever.
NA	Aground. Want assistance.
NC	**Distress.** Want immediate assistance.
NF	Dying for want of water.
NH	Fire, or leak. Send assistance.
NM	Am on fire.
NO	Sinking. Send boats for passengers and crew.
NS	In distress. Want assistance.
NV	Provisions short. Starving.
OR	Fire amongst cargo.
OXT	Whooping cough.
OYE	Horses.
OYP	Hospital.
OYQ	Can I send sick to hospital ?
OYR	Hospital case.
OYU	Require hospital treatment.
OYV	Send to the hospital.
PCS	Illness.
PCU	Have illness on board.
PCX	Infection amongst passengers or crew.
PJG	Infected.
PJH	Have infectious cases on board,
PJV	Influenza.
PT	**Pilot wanted.**
RA	Lighter adrift.
RC	Lighters wanted quickly.
RDN	Vaccine lymph.
RI	Hot bearings.
ROJ	Medical officer.
RZ	Where am I ?

SAV	Mosquito.
SIU	Nobody.
SPI	Boarding Officer.
TE	Wait for orders.
TIF	Pigs.
TLQ	Plague.
TP	Am in quarantine.
TQ	Clean Bill of Health.
TR	Are you from infected port ?
TS	I have pratique.
TU	Have you clean Bill of Health ?
TV	Hoist quarantine flag.
TW	You have pratique.
TUZ	Can I land my sick ?
UCH	Purgative.
UDZ	Quarantine.
UEF	Quarantine Officer.
UEG	Quarantine station.
VE	Annul last hoist. Will repeat.
VM	Cannot read your flags. Make distant signals.
VUK	Sheep.
WAZ	Are there sick nurses to be got ?
WBA	Have you had sickness on board ?
WK	Have you a surgeon ?
WL	May I send sick to see your surgeon ?
WN	Surgeon will come immediately.
WO	Want surgeon. Send nearest.
WP	Will your surgeon come on board ?
XFZ	Surgeon.
XGQ	Suspected.
XUO	To-morrow.
XUQ	To-night.
YE	Want assistance.
YFS	Typhus fever.
YI	Want coal immediately.
YL	Want immediate medical assistance.
YM	Want lighter immediately.
YMI	Urgent.
YN	Want police.
YO	Want provisions immediately.
YP	Want a tug.
YR	Want water immediately.
YVB	Water.
YVG	Short of water. Want some.
YX	War is declared.
ZBH	Welcome.

A glance through the above code list will show that no medical man was consulted when the code was compiled, for two different signals (MWS and MFE) express "typhoid fever."

Nor does much discriminative common sense appear to have been exercised by the compilers, for at least six different signals may be used by a ship who wants to call a Surgeon !

The code list as here given is, of course, very abbreviated, but will be found to contain most signals of importance to the Health Officer, and many non-medical signals in common use which he may meet with.

Some of the signals, such as DWR, DXV, EQY, ERC, etc., may be used as handy abbreviations for entries in the Ship's Surgeon's Medical Log-book.

APPENDIX IV

MARINE DATA

Water Measurements.

1 *gallon* (277·27 cubic inches) weighs 10 *lb.* (distilled water).

224 *gallons* (35·943 cubic feet) = 1 *ton.*

4	gills	= 1 pint	= 20 fl. oz.
2	pints	= 1 quart	= 40 fl. oz.
2	quarts	= 1 winchester quart	= 80 fl. oz. = ½ gallon.
4	,,	= 1 gallon	= 160 fl. oz.
31½	gallons	= 1 barrel.	
2	barrels	= 1 hogshead.	

The old measurement of water for ships was:

18	gals.	= 1 kilderkin.
36	,,	= 1 barrel.
72	,,	= 1 puncheon.
110	,,	= 1 butt.
210	,,	= 1 tun.

Ship Measurements.

The ton-measurement of cargo was originally the space occupied by 4 hogsheads = a tun of wine = 50 cubic feet. It is now 40 cubic feet, which is approximately the bulk of 4 quarters, or a short ton, of wheat.

The *ton-register*, the unit of capacity of a ship, was originally the space occupied by a last of 10 quarters of wheat = 100 cubic feet. This cubic space is the ton-register used by all maritime nations, 100 English cubic feet.

Gross tonnage is the sum in cubic feet of all the various enclosed spaces of a vessel, divided by 100.

Net tonnage is the gross tonnage *less* certain deductions on account of crew spaces, engine room, water ballast, and other spaces not used for passengers or cargo.

Dead-weight tonnage, or carrying capacity, is the number of tons (of 2,240 lb.) of cargo that a vessel is capable of carrying when charged to the load water line (*q.v.*).

Displacement tonnage is the number of tons of sea water displaced by a vessel when charged to the load water line (*q.v.*).

Load water line is the line that would be made round the shell of a vessel when loaded as deep as the minimum freeboard regulations permit.

Draught is the distance in feet from the lowest part of the bottom of a vessel to the actual water line at which the vessel is floating. Thus the load water line marks the greatest, or loaded, draught of a vessel. A vessel without any cargo in her hold or passengers or their luggage aboard is said to be "light ship," or "light," or "in ballast."

Free Board is the distance from the main or upper deck to the load water line of a vessel. As a general rule the minimum free board provides an amount of reserve buoyancy that will keep a vessel afloat with two compartments holed.

Linear Measurements.

A *Geographical Mile* is the length of one minute of latitude, If the earth was a sphere, every minute of latitude would be of the same length; but, as it is a spheroid, the length of a minute increases from 6,046 feet at the equator to 6,108 feet at the poles. The mean length of the geographical mile is 6,076·8 feet. The *Nautical Mile* is (strictly speaking) the length of a minute of the meridian, and is thus identical with the geographical mile. In practice, however, it is taken as the *Admiralty Knot* of 6,080 feet, divided into 10 cables, which are assumed to be 100 fathoms, or 600 feet.

In rough practice the following are used:

6 ft.	=	1 fathom.
60 ,,	=	10 fathoms.
600 ,,	=	100 ,, = 1 cable.
6,080 ,,	=	10 cables = 1 knot, or nautical mile.
6,082·66 ,,	=	1 geographical mile.
5,280 ,,	=	1 statute mile.

Time and Watch on Board Ship.

Time is announced by means of a bell hit with a clapper by hand. The bell is struck every half-hour. In the *morning* 1 bell sounds at 12.30 a.m., and every half-hour the number

increases until 8 bells at 4 a.m.; then 1 bell again at 4.30 a.m. to 8 bells at 8 a.m.; 1 bell at 8.30 a.m. and 8 bells at noon. In the *afternoon* 1 bell sounds at 12.30 p.m. and 8 bells at 4 p.m., after which is the *First Dog Watch* (1 bell 4.30, 2 bells 5.0, 3 bells 5.30, 4 bells 6.0) and the *Second Dog Watch* (1 bell 6.30, 2 bells 7.0, 3 bells 7.30, 4 bells 8.0), and thence 1 bell at 8.30 to 8 bells at midnight.

Watch.—For purposes of discipline, and to divide the work fairly, the crew is mustered in two divisions: the *Starboard* (right side, looking forward) and the *Port* (left). The day commences at noon, and is thus divided:

Afternoon *Watch*	.. .. ..	noon to 4 p.m.
First Dog ,,	.. .. ..	4 p.m. to 6 p.m.
Second Dog ,,	.. .. ..	6 p.m. to 8 p.m.
First ,,	.. .. ..	8 p.m. to midnight.
Middle ,,	.. .. ..	midnight to 4 a.m.
Morning ,,	.. .. ..	4 a.m. to 8 a.m.
Forenoon ,,	.. .. ..	8 a.m. to noon.

This makes seven Watches, which enables the crew to keep them alternately, as the Watch which is on duty in the forenoon one day has the afternoon next day, and the men who have only four hours' rest one night have eight hours the next. This is the reason for having *Dog Watches*, which are made by dividing the hours between 4 p.m. and 8 p.m. into *two* Watches.

The Use of Masks for Influenza Work, etc.

This matter was investigated by Dr. Cumpston during the recent influenza in Australia. His findings are as follows:

The objects for which masks appeared to be required were:—

(1) Protection of officers and employees whose duties brought them into contact with infected vessels or infected persons.
(2) Limitation of range of infected sputum from patients, the mask being worn in this case by the patient.
(3) Mitigation of risks of possible conveyance of infection by officers boarding uninfected vessels during observational detention, and during necessary communication between station staff and persons from outside.
(4) Psychological advantages from sense of protection experienced by nervous persons.

The types of masks employed at various station hospitals included the following:—

(1) Full hood descending to or below shoulders, with or without celluloid eye pieces.
(2) Short hood, with or without celluloid eye pieces, tied under the chin.
(3) Wire-frame mask, fitting over the nose and mouth and secured by tapes or ear loops.
(4) Plain rectangular fold covering nose and mouth and extending over the cheeks. This was variously combined with goggles, and with wool plugs designed to filter air passing down alongside the nose.

Various antiseptics were used to moisten the masks, principally 1 in 20 carbolic.

The material used for masks consisted of gauze in various thicknesses, or plain lint in two thicknesses with the soft sides in approximation.

The defects noticed in the practical application of masking comprised:

(1) Obstruction to respiration. With thick masks, this was very noticeable, especially in warm weather, causing discomfort from insufficient supply of air, and the rebreathing of partly respired warm air.
(2) Heat and stuffiness. This is the principal drawback to the hood type in warm weather.
(3) Inaccurate fitting. This may be due either to incorrect type or adjustment of frame masks, or to careless wearing. Frame masks may be improved by fitting a small roll of cotton-wool on the border-wire and moulding the frame accurately to the facial outline. The use of wool plugs alongside the nose is necessary to insure accurate fitting of the rectangular type of flat mask. This type should be of proper size, at least 8 inches by $4\frac{1}{2}$ inches for an adult, and should be properly secured to fit closely around the chin and cheeks.
(4) Careless wearing. This is the principal defect of all patterns of mask, and there is a decided, and even unconscious, tendency to slip a frame or flat mask up, in order to obtain freedom of breathing.
(5) Neglect of cleanliness or antiseptic precaution. These essentials require constant attention, and there appears to be an obvious risk in the replacement of a used mask with the exposed side inwards.

From observation of the extreme difficulty encountered in securing the proper and careful use of masks amongst quarantine staffs, who might be expected to recognise the risks constantly before them, and who worked under close discipline, there would appear to be little value in any compulsory scheme of public masking, so far as actual protection from infection is concerned.

The value of masks in practice would appear to be limited to protection against gross infection at short range, under conditions involving short duration to exposure, and to be determined by the make, fitting, and use of the apparatus. The observations of Teague and Strong in

connection with mask protection against pneumonic plague go to show that, for absolute protection from droplet infection by the *Bacillus prodigiosus* for even short periods, an elaborate hood of several thicknesses of Canton flannel is required. This is incompatible with the requirements of ordinary ward or station work in warm weather. Short of absolute protection, however, a properly fitting flat mask of two thicknesses of lint, or six or more thicknesses of close woven gauze, with nose plugs of wool, appeared to afford very substantial protection, if the defects involved above were avoided.

APPENDIX V

THE INTERNATIONAL SANITARY CONVENTION OF PARIS, 1911-12.

(Up to the end of Article 142.)

PART I.

CHAPTER I

PROVISIONS TO BE OBSERVED BY THE COUNTRIES SIGNING THE CONVENTION ON THE APPEARANCE OF PLAGUE, CHOLERA, OR YELLOW FEVER IN THEIR TERRITORY.

Section I.—Notification.

1. Every Government must immediately notify to the other Governments the first appearance of recognised cases of Plague, Cholera, or Yellow Fever in its territory.

2. Such notification shall be accompanied, or very promptly followed, by detailed information as to:

(1) Where the disease has appeared;
(2) the date of its appearance, its source, and its type;
(3) the number of known cases and deaths;
(4) the extent of areas affected;
(5) in the case of Plague, the presence of that disease or of unusual mortality among rats or mice;
(6) in the case of Yellow Fever, the presence of *Stegomyia fasciata;*
(7) the measures taken immediately on the first appearance of the disease.

3. The notification and the information prescribed in Articles 1 and 2 shall be supplied to the Diplomatic or Consular Agencies in the capital of the infected country.

In the case of countries not represented there, the notification and the information shall be telegraphed direct to the Governments of these countries.

4. The notification and the information prescribed in Articles 1 and 2 shall be followed by subsequent communications furnished regularly, and in such fashion as to keep the Governments informed of the course of the epidemic.

These communications shall be made at least once a week, shall

be as complete as possible, and shall, in particular, indicate the precautions adopted with a view to prevent the spread of the disease.

They must set out with precision:

(1) The preventive measures taken in the way of sanitary inspection or of medical investigation, of isolation, and of disinfection;
(2) the measures adopted in the case of outgoing vessels to prevent exportation of the disease, and particularly in the case contemplated in Article 2 (4) the measures taken against rats.

5. It is of primary importance that the foregoing provisions be promptly and scrupulously complied with.

Notification is of no real value unless every Government be itself informed, in time, of cases of Plague, Cholera, and Yellow Fever, and also of doubtful cases occurring in its territory. It cannot therefore be too strongly impressed on the several Governments that they should make notification of Plague, Cholera, and Yellow Fever compulsory, and that they should keep themselves informed as to any unusual mortality among rats or mice, particularly in ports.

6. It is to be understood that neighbouring countries reserve to themselves the right to make special arrangements, with the object of organising direct exchange of information between the principal administrative officers on their frontiers.

Section II.—Conditions causing Local Area to be regarded as Infected.

7. The notification of a first case of Plague, Cholera, or Yellow Fever shall not lead to the adoption of the measures prescribed in the following Chapter II. against the local area in which the case has occurred.

But when several non-imported cases of Plague or Yellow Fever have occurred, or when the cases of Cholera constitute a foyer (*i.e.*, a centre of dissemination) the local area shall be declared infected.

8. In order that the measures be limited to places which are infected, the Governments must apply them to arrivals from infected local areas only.

"Local Area" means a portion of territory clearly defined in the information that accompanies or follows notification—as, for instance, a province, a "government," a district, a department, a canton, an island, a commune, a town, a quarter in a town, a village, a port, a polder, an agglomeration, etc., whatever may be the extent and population of these portions of territory.

But this limitation to the infected local area must be accepted only on the definite condition that the Government of the infected country take the measures necessary:

(*a*) In case of Plague or Cholera for preventing the export of the things specified in Article 12 (1) and (2) derived from the infected local area, unless previously disinfected, and
(*b*) for checking the spread of the epidemic.

When a local area is infected, no restrictive measure shall be taken against arrivals from that local area, if they have left it not less than five days before the beginning of the epidemic.

9. In order that a local area cease to be regarded as infected it must be officially established:

(1) That no death from, nor fresh case of, Plague or Cholera, has occurred within the five days, or, in case of Yellow Fever, within the eighteen days following either the isolation or death or recovery of the last case of Plague or Cholera or Yellow Fever.

(2) That since the isolation, death or recovery of the last case, no fresh case nor death shall have occurred during a period of five days as regards Cholera or Plague, and eighteen days as regards Yellow Fever.

(3) That all measures of disinfection have been carried out, and that, in the case of Plague, measures have been taken against rats and in the case of Yellow Fever against mosquitoes.

10. (1) The competent authority shall take effectual measures to prevent the embarkation of persons showing symptoms of Plague, Cholera, or Yellow Fever;

(2) in the case of Plague or Cholera, to prevent the exportation of such merchandise or articles of any sort, as it may regard as infected and which have not previously been disinfected on shore, under the supervision of a doctor appointed by the public authority;

(3) in the case of Plague, to prevent rats gaining access to ships;

(4) in the case of Cholera, to see that drinking water taken on board is wholesome;

(5) in the case of Yellow Fever, to prevent mosquitoes gaining access to ships.

CHAPTER II

Measures of Defence by other Countries.

Section I.—Publication of Measures.

11. The Government of each country shall immediately make public the measures which it considers necessary to prescribe with regard to arrivals from an infected country or local area.

It shall forthwith communicate these measures to the Diplomatic or Consular Agent of the infected country resident in the capital, and also to the International Sanitary Boards.

It shall also communicate, through the same channels, the withdrawal of these measures or any modifications of them. In the absence of a Diplomatic or Consular Agency in the capital, the communications shall be made direct to the Government of the country concerned.

Section II.—Merchandise and Disinfection.

12. No article of merchandise is in itself capable of conveying Plague, Cholera, or Yellow Fever.

13. Disinfection may not be carried out except in the case of Plague or Cholera, and only such merchandise and things as the Local Sanitary Authority considers infected may be subjected to disinfection. Provided always that in the case of Plague or Cholera the merchandise, or things hereinafter specified, may be subjected to disinfection, or their importation may even be prohibited, irrespective of any evidence as to whether or not they are infected:

(1) Body-linen, wearing apparel, bedding that has been in use. But when these things are carried as baggage, or in consequence of a change of abode (household goods), their importation may not be prohibited, but they shall be dealt with as prescribed in Article 20.

Soldiers' or sailors' kits, returned to their country after their death, are to be regarded as of the nature of the things specified in the first sentence of (1) of this Article.

(2) Rags, save, in the case of Cholera, rags compressed and carried in bound bales as merchandise in bulk.

The importation of the following articles may not be prohibited: Fresh waste derived directly from spinning, weaving, making up, or bleaching establishments, artificial wools (Kunstmolle, shoddy), and new paper clippings.

14. The transit of the merchandise and things specified in (1) and (2) of the foregoing Article may not be prohibited, if they are packed so that they cannot be manipulated on the way.

Similarly, when such merchandise and things have been so conveyed that they cannot have come into contact with contaminated articles on the way, their transit through an infected local area must not hinder their importation into the country to which they are consigned.

15. Importation of the merchandise and things specified in (1) and (2) of Article 13, shall not be prohibited if it be proved to the satisfaction of the country to which they are consigned that they were despatched not less than five days before the commencement of the epidemic.

16. It rests with the authority of the country to which the merchandise and things are consigned to decide in what manner and at what place disinfection shall be carried out, and what shall be the methods adopted to secure destruction of rats, insects, and mosquitoes. These operations must be performed in such fashion as to injure articles as little as possible. Clothes, rags, infected dressings, papers, and other articles of small value, may be destroyed by fire.

It rests with each State to settle questions of consequent compensation for damage caused by measures of disinfection or destruction of the things referred to above or of rats, insects, or mosquitoes.

If on account of measures taken to secure destruction of rats, insects,

or mosquitoes, on board ship, charges are levied by the Sanitary Authority either directly or indirectly through a company, or a private person, the rates of these charges must be in accordance with a tariff made public beforehand, and so drawn up that the State or the Sanitary Authority shall, on the whole, derive no profit from its application.

17. Letters and correspondence, printed matter, books, newspapers, business documents, etc. (not including parcels, conveyed by post), shall not be subject to disinfection or to any restriction whatsoever.

In the case of Yellow Fever, parcels conveyed by post shall not be subject to disinfection or to any restriction whatsoever.

18. Merchandise, whether it has come by land or by sea, may not be detained at frontiers or at ports. The only measures that may be taken are those specified in the foregoing Articles 13 and 16.

Provided always that if merchandise which has come by sea and is either not packed or imperfectly packed has become infected during the voyage by rats ascertained to have plague, and if such merchandise cannot be disinfected, the destruction of the germs may be secured by storing the merchandise during a period not to exceed two weeks.

It is to be understood that the application of this measure shall not in any way delay the ship nor give rise to extra expenses by reason of deficient storage accommodation in any port.

19. When merchandise has undergone disinfection in accordance with the provisions of Article 13 or has been temporarily stored in virtue of the proviso contained in Article 18, the proprietor of such merchandise or his representative has the right to exact from the Sanitary Authority that has ordered the disinfection or the storage a certificate showing the measures that have been taken.

20. *Baggage.*—Soiled linen, clothing, and articles carried as baggage or as household goods, from a local area declared to be infected shall not undergo disinfection except in the case of Plague, Cholera, etc., only in those instances where the Sanitary Authority considers them infected.

Section III.—Measures at Ports and Land Frontiers.

A. *Classification of Ships.*

21. A ship shall be regarded as infected if there is Cholera, Plague, or Yellow Fever on board, or if there have been one or more cases of Plague, Cholera, or Yellow Fever on board within seven days.

A ship shall be regarded as suspected if there have been cases of Plague, Cholera, or Yellow Fever on board at the time of departure or during the voyage, but no fresh case within seven days.

A ship shall be regarded as healthy notwithstanding its having come from an infected port, if there has been no death from nor case of Plague, Cholera, or Yellow Fever on board, either before departure, or during the voyage, or on arrival.

B. *Measures in Case of Plague.*

22. In the case of Plague, infected ships shall undergo the following measures:

(1) Medical inspection.
(2) The sick shall immediately be disembarked and isolated.
(3) Persons who have been in contact with the sick and those whom the Port Sanitary Authority has reason to consider suspect, shall be disembarked if possible. They may be subjected to observation or surveillance or to a period of observation followed by surveillance, provided the total duration of these measures does not exceed five days from the arrival of the ship.

It rests with the Sanitary Authority of the port, after taking into consideration the date of the last case, the condition of the ship, and the local possibilities, to take that of these measures which seems to them preferable.

(4) Such soiled linen, wearing apparel, and articles belonging to the crew and passengers as are, in the opinion of the Sanitary Authority, infected shall be disinfected.
(5) The parts of the ship that have been occupied by persons ill with Plague, or that, in the opinion of the Sanitary Authority, are infected must be disinfected.
(6) The rats on board must be destroyed, either before or after discharge of cargo, as quickly as possible, and in any case within a maximum time of forty-eight hours, and in such a manner as to avoid damage to merchandise, and to the ship's plating and engines. In the case of ships in ballast, this process must be carried out as soon as possible before taking cargo.

23. In the case of Plague, suspected ships shall undergo the measures specified in (1), (4), and (5) of Article 22.

In addition, the crew and passengers may be subjected to surveillance, the duration of which, dating from the arrival of the ship, shall not exceed five days. The crew may, during the same period, be prevented from leaving the ship except on duty.

24. In the case of Plague, healthy ships shall be given free pratique immediately, whatever their health may be.

The only measures which the Authority of the port of arrival may take as regards the ships are the following:

(1) Medical inspection.
(2) Disinfection of soiled linen, wearing apparel, and other articles belonging to the crew and passengers, but only in exceptional instances when the Sanitary Authority has special reasons for regarding them as infected.
(3) The Sanitary Authority may subject ships from an infected port to a process intended to secure destruction of rats on board, either before or after discharge of cargo, although this measure must not be resorted to as a general rule. This process must be carried out as soon as possible, and in any case must not take longer than twenty-four hours, and so as to avoid damage to merchandise and to the ship's plating and engines, and

also so as not to interfere with the coming and going of passengers and crew, between ship and shore. In the case of ships in ballast, the process, if there be occasion for it, shall be carried out as soon as possible, and in any case before taking cargo.

The crew and passengers may be subjected to surveillance during a period which shall not exceed five days reckoned from that date on which the ship left the infected port. The crew may during the same period be prevented from leaving the ship except on duty.

The competent Authority at the port of arrival may in all cases exact a certificate, given on oath, from the doctor of the ship, or, in his default, from the Captain, testifying that there has not been a case of Plague on board since departure, and that unusual mortality among rats has not been observed.

25. When rats on a healthy ship have been shown by bacteriological examination to have Plague, or when unusual mortality among these rodents has been observed, the measures to adopt are as follows:

I. Ships with rats having Plague:
- (*a*) Medical inspection.
- (*b*) The rats must be destroyed, either before or after discharge of cargo, as quickly as possible, and in any case, within a maximum time of forty-eight hours, and so as to avoid damage to merchandise and to the ship's plating and engines.

  Ships in ballast shall undergo this process as soon as possible, and in any case before taking cargo.
- (*c*) Such parts of the ship and such articles as the local Sanitary Authority regards as infected shall be disinfected.
- (*d*) The passengers and crew may be subjected to surveillance during a period which must not exceed five days, reckoned from the date of arrival.

II. Ships on which unusual mortality among rats has been observed:
- (*a*) Medical inspection.
- (*b*) The rats shall be examined for Plague as far and as quickly as possible.
- (*c*) If it be considered necessary to destroy the rats, such destruction shall take place subject to the conditions specified above as regards ships with rats with Plague.
- (*d*) Until all suspicion shall have been removed, the passengers and crew may be subjected to surveillance for a period which shall not exceed five days reckoned from the date of arrival.

26. It is recommended that ships should be periodically subjected to a process of rat destruction at least once in every six months. The Sanitary Authority of the port, where the process of rat destruction has been carried out shall, whenever requested, furnish the Captain, the Ship Owner, or the Ship Owner's agent, with a certificate, stating the date of the operation, the port where it took place, and the nature of the process employed.

It is recommended that Port Sanitary Authorities in case of ships upon which periodical rat destruction is practised should take the above-mentioned certificate into account in considering what measures should be taken, especially with regard to measures taken under Article 24 (3).

C. *Measures in Case of Cholera.*

27. In the case of Cholera, infected ships shall undergo the following measures:

(1) Medical inspection.
(2) The sick shall be immediately disembarked and isolated.
(3) The other persons must also be disembarked, if possible, and either be kept under observation or subjected to surveillance during a period which shall vary with the health conditions of the ship and the date of the last case, but which shall not exceed five days reckoned from the arrival of the ship.
(4) Such soiled linen, wearing apparel, and articles belonging to the crew and passengers as are, in the opinion of the Sanitary Authority of the port, infected shall be disinfected.
(5) The parts of the ship that have been occupied by persons ill with Cholera, or that the Sanitary Authority regard as infected, shall be disinfected.
(6) The bilge-water shall be disinfected and pumped out.

The Sanitary Authority may order that a supply of wholesome drinking water be substituted for that stored on board.

Casting human excreta, or allowing them to pass without preliminary disinfection into the waters of the port may be prohibited.

28. In the case of Cholera, suspected ships shall undergo the measures prescribed in (1), (4), (5), and (6) of Article 26.

The crew and passengers may be subjected to surveillance during a period which must not exceed five days reckoned from the arrival of the ship. It is recommended that the crew be prevented during the same period from leaving the ship except on duty.

29. In the case of Cholera, healthy ships shall be given free pratique immediately, whatever their Bill of Health may be.

The only measures that the Authority of the port of arrival may prescribe as regards these ships are those specified in (1), (4), and (6) of Article 26.

The crew and passengers may be subjected to surveillance in respect of their state of health during a period which must not exceed five days reckoned from the date on which the ship left the infected port. It is recommended that the crew be prevented during the same period from leaving the ship except on duty.

The competent Authority at the port of arrival may, in all cases, exact a certificate, given on oath, from the doctor of the ship, or, in his default, from the Captain, testifying that there has not been a case of Cholera on board since departure.

D. *Measures in Case of Yellow Fever.*

30. Ships infected with Yellow Fever shall undergo the following measures:

(1) Medical inspection.
(2) The sick shall be disembarked under protection from the bite of mosquitoes and shall be duly isolated.
(3) The other persons may also be disembarked, and may either be kept under observation or subjected to surveillance during a period which shall not exceed six days from the time of arrival.
(4) Ships must be moored whenever possible 200 metres from the shore.
(5) If possible the destruction of mosquitoes must be carried out on board, before discharging the cargo. If this is not possible all necessary measures must be taken to avoid infecting the people employed in unloading. These people must be subjected to surveillance for a period not exceeding six days from the time at which they ceased to work on board.

31. In the case of Yellow Fever, suspected ships shall undergo the measures indicated under (1), (4), and (5) of the preceding Article.

In addition the crew and the passengers may be subjected to surveillance during a period which shall not exceed six days from the time of the ship's arrival.

32. In the case of Yellow Fever, healthy ships shall be given free pratique immediately after medical inspection, whatever their Bill of Health may be.

33. The measures prescribed in Articles 30 and 31 concern only those countries in which the Stegomyia exists. In other countries they shall be applied to the extent considered necessary by the Sanitary Authority.

E. *Provisions Common to all Three Diseases.*

34. In applying the measures specified in Articles 22 to 28, the fact of a ship of any of these classes before mentioned carrying a doctor and disinfecting apparatus (disinfecting chambers) shall receive due consideration on the part of the competent Authority. In the case of Plague like consideration shall be given when the ship is provided with apparatus for the destruction of rats.

The Sanitary Authorities of States that find it convenient to come to an agreement on the matter may dispense with medical inspection and other measures in the case of healthy ships carrying a doctor specially commissioned by their country.

35. Special measures may be prescribed as regards ships that are overcrowded or in an unsanitary condition, especially bacteriological examination in the case of Cholera.

36. Ships refusing to submit to measures prescribed by a Port Authority in virtue of the provisions of this convention shall be at

liberty to put out to sea. Such ships may be permitted to land goods after the following necessary precautions have been taken, viz.:

(1) Isolation of the ship, crew, and passengers.
(2) In the case of Plague, request for information as to whether there has been any unusual mortality among rats on board.
(3) In the case of Cholera, the substitution of wholesome drinking water for that stored on board, when the latter is suspected.

Such ships may also be authorised to disembark passengers at their request, on the condition that such passengers submit to the measures prescribed by the local Authority.

37. Ships from an infected place that have been disinfected and have undergone adequate sanitary measures, in a port belonging to one of the countries which adhere to the convention, shall not, on their arrival in another port, be subjected to these measures a second time, if no incident has occurred in the interval calling for fresh measures, and if they have not called at an infected port.

A ship which has merely embarked or disembarked passengers, who have not communicated with the port or infected area, and their baggage or mails, without having been in communication with the shore, shall not be regarded as having called at the port. In the case of Yellow Fever the ship must in addition have kept as far as possible from the shore, at least 200 metres, in order to prevent the access of mosquitoes.

38. The Sanitary Authority of the port imposing sanitary measures shall, when requested, furnish the Captain, the Ship Owners, or the Ship-owners' agent, with a certificate specifying the nature of the measures, and the cause of their application.

39. Passengers arriving by an infected ship are entitled to exact from the Sanitary Authority of the port a certificate showing the date of their arrival and the measures taken as regards themselves and their baggage.

40. Coasting traffic shall be dealt with by special regulations to be agreed upon by the countries concerned.

41. The Governments of States bordering upon the same sea, taking into account their particular situation, may conclude special agreements among themselves, in order to make the sanitary measures prescribed by the Convention more efficacious and less burdensome.

42. It is desirable that the number of ports furnished with an organisation and equipment sufficient for the reception of a ship should be in each country in proportion to the importance of the trade and shipping.

Meanwhile without prejudice to the right of Governments to agree to establish sanitary stations in common, every country must provide at least one port on each of its seaboards with an organisation and an equipment sufficient for the reception of a ship, whatever its health conditions may be.

Moreover, it is recommended that all large sea ports should be so equipped that healthy ships, at any rate, can there undergo the pre-

scribed measures upon their arrival and not be sent to another port for the purpose.

Governments shall make known what ports in their country are open to arrivals from ports infected with Plague, Cholera, Yellow Fever, and in particular those open to infected and suspected ships.

43. It is recommended that there be provided in large sea ports:

(*a*) A properly organised port medical service and permanent supervision of the health conditions of crew, and of the population of the port.

(*b*) An equipment for the transport of the sick, and suitable accommodation for their isolation, and for keeping suspected persons under observation.

(*c*) Bacteriological laboratories and the buildings and plans necessary for efficient disinfection.

(*d*) A supply of drinking water of quality above suspicion at the disposal of the port, and a system of scavenging that offers every possible guarantee for the removal of excrement and refuse.

44. It is likewise recommended that contracting States should take into consideration, in their treatment of arrivals from a country, the measures which this country has adopted for dealing with infectious diseases and for preventing their exportation.

Section IV.—Measures at Land Frontiers—Travellers—Railways—Frontier Tracts—Riverways.

45. Land quarantine must not be resorted to. Only such persons as show symptoms of Plague, Cholera, or of Yellow Fever may be detained at frontiers.

This principle does not deprive a State of the right to close a portion of its frontiers in case of need.

46. It is important that the railway staff keep watch over the state of health of travellers.

47. Medical intervention shall be limited to inspection of travellers and care of the sick. When this inspection is resorted to it shall, as far as possible, be combined with the Customs examination in order that travellers may suffer as little delay as possible. Only those persons who are visibly ailing shall be subjected to a thorough medical examination.

48. It is a measure of the greatest value to subject travellers that have come from an infected place on their arrival at their destination to surveillance for a period which should not exceed five days, reckoned from the date of their departure, in the case of Plague or Cholera, and six days in the case of Yellow Fever.

49. Governments have the right reserved to them of taking special measures in regard to certain classes, notably gypsies, vagrants, as well as emigrants, travelling or crossing the frontier in bands.

50. Railway carriages for passengers, mails, or luggage, may not be detained at a frontier.

If one of these carriages be infected or shall have been occupied by a person suffering from Plague or from Cholera, it shall be detached from the train for disinfection at the earliest possible moment. The same procedure shall apply in the case of goods trucks.

51. Measures relative to the crossings of frontiers by railway and postal staff come within the scope of the administrations concerned. They should be arranged so as not to hamper the service.

52. The regulation of frontier traffic and questions connected therewith, as also the adoption of exceptional measures of surveillance, must be left as matters for special arrangement between adjoining States.

53. The sanitary control of riverways is a matter for special arrangement by the Governments of States abutting thereon.

PART II.—SPECIAL PROVISIONS FOR THE EAST AND THE FAR WEST.

SECTION I.

Measures at Infected Ports on the Departure of Vessels.

54. Every person taking passage by a ship, the crew included, must be individually examined at the time of embarkation, by day and on shore, during such time as may be necessary by a doctor, appointed by the Port Authority. The Consular Authority of the country to which the ship belongs may be represented at this examination.

In exception of this provision the medical examination may at Alexandria and Port Said take place on board whenever the local Sanitary Authority considers this course to be of service, subject, however, to the reservation that third-class passengers should not afterwards be authorised to leave the ship.

The medical examination may be conducted by night in case of first and second class passengers but not in case of third-class passengers.

SECTION II.

Measures regarding Ordinary Ships from Infected Northern Ports on their Arrival at the Entrance to the Suez Canal or at Egyptian Ports.

55. Ordinary healthy ships from a port infected with Plague or with Cholera, in Europe or in the Mediterranean basin, proposing to pass through the Suez Canal, shall be granted passage in quarantine, and shall continue their voyage under five days' observation.

56. Ordinary healthy ships wishing to touch at Egypt may put in at Alexandria or Port Said, where their passengers shall complete the period of five days' observation, either on board or in a sanitary station, as the local Sanitary Authority may decide.

57. The measures to be taken as regards infected and suspected ships from a European or Mediterranean port infected with Plague or with Cholera, wishing to touch at an Egyptian port, or to pass through the Suez Canal shall be settled by the Egyptian Sanitary Board in conformity with the provisions of this Convention.

The regulations embodying these measures must, to become effective, be accepted by the several Powers represented on the Board; they shall establish the measures to which ships, passengers, and merchandise are to be subjected, and must be submitted with the least possible delay.

SECTION III.

Measures in the Red Sea.

A. *Measures regarding ordinary ships from the south, touching at Red Sea Ports, etc., bound for the Mediterranean.*

58. In addition to the general provisions comprised in Part I., Chapter II., Section III., concerning the classification of ships as infected, suspected, or healthy, and the measures regarding them, the special provisions, embodied in the following Article, shall apply to ordinary ships entering the Red Sea from the south.

59. Healthy ships must have completed or must complete five full days' observation reckoned from the time of their departure from the last infected port touched at.

They shall be entitled to pass through the Suez Canal in quarantine, and shall enter the Mediterranean continuing the above-mentioned five days' observation. Ships with a doctor and a disinfecting chamber shall not undergo disinfection prior to the passage in quarantine.

60. Suspected ships shall be treated in a manner which shall differ according as to whether they have or have not a doctor and a disinfecting apparatus (disinfecting chamber).

(*a*) Those that have a doctor and a disinfecting apparatus (disinfecting chamber) that fulfils the requisite conditions shall be allowed to pass through the Suez Canal in quarantine, subject to the Regulations prescribed for the passage.

(*b*) Those that have neither doctor nor disinfecting apparatus (disinfecting chamber) shall, before being allowed to pass through the Canal in quarantine, be detained at Suez or at Moses' Wells for such time as may be necessary for the performance of the disinfection prescribed and for assurance that the health conditions on board are satisfactory.

Passage in quarantine shall be granted to mail-boats or packets specially devoted to passenger traffic that have a doctor but no disinfecting apparatus (disinfecting chamber), if it be officially established to the satisfaction of the local authority that cleansing and disinfection have been properly carried out at the place of departure or during the voyage.

Free pratique may be granted at Suez, on the termination of the procedure prescribed by the regulations, to mail boats or packets specially devoted to passenger traffic that have a doctor but no disinfecting apparatus (disinfecting chamber), if the last case of Plague or Cholera occurred more than seven days before and if the health conditions of the ship are satisfactory.

In the case of a vessel that has had a healthy voyage of less than seven days' duration, passengers for Egypt shall be landed at an establishment appointed by the Alexandria Board and isolated for such time as may be necessary for the completion of five days' observation. The soiled linen and their wearing apparel shall be disinfected. They shall then be granted free pratique.

Ships that have had a healthy voyage of less than seven days' duration and that wish to have free pratique for Egypt shall be detained at an establishment, appointed by the Alexandria Board, during such time as may be necessary for the completion of five days' observation; they shall undergo the measures prescribed by the regulations for suspected vessels.

When Cholera or Plague has occurred among the crew only, no soiled linen shall be disinfected save that of the crew, the whole of which, however, shall undergo disinfection; the crew's quarters shall also be disinfected.

61. Infected ships shall be divided into two classes: ships with a doctor and a disinfecting apparatus (disinfecting chamber), and ships without a doctor and without a disinfecting apparatus (disinfecting chamber).

(*a*) Ships without a doctor and without disinfecting apparatus (disinfecting chamber) shall be detained at Moses' Wells; persons that show symptoms of Plague or Cholera shall be disembarked and isolated in a hospital; disinfection shall be thoroughly carried out. The other persons shall be disembarked and isolated in as small groups as possible, so that, if Plague or Cholera break out in one group, the whole party will not be affected. The soiled linen and the clothing of passengers and crew, and other articles used by them, shall be disinfected, as also shall the ship.

It is to be understood that there is no question of discharging merchandise, but only of disinfecting the infected part of the ship. The passengers shall remain five days at an establishment appointed by the Egyptian Sanitary Maritime and Quarantine Board. When cases of Plague and Cholera have not occurred for several days, the term of isolation shall be shortened. Its duration shall vary according to the date of recovery, death, or isolation of the last case.

Thus, if six days have elapsed since the recovery, death, or isolation of the last case the period of observation shall be one day; if only five days have elapsed, the period shall be three days; if only two days or one day have elapsed, the period shall be five days.

(*b*) Ships with a doctor and disinfecting apparatus (disinfecting chamber) shall be detained at Moses' Wells. The ship's doctor must state on oath which persons on board have symptoms of Plague or of Cholera. These persons shall be disembarked and isolated. After these persons have been disembarked, such of the soiled linen of the other passengers as the Sanitary Authority regards as dangerous and that of the crew shall be disinfected on board. When Plague or Cholera has occurred only among the crew, the disinfection of linen shall be carried out only as regards the soiled linen of the crew and the linen of the crew's quarters.

The ship's doctor must also declare, on oath, which part or compartment of the ship was occupied by the sick and to which section of the hospital they were removed. He must also declare on oath which persons have been in relation with the Plague or Cholera patient since the first appearance of the disease, either by direct contact or by contact with objects that may have been infected. Only these persons shall be regarded as suspected.

The part or compartment of the ship and the section of the hospital that have been occupied by the sick shall be thoroughly disinfected.

"Part of the ship" shall mean the cabin of the sick person, the adjoining cabins, the passage to the cabins, the deck, the parts of the deck where the sick person or persons have remained for some time.

If it be impossible to disinfect the part or compartment of the ship that has been occupied by Plague or Cholera sick without disembarking the persons declared to be suspected, these persons shall either be transferred to another ship specially reserved for the purpose, or be landed and accommodated in the sanitary station without being brought into contact with the sick, who must be kept in the hospital.

This stay on board ship, or on shore, for purposes of disinfection, shall be as short as possible, and shall not exceed twenty-four hours. The suspected persons shall be kept under observation, either on their own ship or on the ship reserved for that purpose, for a period which shall vary according to the circumstances and in the manner set out in the third paragraph of sub-section (*a*) of this Article.

The time occupied in carrying out the measures prescribed by the regulations shall be included in the observation period.

Passage in quarantine may, if deemed possible by the Sanitary Authority, be allowed before expiry of the periods of detention indicated above. It shall in any case be granted on the completion of disinfection if the ship leaves behind, in addition to its sick, the persons classed above as "suspected." A barge fitted with a disinfecting chamber may be brought alongside the ship with a view to hastening the process of disinfection. Infected vessels seeking free pratique in Egypt shall be detained five days at Moses' Wells; they shall, in addition, undergo the same measures as are taken in the case of infected ships arriving in Europe.

B.—*Measures regarding ordinary Ships from Infected Ports in the Hedjaz during the Pilgrimage Season.*

62. If, during the Mecca pilgrimage, Plague or Cholera is prevalent in the Hedjaz, ships from the Hedjaz or from any other part of the Arabian Coast of the Red Sea that have not there taken on board any pilgrims or like collections of persons, and on which there has been no suspicious incident during the voyage, shall be classed as ordinary suspected ships, and shall be subjected to the preventive measures and the treatment prescribed for such ships.

If they are bound for Egypt they shall undergo, at a sanitary station appointed by the Sanitary Maritime and Quarantine Board, five days' observation, reckoned from the date of their departure, whether it be Cholera or Plague that is in question. They shall, moreover, be subjected to all the measures prescribed for suspected ships (disinfection, etc.), and shall not be granted free pratique until after favourable medical inspection.

It is to be understood that, if there have been suspicious incidents on board during the voyage the period of observation shall be undergone at Moses' Wells, and shall be five days, whether it be Cholera or Plague that is in question.

SECTION IV.

The Organisation for securing Surveillance and Disinfection at Suez and at Moses' Wells.

63. Every ship arriving at Suez shall undergo the medical inspection prescribed by the Regulations. This inspection shall be conducted by one or more of the doctors attached to the station, and shall, in the case of ships from a port infected with Plague or with Cholera, be made by day.

It may, however, in the case of ships wishing to pass through the Canal, take place by night when the ship is lighted by electricity, and in all cases in which the local Sanitary Authority is satisfied that the ship is sufficiently well lighted.

64. There shall be at least seven doctors at the Suez Station—a principal Medical Officer, and six Medical Officers. They must hold a recognised diploma, and in their selection preference is to be given to medical men who have made a special study of practical epidemiology and practical bacteriology. They shall be appointed by the Minister of the Interior, on the recommendation of the Sanitary Maritime and Quarantine Board of Egypt.

The salary of the Medical Officers shall commence at 8,000 francs, and rise by progressive increments to 12,000 francs; that of the Principal Medical Officer shall commence at 12,000 francs and rise to 15,000 francs.

Should this medical staff prove insufficient, naval doctors of several States may be employed under the orders of the Principal Civil Medical Officer of the sanitary station.

65. The supervision and performance of the Suez Canal prophylactic measures at the Moses' Wells and Tor Stations shall be entrusted to a staff of sanitary guards.

66. This staff shall consist of ten guards. They shall be selected from retired non-commissioned officers of higher than corporal's rank, of the armies and navies of Europe and Egypt. These guards are elected, after the Board is satisfied as to their fitness, according to the procedure laid down in Article 14 of the Khedivial Decree of the 19th June, 1893.

67. There shall be two classes of guards—four of the first class, six of the second class.

68. The yearly pay of these guards shall be—E.£160, rising by progressive increments to a maximum of E.£200, for the first class.

E.£120, rising by progressive increments to a maximum of E.£168, for the second class.

69. These guards shall have the status of police officers with the right to invoke aid in cases where the Sanitary Regulations are infringed.

They shall be under the immediate control of the Administrator-in-Chief of the establishment at Suez or Tor.

SECTION V.

The Passage of the Suez Canal in Quarantine.

70. Permission to pass the Suez Canal in quarantine shall be granted by the Suez Sanitary Authority; the Board shall be immediately informed when such permission is given. In doubtful cases the decision shall rest with the Board.

71. When the permission provided for in the preceding Article has been given, a telegram shall at once be sent to the authority appointed by each Power. The telegram shall be sent at the expense of the ship.

72. Each Power shall issue an edict subjecting to penalties those vessels which depart from the course declared by the Captain and enter without licence one of the ports of that Power. Exception shall be made in the case of circumstances beyond control and when a break in the voyage cannot be avoided.

73. When the health visit takes place the Captain must declare if he has on board gangs of native stokers or hired servants of any description not included in the roll of the crew or the register kept for the purpose.

The following questions in particular shall be put to the Captains of all ships arriving at Suez from the South, and shall be answered by them on oath:

Have you any supernumeraries, stokers, or other hands, not included in the ship's roll or in the special register ?

What is their nationality ?

Where did you embark them ?

The Medical Officers must satisfy themselves as to the presence of the supernumeraries, and, if they find that any of their number are missing, they must inquire carefully into the cause of their absence.

74. A Sanitary Officer and two sanitary guards shall go on board. They must accompany the ship as far as Port Said; their duty is to prevent communication, and to see to the execution of the measures prescribed for the passage of the Canal.

75. All embarkation and disembarkation, and all transhipment of passengers or goods are forbidden during the passage of the Canal from Suez to Port Said.

Provided always that travellers may embark at Port Said in quarantine.

76. Ships passing through the Canal in quarantine must make the journey from Suez to Port Said without lying up.

In case of the vessel running aground, or being compelled to lie up, the necessary operations shall be carried out by the staff of the ship, all communication with the staff of the Suez Canal Company being avoided.

77. Infected or suspected transports passing through the Canal in quarantine with troops must do so only by day. If they are compelled to pass the night in the Canal, they shall anchor in Lake Timsale or in the Great Lake.

78. Ships that pass through the Canal in quarantine are forbidden to stop at Port Said, except as provided for by the second paragraph of Article 75 and by Article 79.

Revictualling must be effected by the means at the disposal of the ship.

All stevedores and others who have gone on board shall be isolated on the quarantine barge, where their clothing shall be disinfected as prescribed by the Regulations.

79. When it is absolutely necessary for ships passing in quarantine to coal at Port Said, they must do so at a place to be fixed by the Sanitary Board, where the necessary isolation and sanitary supervision can be secured. The coaling may be done by the labourers of the port, in cases where effective supervision of this operation is possible, and when all contact with the crew can be avoided. At night, the coaling places must be lighted by electricity.

80. Pilots, electricians, agents of the company, and sanitary guards shall be disembarked at Port Said outside the port, between the jetties, and shall be taken thence direct to the quarantine-barge, where their clothing shall be disinfected if necessary.

81. As regards the passage of the Suez Canal, the following advantages shall be accorded to *ships of war* as hereinafter specified:

The quarantine authority shall accept them as healthy on their presenting a certificate signed by the Ship Surgeons, countersigned by the Captain, and stating on oath—

(*a*) That there has not been, either at the time of departure or during the voyage, a case of Plague or of Cholera on board;

(*b*) that a careful examination of everyone on board, without exception, has been made within twelve hours of arrival at the Egyptian port, and that no case of either of these diseases has been detected.

These ships shall not undergo medical inspection, and shall be given free pratique at once, subject to their having completed five clear days since leaving the last infected port at which they called. Such of those ships as have not completed the requisite period may pass through the Canal in quarantine without medical inspection, provided they produce the certificate above mentioned to the quarantine authority. Notwithstanding the foregoing provisions the quarantine authority shall have the right of medically inspecting by its officers, ships of war in all instances in which it considers the procedure necessary.

Infected or suspected ships of war shall be subject to the Regulations in force.

Only fighting units shall be regarded as ships of war. Transports and hospital ships shall be classed as ordinary ships.

82. The Egyptian Maritime and Quarantine Board may arrange the conveyance by rail over Egyptian Territory of mails and ordinary passengers from infected countries in quarantine trains, under the conditions specified in Annex No. I.

SECTION VI.

Sanitary Control of the Persian Gulf.

83. The Sanitary Regulations prescribed in the Articles of this Convention shall be applied to ships entering the Persian Gulf by the Sanitary Authority of the ports of arrival, subject to the three following modifications:

(1) Observation, for the same period, shall always be substituted for surveillance of passengers and crew.

(2) Healthy ships cannot be granted free pratique unless they have completed five full days since leaving the last infected port at which they have touched.

(3) In the case of suspected ships, the period of five days' observation of passengers and crew shall be reckoned from the time at which there ceased to be a case of Plague or of Cholera on board.

PART III.—SPECIAL PROVISIONS FOR PILGRIMAGES.

CHAPTER I.

General Provisions.

84. The provisions of Article 54, Part II., are applicable to persons and things destined for the Hedjaz or Irak Arabi, that have to be taken on board a pilgrim ship even when the port is not infected with Plague or with Cholera.

85. When there are cases of Plague or of Cholera in the port, embarkation on pilgrim ships shall not take place until the persons, collected in groups, shall have been subjected to observation sufficient to ensure that none of them are suffering from Plague or Cholera.

It is to be understood that, as regards the adoption of this measure, every Government may take local circumstances and possibilities into account.

86. If local circumstances permit, pilgrims must prove that they possess the means absolutely necessary for the accomplishment of the pilgrimage, and, in particular, that they have a return ticket.

87. Only steamships shall be permitted to carry pilgrims on long voyages. The carriage of pilgrims by other ships on such voyages shall be prohibited.

88. Pilgrim ships that are coasters intended for short passages known as " coasting voyages " shall be subject to the provisions of the special regulations for the Hedjaz pilgrimage, which shall be published by the Constantinople Board of Health, in conformity with the principles laid down in this Convention.

89. A ship which, in addition to ordinary passengers, among whom pilgrims of the upper classes may be included, carries pilgrims of the lowest class in less proportion than one pilgrim per 100 tons gross, shall not be considered a pilgrim ship.

90. Every pilgrim ship, on entering the Red Sea or the Persian Gulf, must observe the provisions of the special regulations for the Hedjaz pilgrimage, which shall be published by the Constantinople Board of Health, in conformity with the principles laid down in this Convention.

91. The Captain must pay all sanitary imposts leviable on pilgrims. These imposts must be covered by the price of the ticket.

92. As far as practicable, pilgrims who embark or disembark at sanitary stations must have no contact with one another at the landing places.

Pilgrims who have been disembarked must be distributed in camp in as small groups as possible.

It is necessary that they be supplied with wholesome drinking water, obtained either from local sources or by distillation.

93. When there is Plague or Cholera in the Hedjaz, provisions brought by pilgrims shall be destroyed if the Sanitary Authority consider it necessary.

CHAPTER II.

PILGRIM SHIPS—SANITARY STATIONS.

Section I.—General Conditions for Ships.

94. The ship must be capable of accommodating the pilgrims in the 'tween decks.

Over and above the space required for the crew, the ship must provide for each person, irrespective of age, an area of 1·5 square metres, equivalent to 16 English square feet, and a height between decks of about 1·8 metres.

In coasting vessels, each pilgrim must be allowed a space at least 2 metres wide along the gunwales.

95. On each side of the ship, on deck, a place must be set apart, screened from view and furnished with a hand-pump, for the supply of sea water for the needs of the pilgrims. One such place must be reserved exclusively for women.

96. The ship must be provided, in addition to closets for the crew, with latrines, fitted with a flushing apparatus or with a water-tap, in a minimum proportion of one latrine per 100 passengers.

Some of these latrines shall be reserved exclusively for women.

There must be no closets between decks or in the hold.

97. The ship must have two places for cooking set apart for the use of the pilgrims. Pilgrims shall be forbidden to light fires elsewhere, especially on deck.

98. Properly fitted hospital quarters, constructed with due attention to safety and health, must be reserved for the accommodation of the sick.

They must be constructed so as to allow persons suffering from infectious diseases to be isolated according to the nature of their illness.

The hospital must be capable of accommodating, at the rate of 3 square metres per patient, not less than 5 per cent. of the pilgrims taken on board.

99. Every ship must carry such medical remedies, disinfectants, and things as are necessary for the treatment of the sick.

The regulations framed for this class of ship by each Government must specify the nature and the quantity of these remedies. Medicine and attendance shall be provided for the pilgrims free of charge.

100. Every ship taking pilgrims must carry a duly qualified doctor, commissioned by the Government of the country to which the ship belongs or by the Government of the port where the pilgrims are embarked. A second doctor must be carried when the number of pilgrims on board exceeds 1,000.

101. The Captain must cause notices, in the languages chiefly spoken in the countries inhabited by the pilgrims he is taking, to be posted

upon the ship in a conspicuous place, accessible to all concerned, showing:

(1) The destination of the ship;
(2) the price of tickets;
(3) the daily ration of food and water allowed to each pilgrim
(4) the price of articles, not included in the daily ration, which may be procured on extra payment.

102. The heavy baggage of pilgrims shall be registered, numbered, and put in the hold. Pilgrims may keep with them only such things as are absolutely necessary. The nature, amount, and dimensions of these things shall be decided by regulations framed by each Government for its own ships.

103. The provisions of Chapter I.; of Sections I., II., and III., of Chapter II.; and of Chapter III. of Part III. of this Convention shall be posted up, in the form of regulations, in the language of the country to which the ship belongs, and also in the languages chiefly spoken in the countries inhabited by the pilgrims to be embarked, in a conspicuous and accessible place on every deck and 'tween decks of every ship carrying pilgrims.

Section II.—Measures before Departure.

104. The Captain or, in his default, the Owner or Agent of every pilgrim ship must, not less than three days before departure, declare to the competent authority of the port of departure his intention to embark pilgrims. At ports of call the Captain or, in his default, the Owner or Agent of every pilgrim ship must make the same declaration twelve hours before the departure of the ship. This declaration must specify the proposed date of departure and the destination of the ship.

105. On receipt of the declaration provided for by the preceding Article the competent Authority shall proceed, at the expense of the Captain, to inspect and measure the ship. The Consular Authority of the country to which the ship belongs may be present at this inspection. Inspection alone shall take place if the Captain already has a certificate of measurement furnished by the competent Authority of his country, unless it be suspected that the certificate no longer represents correctly the real condition of the ship.

106. The competent Authority shall not permit the departure of a pilgrim ship until satisfied:

(*a*) That the ship has been thoroughly cleaned, and, if necessary, disinfected;
(*b*) that the ship is in a condition to undertake the voyage without danger, that she is properly manned, equipped, and ventilated, and provided with a sufficient number of boats; that there is on board nothing that is, or may become, injurious to the health or safety of the passengers, and that the deck is of wood or of iron sheathed in wood;

(*c*) that there is on board properly stowed away, over and above the rations for the crew, sufficient food and fuel of good quality for all the pilgrims, during the declared duration of the voyage;

(*d*) that the drinking water is of good quality and from a source free from risk of contamination; that it is in sufficient quantity; that the tanks for drinking water are safe from all contamination and so closed that the water can be supplied only by means of taps or pumps. The water-supply fittings known as "suçons," shall be absolutely prohibited;

(*e*) that the vessel carries a condenser, capable of distilling a minimum quantity of 5 litres of water per diem for every person on board, including crew;

(*f*) that the ship possesses a disinfecting chamber, ascertained by the Sanitary Authority of the port where the pilgrims embarked to be safe and efficacious;

(*g*) that, in accordance with Articles 99 and 100, the vessel carries a duly qualified doctor commissioned (exception is made in the case of Governments without commissioned doctors) either by the Government of the country to which she belongs or by the Government of the port where the pilgrims embark, and that she carries medical stores;

(*h*) that the deck is free from merchandise and all encumbrances;

(*i*) that the arrangements on board are such as to allow of the measures prescribed in the following Section III. being carried out.

107. The Captain may not start without having in his possession:

(1) A list, countersigned by the competent Authority, showing the name, sex, and total number of pilgrims he is authorised to carry.

(2) A bill of health, giving the name, nationality, and tonnage of the ship, the name of the captain and of the doctor, the exact number of persons embarked—crew, pilgrims, and other passengers—the nature of the cargo, and the place of departure.

The competent Authority shall note on the bill of health whether the number of pilgrims permissible under the Regulations has been embarked or not, and, in the latter case, the additional number of passengers the vessel is authorised to embark at subsequent ports of call.

Section III.—Measures during the Voyage.

108. During the voyage the deck must be kept free from encumbrances; it must be reserved night and day for the passengers, and placed at their disposal without charge.

109. The 'tween decks must be carefully cleansed and rubbed with dry sand mixed with disinfectants, every day while the pilgrims are on deck.

110. The latrines allotted to the passengers, as well as those for the crew, must be kept clean, and must be cleansed and disinfected three times a day.

111. The excretions and dejecta of persons showing symptoms of Plague or of Cholera must be received in vessels containing a disinfecting solution. These vessels shall be emptied into the latrines, which must be thoroughly disinfected every time this is done.

112. All bedding, carpets, and clothing that have been in contact with the sick persons referred to in the preceding Article must be immediately disinfected. The observance of this rule is specially enjoined in respect of the clothes of persons who have been near the sick, and which may have been contaminated.

Such of the above-mentioned as are of no value must be either thrown overboard, if the ship is not in harbour or in a canal, or else burnt. Other articles must be carried to the disinfecting chamber in impermeable bags washed in a disinfecting solution.

113. The quarters occupied by the sick, referred to in Article 98, must be thoroughly disinfected.

114. Pilgrim ships are compelled to undergo such measures of disinfection as are in accordance with the Regulations on this subject that are in force in the country under whose flag they sail.

115. Not less than 5 litres of drinking water must each day be put at the disposal of every pilgrim, irrespective of age, free of charge.

116. If there be any doubt as to the quality of the drinking water, or any reason to suspect that it may possibly have become contaminated, either at its source or during the voyage, it must be boiled or otherwise sterilised, and the Captain shall be responsible for seeing that it is thrown overboard at the first port of call at which he can procure a purer supply.

117. The doctor shall visit the pilgrims, tend the sick, and see that the principles of hygiene are observed on board. He must in particular:

(1) Satisfy himself that the rations issued to the pilgrims are of good quality, that their quantity is in accordance with contract, and that they are properly prepared;
(2) satisfy himself that the provisions of Article 115, regarding the distribution of water, are observed;
(3) if there be any doubt as to the quality of the drinking-water, call the attention of the Captain, in writing, to the provisions of Article 116.
(4) satisfy himself that the ship is always kept clean, and particularly that the latrines are cleansed in accordance with the provisions of Article 110.
(5) satisfy himself that the pilgrims' quarters are kept wholesome, and, in case of the occurrence of infectious disease, that disinfection is carried out in accordance with Articles 113 and 114.
(6) keep a diary of all occurrences relating to health during the voyage, and submit this diary to the competent Authority at the port of arrival.

118. Only the persons charged with the care of Plague or Cholera patients shall have access to them, and these persons must not come in contact with the other persons that have been embarked.

119. In the event of a death occurring during the voyage, the Captain must enter the fact opposite the name of the deceased on the list countersigned by the Authority of the port of departure, and must also enter in the log the name of the deceased, his age, the place from which he came, the supposed cause of death, according to the medical certificate, and the date of death.

In the event of a death from infectious disease the corpse, wrapped in a shroud impregnated with a disinfecting solution, must be committed to the deep.

120. The Captain must see that all preventive measures taken during the voyage are entered in the log. The log shall be submitted by him to the competent authority at the port of arrival. At each port of call the Captain must cause the list drawn up in accordance with Article 47 to be countersigned by the competent Authority.

In the event of a pilgrim disembarking during the voyage, the Captain must note the fact on the list opposite the pilgrim's name.

In the event of persons embarking, their names must be entered on the list in accordance with the foregoing Article 107.

This must be done before the competent Authority, as in duty bound, again countersigns the list.

121. The Bill of Health given at the port of departure must not be changed during the voyage. It shall be countersigned at each port of call by the Sanitary Authority, who shall enter:

(1) The number of passengers disembarked or embarked at the port;
(2) anything that has happened at sea affecting the life or health of the persons embarked;
(3) the health conditions of the port of call.

Section IV.—Measures on Arrival of Pilgrims in the Red Sea.

A.—*Sanitary control of ships from an infected Port going from the South to the Hedjaz with Mahommedan pilgrims.*

122. Pilgrim ships from the South, bound for the Hedjaz, must in the first instance put in at the Kamaran Sanitary Station, and shall be dealt with as provided by Articles 123 to 125.

123. Ships found, on medical inspection, to be healthy shall be given free pratique on completion of the following procedure:

The pilgrims shall be disembarked; they shall take a shower bath or bathe in the sea; their soiled linen and any portion of their personal effects or their baggage open, in the opinion of the Sanitary Authority, to suspicion, shall be disinfected. The duration of these operations, including disembarkation and embarkation, must not exceed forty-eight hours.

If no recognised or suspected case of Plague or of Cholera be discovered during these operations the pilgrims shall immediately be re-embarked and the ship shall proceed to the Hedjaz. In the case of

Plague, the provisions of Articles 24 and 25 regarding rats shall apply in the event of there being any of these vermin on board.

124. Suspected ships, which have had cases of Plague or of Cholera on board at the time of departure, but no fresh case of Plague or of Cholera within seven days, shall be dealt with as follows:

The pilgrims shall be disembarked; they shall all take a shower bath or bathe in the sea; their soiled linen, and any portion of their personal effects or their baggage open, in the opinion of the Sanitary Authority, to suspicion, shall be disinfected.

In time of Cholera, the bilge-water shall be pumped out.

The parts of the ship occupied by the sick shall be disinfected. The duration of these operations, including disembarkation and embarktion, must not exceed forty-eight hours.

If no case or suspected case of Plague or of Cholera be discovered during these operations, the pilgrims shall immediately be re-embarked and the ship shall proceed to Jeddah, where a second medical inspection shall take place on board. If the result be favourable and if the ship's doctor certifies in writing and on oath that there has been no case of Plague or of Cholera during the passage, the pilgrims shall be landed forthwith. If, however, one or more recognised or suspected cases of Plague or of Cholera prove to have occurred during the voyage or on arrival, the ship shall be sent back to Kamaran, where she shall again be dealt with as infected.

In the case of Plague, the provisions of the sixth paragraph of Article 22 shall apply in the event of there being rats on board.

125. Infected ships—that is to say, ships with cases of Plague or of Cholera on board, or that have had cases of Plague or of Cholera on board within seven days—shall be dealt with as follows:

Persons suffering from Plague or from Cholera shall be disembarked and isolated in hospital. The other passengers shall be disembarked and isolated in as small groups as possible, in order that if Plague or Cholera break out in one group, the whole party may not be affected.

The soiled linen, clothing, and personal effects of the crew and the passengers shall be disinfected, as also shall the ship. The disinfection shall be carried out thoroughly.

Provided always that the local Sanitary Authority may decide that heavy luggage and merchandise need not be unloaded, and that only part of the ship need be disinfected.

The passengers shall remain at the Kamaran station five days. When no cases of Plague or of Cholera have occurred for several days the period of isolation may be shortened, and may vary according to the date of occurrence of the last case and the decision of the Sanitary Authority. The ship shall then proceed to Jeddah, where everyone on board shall undergo a thorough medical examination. If the result be favourable the ship shall be given free pratique. If, however, recognised cases of Plague or of Cholera have occurred on board during the voyage or on arrival, the ship shall be sent back to Kamaran, where she shall again be dealt with as infected.

In the case of Plague, the measures specified in Article 22 regarding rats shall be adopted in the event of there being any of these vermin on board.

126. Every sanitary station intended for the reception of pilgrims must be provided with a skilled and experienced staff, in sufficient number, together with all the constructions and plant necessary for ensuring the complete application of the measures to which pilgrims are liable.

B.—*Sanitary Control of Ships from North going to the Hedjaz with Pilgrims.*

127. If it be not established that there is Plague or Cholera at the port of departure or in its neighbourhood, and if no case of Plague or of Cholera has occurred during the voyage, the ship shall be granted free pratique forthwith.

128. If it be established that there is Plague or Cholera at the port of departure or in its neighbourhood, or if a case of Plague or of Cholera has occurred during the voyage, the ship shall be dealt with at El-Tor in the manner prescribed for ships coming from the South and stopping at Kamaran. The ships shall thereafter be granted free pratique.

Section V.—Measures for Returning Pilgrims.

A. *Homeward Bound to North.*

129. Every ship from a port in the Hedjaz or from any other port on the Arabian coast of the Red Sea, carrying pilgrims or any like collection of persons and bound for Suez or a Mediterranean port, must proceed to El-Tor, there to undergo the observation and the sanitary measures specified in Articles 133 to 135.

130. Ships bringing back Mahommedan pilgrims to the Mediterranean shall not pass through the Canal save in quarantine.

131. Agents of shipping lines and Captains of ships are warned that, on completion of their period of observation at El-Tor Sanitary Station, only Egyptian pilgrims will be permitted to leave the ship definitely in order to return to their homes.

Only pilgrims with a certificate of residence, issued by an Egyptian authority and made out in the form prescribed, shall be recognised as Egyptians or inhabitants of Egypt. Specimens of this certificate shall be deposited with the Consular and Sanitary Authorities at Jeddah and Yambo, where they may be seen by shipping Agents and ship Captains.

Non-Egyptian pilgrims, such as Turks, Russians, Persians, Tunisians, Algerians, inhabitants of Morocco, etc., may not, after leaving El-Tor, be disembarked at an Egyptian post. Agents of shipping lines and ship Captains are therefore warned that the transhipment of non-Egyptian pilgrims at Tor, Suez, Port Said, or Alexandria is prohibited.

Vessels carrying pilgrims belonging to the nationalities mentioned in the preceding paragraph shall be treated according to the rules for

such pilgrims, and shall not be permitted to enter any Egyptian port in the Mediterranean.

132. Egyptian pilgrims shall undergo at El-Tor, Suakim, or any other station appointed by the Egyptian Sanitary Board, observation for a period of three days and medical inspection before being given free pratique.

133. If it be established that there is Plague or Cholera in the Hedjaz or at the port whence the ship has come, or that either of these diseases has occurred in the Hedjaz during the pilgrimage, the ship shall be dealt with at El-Tor, in the manner prescribed for infected ships at Kamaran.

Persons suffering from Plague or Cholera shall be landed and isolated in hospital. The other passengers shall be landed and isolated in as small groups as possible in order that, if Plague or Cholera break out in one group, the whole party may not be affected.

The soiled linen, clothing, and personal effects of the crew and the passengers, and such baggage and merchandise as are suspected of being infected, shall be landed for purposes of disinfection. These articles, and also the ship, shall be thoroughly disinfected.

Provided always that the local S.A. may decide that heavy baggage and merchandise need not be unloaded and that only part of the ship need be disinfected.

The provisions of Articles 22 and 25 regarding rats shall apply in the event of there being any of these vermin on board.

Whether it be Plague or Cholera that is in question, all the pilgrims shall be kept under observation for seven clear days, reckoned from the day on which the measures of disinfection were completed. If a case of Plague or of Cholera occur in a section, the period of seven days for that section shall be reckoned from the day on which the last case occurred.

134. In the circumstances provided for by the foregoing Article, Egyptian pilgrims shall, in addition, be kept under observation for a further period of three days.

135. If it be not established that there is Plague or Cholera in the Hedjaz or at the port whence the ship has come, or that either of these diseases has occurred in the Hedjaz during the pilgrimage, the ship shall be dealt with at El-Tor, in the manner prescribed for healthy ships at Kamaran.

The pilgrims shall be landed; they shall take a shower bath or bathe in the sea; their soiled linen and any portion of their personal effects or their baggage open, in the opinion of the Sanitary Authority, to suspicion, shall be disinfected. The duration of these operations, including disembarkation and embarkation, must not exceed seventy-two hours.

Provided always that a pilgrim ship belonging to a country that has given its adhesion to the provisions of this Convention and of previous Conventions, if she has had no case of Plague or of Cholera during the voyage from Jeddah to Yambo and El-Tor, and if it be established by

medical examination, conducted at El-Tor after disembarkation of everyone on board, that she has no such case, may be permitted by the Egyptian Sanitary Board to pass through the Suez Canal in quarantine, even by night, subject to the fulfilment of the four following conditions:

(1) That, in order to secure medical attendance of persons on board, the ship carries one or more doctors, commissioned by the Government of the country to which she belongs;
(2) that the ship is provided with disinfecting chambers, and it is established that the soiled linen has been disinfected during the voyage;
(3) that it is proved that the number of pilgrims is not in excess of that permitted by the pilgrim regulations;
(4) that the Captain undertakes to sail direct to a port in the country to which the ship belongs.

The medical examination, after disembarkation at El-Tor, must be made with as little delay as possible.

The sanitary tax, payable to the Quarantine Administration, shall be the same as the pilgrims would have had to pay if they had remained in quarantine for three days.

136. In the event of a suspicious case occurring on board during the voyage from El-Tor to Suez, the ship shall be sent back to El-Tor.

137. Transhipment of pilgrims at Egyptian ports is strictly prohibited.

138. Ships from the Hedjaz, carrying pilgrims bound for the African coast of the Red Sea, shall be permitted to proceed direct to Suakim, or such other place as the Alexandria Sanitary Board shall appoint, there to undergo the same quarantine measures as those at El-Tor.

139. Ships from the Hedjaz or from a port on the Arabian coast of the Red Sea, with a clean Bill of Health, not carrying pilgrims or like collections of persons, and without suspicious incident during the voyage, shall on favourable medical inspection, be given free pratique at Suez.

140. When it is established that there is Plague or Cholera in the Hedjaz:

(1) Caravans of Egyptian pilgrims must, before proceeding to Egypt, undergo strict quarantine at El-Tor for seven days, whether it be Plague or Cholera that is in question; they must thereafter be kept under observation at El-Tor for three days, after which they shall not be granted free pratique until after favourable medical inspection and disinfection of effects;
(2) caravans of pilgrims from other countries, returning home by land, shall undergo the same measures as Egyptian caravans, and must be accompanied by sanitary guards to the borders of the desert.

141. When Plague or Cholera has not been reported to have occurred in the Hedjaz, caravans of pilgrims coming from the Hedjaz by way of Akaba, or Moila, shall, on their arrival at the Canal, or at Nakhel, undergo medical inspection and disinfection of soiled linen and personal effects.

B.—*Homeward Bound to South.*

142. The ports of embarkation in the Hedjaz shall be provided with buildings and plant for sanitary purposes sufficient to permit, in the case of pilgrims homeward bound to the South, the taking of the measures, rendered compulsory by the provisions of Articles 10 and 54, on the departure of these pilgrims from ports beyond the Straits of Bab-el-Mandeb.

These measures shall be optional—that is to say, they shall not be carried out unless the Consular Authority of the country to which the pilgrims belong, or the doctor of the ship by which they propose to go, considers them necessary.

Note.

The few remaining articles on " Penalties " and on " Administration and Control " are here omitted, as being unnecessary to the scope of this book.

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