tive purposes. Legal bacterial standards exist abroad, particularly in American cities. Boston, for instance, has a legal standard of 500,000 bacteria per c.c. Research in other parts of India is suggested. In the meantime, the following tentative standard for Bombay City is suggested by Dr. Joshi. :—

1. *Microbes per c.c.*—The total number of microbes per c.c. should not exceed two millions during the cold weather (November to March) and five millions during the hot and rainy seasons (April to October).

2. *Lactose Fermenters.*—These should be absent in at least 1 c.c. of the sample, if it is taken with strict sanitary precautions.

(*a*) *During the cold season* (*November to March*), the sample is of—

Pure	Milk, if lactose fermenters	are	absent in	1	c.c.
Good	,, ,,	,,	,,	0·1	,,
Fair	,, ,,	,,	,,	0·01	,,
Unsatisfactory	,, ,,	,,	present in	0·01	,,
Bad	,, ,,	,,	,,	0·001	,,
Contaminated	,, ,,	,,	,,	0·0001	,,
Highly contaminated	,, ,,	,,	,,	0·00001	,,
				and less.	

(*b*) During the hot weather and monsoon (April to October) the sample is of—

Pure	Milk, if lactose fermenters	are	absent in	0·1	c. c.
Good	,, ,,	,,	,,	0·01	,,
Fair	,, ,,	,,	,,	0·001	,,
Unsatisfactory	,, ,,	,,	present in	0·001	,,
Bad	,, ,,	,,	,,	0·0001	,,
Contaminated	,, ,,	,,	,,	0·00001	,,
Highly contaminated	,, ,,	,,	,,	0.000001	,,
				and less.	

3. *Microscopic examination of the centrifugalised sediment* should show only a few leucocytes and perhaps a few cocci and bacilli, but Pus cells and (pathogenic) Streptococci should be absent. There should be no leucocytosis, especially of the poly-morpho-nuclear variety.

4. *Pathogenic microbes, e.g.*, Tubercle bacilli, Cholera vibrio, B. Typhosus, etc., must be *always absent.*

Lactose Fermenters in Milk.—About a hundred samples were examined at the Bombay Municipal Laboratory. In most of the samples, lactose fermenters were found to be present in 0·000001 c.c. and more of milk, which would indicate much pollution.

In the samples collected under proper precautions, lactose fermenters were entirely absent.

ARE TUBERCLE BACILLI CONVEYED BY MILK IN INDIA ?

Here, again, except in Bombay, no systematic investigation seems to have been carried out in India. Dr. Joshi reports that out of a total of 741 samples of milk examined by him during four years (1910-13), acid fast bacilli were detected in only 48, giving 6·47 per cent., but in no single case were genuine Tubercle bacilli found by animal experiments. These results have been confirmed since by those of the Bombay Bacteriological Laboratory, Parel.

Judging from these results, it appears that Tubercle bacilli are rarely conveyed by milk in India.

PASTEURISATION.

Pasteurisation is a term applied to a process of rendering milk, which has been or may have been bacterially polluted, safe for consumption without at the same time depriving it of any valuable nutritive properties ; in other words, milk is raised to a certain temperature and maintained at that temperature for a certain period sufficient to kill all

pathogenic and harmful bacteria—at the same time preserving all the properties of normal fresh milk. Opinions differ as to the length of time the milk should be exposed to a certain specified temperature, and accordingly two types of pasteurisers have been devised :—(1) Continuous flow (flash) pasteuriser, in which the milk is heated to a certain temperature and exposed to that degree only for a moment ; (2) while in the other, a " retainer pasteuriser", the milk is heated to a lower temperature and kept at that degree for a definite period, generally not exceeding 25 minutes. From the hygienic and domestic point of view, the latter appears to be the better, while the former is better for trade purposes, since a large quantity of milk can be treated in a given time. Bacteria which live and flourish in milk have a certain thermal death-point. These die when milk attains a certain heat and the bacilli are exposed to that heat for a sufficient period. The most resistent of all the bacilli found to flourish in milk is the B. tuberculosis, and it has been found by experiments that B. tuberculosis is killed if exposed to 71°C. (160° F.) for a minute, or to 60° C. (140° F.) for 20 minutes ; but as there is a disagreement among experts as to the degree of thermal death-point, it is safer for practical purposes that a few degrees higher should be adopted—77° C. in continuous flow (flash) pasteuriser for one minute, or 65° C. for about 20 minutes in the " holder " or " retainer." Although most of the organisms are destroyed by this process, there is no evidence to show if the toxins produced by them are also destroyed. It must be borne in mind that pasteurised milk may be infected with pathogenic bacteria or other toxin-forming organisms in the process of storing, keeping or handling pasteurised milk. It has been found that at 60° C. milk remains unchanged, but at 71° C. its properties are affected and cream will not rise as in fresh milk.

Cholera vibrios freely swimming in milk heated even for five minutes to 155° F. or 68·5° C. are killed.

The process of pasteurisation would be sufficient if it was only a matter of killing Cholera bacilli freely moving about in the milk. As a matter of fact when a large bulk of milk has to be dealt with, this ideal condition is seldom if ever obtained. For example, it is quite possible that the Cholera vibrios instead of being free in the milk might be contained within the body of a piece of straw, or in the middle of some fragment of dust ; when milk containing such infected materials is heated for a few minutes only, the heat may not penetrate to the interior of the particle containing the Cholera germs, and the Cholera germs may thus fail to be killed. Later, they may multiply and may cause the milk to be dangerous if consumed.

CHEMICAL PRESERVATIVES.

Chemical preservatives are often added to milk with a view to preventing bacterial growth or keeping it in an apparently unaltered condition for a prolonged period. This is chiefly done for commercial purposes. The chemicals most frequently used are boric acid and formaldehyde. Others, however, are sometimes added, such as benzoin, salicylic acid, soda bicarbonate and hydrogen peroxide. It has been found, however, that these preservatives are added in variable quantities and in almost all cases more in amount than actually required to preserve the milk for 24 hours. All such preservatives are positively harmful and dangerous to health, especially to invalids, children and infants. It has been found by experience that chemical preservatives are totally unnecessary for keeping milk for 24 hours, and the knowledge that these preserve milk serves the milk supplier's purpose of selling preserved stale milk, which may contain pathogenic bacteria and toxins, and forms also an incentive for the supplier to collect milk under conditions of neglect and dirt.

REFRIGERATION.

In this method if milk is kept between 0° C. to 10° C, the bacteria in the milk are not killed, but do not multiply to such extent as they would in ordinary temperatures. In consequence, it would prevent the increase of toxic products. It is therefore obvious that milk should be cooled at the place of collection and not after its transit to the milk vendors. Refrigeration is now done in ocean-going steamers, where refrigerating chambers are provided and the milk is frozen in blocks in ice-making machines.

STERILISATION.

This method has not been found to be suitable for commercial purposes in India, for to sterilise milk it would be necessary to raise the temperature to a higher degree than that of boiling water, by heating it in sealed chambers under steam pressure. Such heating would kill all germs and their spores but would alter materially the taste and appearance of milk. It has been found by analysis that ordinary sterile milk (*sic*) sold in the European markets is not sterile at all, but contains many varieties of bacteria.

BOILING.

For domestic purposes milk, if boiled, would keep for a certain length of time. The boiling point of milk is 978° C, and if this temperature is reached by gradual and slow heating, it will destroy all pathogenic germs and the milk may be called bacterially safe to consume. It is said, however, that milk alters materially, by boiling, both in taste and other properties. The following are the changes which occur :—

(1) The cream does not rise ; (2) all gases are expelled ; (3) salts of magnesium and calcium are precipitated ; (4) the lactose is burnt or " caramelised " and becomes brownish in colour ; (5) the milk acquires a peculiar taste and kills all

the milk ferments present in milk ; (6) the germicidal power of milk is lost ; (7) lecithin and nuclein are said to be decomposed and the normal emulsion of fat globules is disturbed so that cream does not rise. It has, however, been found experimentally that boiled milk does not suffer as regards its digestibility or nutritive value.

CONDENSATION.

Condensed milk may be of whole or skim milk, evaporated to one-third its bulk. It may be unsweetened, or sweetened with addition of cane sugar. To milk is added one-eighth of its weight of cane sugar (1¼ lbs. per gallon) and dissolved by moderate heat. This is then transferred to a vacuum pan, where it attains a temperature of 60° or 70° C., and condensed to one-third its original bulk.

The chief feature of this process is that the air inside the oven or pan is kept in a state of rarefaction by means of a pump, so that the milk shall boil at a low temperature, and not cause any " browning " and other changes incident to exposure to 100° C. (212° F.) and upwards. During the process all the gases and air are expelled, and it boils without frothing over.

Unsweetened condensed milk is prepared by placing the milk in a tank and heating by a hot water jacket ; gradual evaporation occurs and it is reduced to the required consistence. The milk is then canned and hermetically sealed and lastly exposed to a temperature of 280° F. to ensure perfect sterilization. Condensed milks should contain, as they are reduced to one-third of their bulk, 10 per cent. of fat and 25 per cent. of solids not fat. The sweetened variety is generally used by the public. No preservatives are necessary, as the low proportion of water and large percentage of sugar do not favour bacterial growth. Unsweetened condensed milk can be used like fresh milk in many ways. Since its bulk is reduced from 3 to 1, it should be

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raised to that by the addition of twice its volume of water. It can be used in cookery like ordinary milk in places where fresh milk is not available. Condensed milk is not suitable for infants, as during its preparation it loses many of its characteristics, especially by the destruction of lecithin and the bactericidal properties possessed by fresh milk. Afghanis and Bhokaris carry with them, while going on long pilgrimages, small square cakes of desiccated milk; these are prepared by slow evaporation of milk at low temperatures to a firm consistency, then pressed and dried and cut into small square cakes.

Powdered milk is also now being used. It is prepared by evaporating milk in a water-bath until the required consistency is reached; this is then transferred to a rolling drum through which hot air is driven until it becomes a semi-solid mass. It is then pressed through a sieve, and the granules thus obtained are then reduced to powder. The powdered milk serves all the purposes of fresh milk and is very convenient for transport.

The Local Government Board, England, have now issued orders *re.*, the use of preservatives in milk, largely based on the recommendations of the Committee which have been enumerated above. The regulations as they apply to cream are more stringent than the recommendations. They came into force on June 1, 1912, with the exception of the provision relating to the labelling of preserved cream, which took effect on January 1st, 1913.

They provide that no person shall add, or order, or permit any other person to add, any preservative substance to milk intended for sale for human consumption and that no person shall sell, or expose, or offer for sale, or have in his possession for the purpose of sale, any milk to which any preservative substance has been added in contravention of subdivision 1 of this article. The expression "milk" includes skimmed, separated, condensed and dried milk, but as the

traffic in condensed milk would be seriously impeded if the use of sugar were disallowed, it is provided that neither cane nor beet sugar shall be regarded as a preservative or a thickening substance.

With regard to cream, the regulations provide that no person shall add, or order or permit any other person to add, or sell (*a*) any thickening substance to cream or preserved cream, (*b*) any preservative substance to cream containing less than 40% by weight of milk fat, (*c*) cream containing 40% or more by weight of milk fat, any preservative substance other than boric acid, borax or a mixture of those preservative substances or hydrogen peroxide in amount not exceeding 0·1% by weight, in any case in which the cream is intended for human consumption.

Dealers in cream preserved in a manner which does not contravene the above regulations will be required by means of labels on the receptacles, to declare that the cream is preserved and to state the name of the preservative.

PREPARATIONS FROM MILK.

Two of the preparations from milk, *viz.*, *Mawa and Basundi* have been referred to above.

Cream.—When milk is allowed to stand undisturbed, the fat globules rise to the surface, as their specific gravity is lower than that of the entire milk. This supernatant layer of fat globules is called cream. Cream may also be obtained by mechanical means, by the use of a centrifugal separator, and this is done especially when cream is needed for commercial purposes. The colour of cream is yellowish white, due to lactochrome, but the commercial cream is sometimes heightened in colour by means of *annatto*. The amount of fat in domestically prepared cream varies according to the time which has been allowed for its separation; on an average it is about 18 per cent. but may range between

15 to 25 per cent. Commercial cream is also sold in two grades according to the quantity of cream: "single," having about 25 per cent., and "double," having about 50 per cent.

Cream separated by mechanical means needs no preservatives, but domestic cream may, as the milk is exposed to air for a prolonged period and, besides lactic acid bacilli, other bacteria may have grown in it: 1¼ grains of boric acid per ounce of cream is allowed by the Local Government Board in England.

'*Junket*' is prepared by the addition of rennet to milk and allowing it to stand until it coagulates. It is largely used in the sick room. When junket is broken up, the caseine separates and the substance is divided into whey and curds.

Whey is prepared by the addition of essence of rennet, or some weak acid, to some warmed milk and setting it aside until it is firmly coagulated. The coagulum is then cut into pieces and transferred to a muslin cloth and hung up and allowed to drain. Thus 1½ pints of milk yield about a pint of whey, which is collected as it drains through the muslin. It forms a pleasant, sweetish, sour drink. It contains all the soluble proteins (1·24 per cent.) and milk sugar (4·45 per cent). If added in equal bulk to cow's milk, it renders the composition of the milk nearly equal to that of human milk. Whey is recommended in Enteric Fevers, in catarrhal conditions of the alimentary canal and in many chronic renal and lung complaints.

Butter milk is the fluid which remains after butter is prepared, and is as useful as whey in dietetics. It contains more fat and proteins than whey. Butter milk contains about 8 per cent. of milk solids. Butter milk prepared domestically is superior to that obtained from the separator, as it is acid in reaction owing to the development of lactic acid during the "ripening" of the cream. It is most useful in cases of Gastro-Enteritis, as the casein forms into flocculi which are more readily digested in the stomach.

Fermented and Sour Milk.—When fresh milk is exposed to air, it absorbs certain acid-forming bacteria which multiply in the milk and render it acid. The most common of these is the Bacillus acidi lactici ; it produces enzymes which act on the milk-sugar converting it into lactose and galactose and finally into *para* and *laevolactic* acid. The conversion of milk-sugar into lactic acid goes on continuously until it attains a proportion of 1 per cent., when the acidity formed checks further multiplication of bacteria and secretion of enzymes and the milk coagulates spontaneously. Sour milk is largely used in Diabetes, as it is practically sugar-free, and in Gout as it reduces the formation of toxins from nitrogenous food. It is also useful in renal diseases. Sour milk, on account of the lactic acid it contains, exercises an antiseptic action on the alimentary canal and checks and arrests the growth of pathogenic and putrefactive bacteria. As developed in the sour milk, lactic acid has a more powerful action than the lactic acid artificially prepared. Metchnikoff strongly advocates the use of lactic acid organisms as a means of lengthening life by preventing fermentative changes going on in the alimentary canal. As a result of his teaching, artificially soured milk has come strongly in public favour and is being largely consumed. Several dairy companies sell sour milk thus prepared for immediate consumption ; it is prepared from pasteurised milk to which a culture of lactic acid organisms is added.

Ghee.—Ghee is clarified butter and is largely used in India for the preparation of various kinds of food and sweetmeats. It is also taken along with rice, *dhals*, curries and other articles of food.

It is prepared either from the milk of the cow or the milk of the buffalo. The milk is first boiled and then curdled. After the lapse of about six hours, the curdled milk is churned, a little water being added so that the butter floats to the top. The butter is then collected, washed in water, and boiled

in an iron pan placed over an open fire. The effect of this is to melt the butter, the casein and water falling to the bottom. The floating ghee is then finally strained and stored in earthenware vessels or in tin cases.

In Bombay most of the ghee comes from certain places in Gujerat and Kathiawar, but there are certain premises in this City which are used for the manufacture of ghee. They are all situated in one locality on the ground floors of dwelling houses in a thickly populated area. There is no preliminary manufacture of butter on these premises. Butter is brought in baskets from up-country and melted on the premises.

The following regulations are in force in regard to the licensing of such premises :—

(*a*) No portion of the premises on which the manufacture of ghee is licensed and no room situate over that portion of the premises shall be used for human habitation at night.

(*b*) All butter brought to the premises for being manufactured into ghee shall, until actually required for such manufacture, be stored in a room separate from the room in which the melting is carried on. Such separate storage room shall be airy and well ventilated : it shall be entirely disconnected from any drain, nor shall any privy or water-closet be allowed to ventilate into it.

(*c*) The floor of such separate storage room must be paved with impervious material to the satisfaction of the Commissioner.

(*d*) No butter shall be stored in passages, backyards, or spaces under staircases, or within twenty feet of a privy or water-closet.

(*e*) All stored butter must be kept in properly covered metal receptacles.

(*f*) The melting must be done in a properly constructed fire-place provided with a suitable flue.

(*g*) The ladles used for skimming the refuse matter from the surface of the melted butter must at all times be kept in a cleanly state, and must not be placed on the ground, but a suitable shelf or table must be provided for them in close proximity to the fire place, and such shelf or table must be maintained in a cleanly condition.

(*h*) The conditions which apply to the storage of butter shall also apply to the storage of prepared ghee, which may be kept in the separate storage room aforesaid.

(*i*) All coke, coal, or firewood, to be used in the process of melting butter, shall be kept in suitable receptacles and not loose.

Genuine ghee should be clear, white or slightly yellowish in appearance, and agreeable in odour. If it is dirty or has a rancid smell, it should be condemned.

A large percentage of ghee in the Bombay market is adulterated. The principal adulterants are ground-nut oil, cocoanut and cotton-seed oils and animal fat. Plantains, boiled potatoes and other vegetables, suet, &c., have also sometimes been found in ghee.

PREVENTION OF THE ADULTERATION OF GHEE.

For preventing the adulteration of ghee and other articles of human food in the Bombay Presidency, an Act has been passed which is known as Bombay Act No. II of 1899. This Act is based on the provisions of the English Sale of Food and Drugs Act. For example, in the fraudulent substitution of the adulterated article for the genuine one, Section 3 (1) of this Act provides that "whoever sells to the prejudice of the purchaser any article of food which is not of the nature, substance or quality of the article demanded by the purchaser, shall be punished for the first offence with fine which may extend to 100 rupees, and for a second or any subsequent offence with fine which may extend to 500 rupees."

It is important to bear in mind that in proceeding under this Act, all its requirements must be carefully observed. The article must be purchased by an officer duly empowered for the purpose by the Commissioner under Section 4 (1), and must be submitted to the Chemical Analyser to Government for analysis, whose certificate specifying the result of the analysis must be produced in Court. Moreover, the person purchasing the article must, on the completion of the purchase, forthwith notify to the seller his intention to have the article analysed by the Chemical Analyser, and offer to divide it into three parts to be then and there separated and sealed up—one to be delivered to the seller, one to be sent to the Analyst, and one to be retained by him. A

person refusing to sell any article to any officer is liable to a penalty of fifty rupees.

No proceedings under this Act can be instituted without the permission of the Commissioner in the City of Bombay, and of the President or Vice-President in the case of mofussil municipalities. (Section 1 (5) (*d*).) Summons has to be applied for within a reasonable time from the date of the alleged offence and, in the case of a perishable article, the application for summons must be within 28 days from the date of the purchase of such article.

For the present the provisions of this Act only apply to ghee, but under Section 1 (5) (*b*) they can be made to apply to food of all kinds by means of a notification issued by the Governor-in-Council.

In practice the working of this Act has been found to be defective and it has not served the object for which it was passed.

By Section 4 of this Act, in Bombay, the Commissioner, or any officer empowered by him in that behalf, is the only person who can make the purchases necessary to test the genuineness of the article sold as ghee.

The officers usually empowered by him are the Executive Health Officer, the Health Officer's Assistants and the Deputy Health Officers.

These officers are well known and any attempt to purchase ghee by them is usually met with the statement of the shopkeeper that the article sold is not pure ghee, and by this declaration he escapes prosecution.

In Section 3 (2), clause (*c*) of the Act, the following words occur :—" and before the sale thereof the seller has brought to the notice of the purchaser either by means of a label, distinct and legible, or otherwise, the fact that such matter or ingredient has been so added or mixed."

It is to be feared that but rarely is any intimation made to the general public that the article sold is not pure ghee,

though for obvious reasons, such a declaration is made to Municipal Officers suspected of purchasing samples. The word "otherwise" is objectionable, as the vendor has the option of labelling the tins, or giving verbal notice of non-guarantee of purity. Or yet, again, one frequently is confronted with a dirt begrimed board, bearing the notice "Adulterated ghee sold here," on purchasing a sample. This board is supposed to be hung up in a conspicuous place, but this is rarely the case in practice, and it is only when suspicious of the intentions of the purchaser that the vendor draws attention to the notice which otherwise would escape observation.

Such a provision obviously leads to greater difficulty in the proper administration of the Act and, in fact, practically nullifies it. For the better working of the Act, therefore, the words "or otherwise" should be deleted and it should be made incumbent on the vendors to affix very conspicuous labels, both in English and the vernaculars, upon tins containing adulterated ghee ; so that the public may see for themselves what they are buying and the Inspectorial staff cease to be hoodwinked. It is also necessary for Municipal Officers to have the power to purchase samples by the hands of a deputy, so that the vendors may not suspect the purpose for which the purchase is made until the transaction is completed.

Another difficulty, and one which adds considerably to the expense of administering the Act, is the comparative immunity which is at present enjoyed by the wholesale dealers who are the principal offenders. At present, if a small quantity of ghee is asked for from them for the purpose of analysis, they will not sell it. A whole tin must be purchased, and the subsequent division of the contents of this tin into three parts and the sealing and labelling of the vessels containing them present some difficulties and lead to unnecessary waste and expense.

In this connection, it would be as well to follow the procedure of the Margarine Act, 1887, section 9, and compel all manufacturers of artificial ghee to be registered with the Local Authority (in Bombay, the Municipality), and in addition, adopt the procedure of section 7 of the Food and Drugs Act, 1899, which compels wholesale dealers in Margarine—(in India, substitute artificial ghee)—as well as manufacturer to be registered.

This section (7) not only compels registration with the Local Authority but also insists on the proper keeping of a register showing the name and address of any person to whom any Margarine (in India, artificial ghee) was sent. Municipal Officers duly authorized should have power to enter factories where artificial ghee is made and inspect this register.

REGULATION AND CONTROL OF THE SALE OF MILK.

The very unsatisfactory state of the milk-supply of large towns in India has long been realized, but it is only within the last few years that the subject of improving it has received the attention which it deserves.

In Bombay and other large Indian towns, dairies have been established by private enterprise, in which a fairly good attempt is made to handle milk by Western methods. But these establishments cater for the well-to-do classes, who alone can afford to pay the high prices charged for milk at these places. The problem which therefore usually confronts the Health Officer in India is how to obtain a reasonably pure and wholesome milk-supply from indigenous agencies, *viz.*, the *gowli*.

It is well known that milk is stored by these *gowlis* in dirty hovels, the brass milk-vessels undergo a process of so-called cleaning by being scrubbed with mud obtained from filthy sources, and milk is carried a long distance in open

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cans with a wisp of dirty straw floating in it to prevent spilling.

The legal provisions existing in the City of Bombay Municipal Act have been found defective in remedying these glaring evils and for the better regulation of the milk trade, a new section has recently been inserted in the Act. It is section 412 A and runs as follows :—

"No person shall without or otherwise than in conformity with the terms of a license granted by the Commissioner in this behalf—

(*a*) carry on, within the city, the trade or business of a dealer in or importer or seller or hawker of milk, butter or other milk products ;

(*b*) use any place in the city for the sale of milk, butter or other milk products."

In connection with the above section of the Act, the following regulations have been framed and form the conditions of the license to be granted to a milk-seller.

(*a*) Under clause (*a*) of section 412-A :—

1. All dealers, importers, sellers or hawkers of milk in public places must have their names and addresses marked upon the vehicles and cans.

2. All milk exposed for sale must be declared as pure buffalo or cow milk or skimmed milk.

3. No dealer, importer, seller or hawker of milk shall cause or suffer any cow or buffalo, belonging to him or under his care or control, to be milked for the purpose of obtaining milk for sale—

(*i*) unless, at the time of milking, the udder and teats of such cow or buffalo are thoroughly clean ;

(*ii*) unless the hands of the person milking such, are thoroughly clean and free from all infection and contamination ; and

(*iii*) unless the milk-receiving vessel is thoroughly clean and rinsed with clean boiling water.

4. Every dealer, importer, seller or hawker of milk shall take all reasonable and proper precautions in connection with the collection, storage and distribution of the milk, and otherwise to prevent the exposure of the milk to any infection or contamination.

5. He shall not keep milk for sale, or cause or suffer any such milk to be placed in any vessel, receptacle or utensil which is not thoroughly clean

6. He shall cause every vessel, receptacle or utensil used by him for containing milk for sale to be thoroughly cleansed with steam or clean boiling water after it shall have been used, and to be maintained in a constant state of cleanliness.

7. He shall not convey any milk for sale or distribution in open vessels, but the latter shall be provided with proper close-fitting covers under lock and key and a tap at the lower end through which the milk shall be retailed to the customers. If the milk is distributed in cans, they shall also be provided with properly fixed covers.

8. He shall not at any time mix with other milk, or sell or use for human food, the milk of any cow or buffalo which may be suffering from Tuberculosis, Rinderpest, Foot and Mouth Disease, or disease of the udder which may be certified by a Veterinary Surgeon to be tubercular.

9. A dairyman or milk seller shall not permit any person suffering from any dangerous or infectious disease to sell or assist in the sale or distribution of milk, but shall at once cause every such person to be removed from the vicinity of the premises in which milk is stored or sold.

10. A person engaged in selling or assisting in the sale or distribution of milk shall not knowingly come in contact or communication with any person suffering from any dangerous or infectious disease.

(*b*) Under clause (*b*) of section 412-A :—

1. He shall not keep any milk intended for sale in any room or place where it would be liable to become infected or contaminated by impure air, or by any offensive, noxious or deleterious gas or substance, or by noxious or injurious emanation, exhalation or effluvium.

2. He shall not keep any milk intended for sale in any room used as a kitchen or as a living room or in any room where any other trade is carried on, or in any room or building, or part of a building communicating directly by doors, window or otherwise with any room used as a sleeping room, or in which there may be any person suffering from any infectious or contagious disease, or which may have been used by any person suffering from any such disease and may not have been properly disinfected.

3. He shall not keep any milk intended for sale in any room or building or part of a building in which there may be any direct inlet to any drain, or which opens on to a gully or in which a privy or water-closet opens directly.

4. He shall at all times protect the milk, which is intended for sale, from dust and flies by providing suitable covers to the milk-vessels.

5. He shall not retail the milk to his customers by dipping his hands into the vessels, but the latter shall be provided with taps at the lower end through which the milk shall be drawn.

6. He shall cause the floor and drain of every such room or place, and every counter, shelf or bench on which milk-vessels are kept, to be washed and thoroughly cleansed daily.

7. He shall cause every vessel used in his milk-shop to be rinsed with boiling water and thoroughly cleaned before and after use.

8. He shall cause the floor of every such milk-shop to be paved throughout with suitable impervious material approved by the Commissioner, and the paving shall be so sloped as to ensure effectual drainage having a gradient of not less than 1 in 30.

9. He shall cause every part of the internal surface of the walls and ceiling of every such milk-shop to be thoroughly lime-washed twice at least in every year, or oftener if so required by the Commissioner.

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CHAPTER VI.

Infectious Diseases and their Prevention.

Under the heading of 'Infectious Diseases' are included diseases communicable from man to man and from animal to man.

The list of such diseases in India includes many which are not met with in European countries. A knowledge of the causes and the way in which such diseases are communicated is a necessary part of the education of the Sanitary Official, whether he be the Health Officer or the Sanitary Inspector.

Laws for Prevention and Notification of Infectious Diseases.

The Acts relating to the prevention of infectious diseases in England are :—

The Notification of Infectious Diseases Act, 1889, and the Infectious Diseases Prevention Act, 1890, Tuberculosis Act, 1909. The first deals with the compulsory notification, by a medical practitioner to the Medical Officer of Health, as soon as he becomes aware of any such case and by the head of the family or nearest relative, and relates to Small-pox, Typhoid (Enteric), Tuberculosis, Typhus, Cholera, Scarlet Fever, Diphtheria, Croup and Erysipelas and sometimes Measles, Relapsing Fever, Puerperal Fever and Phthisis, for which a fee of 2*s.* 6*d.* is paid for every notification by a medical man in practice and 1*s.* 6*d.* for every case occurring in a public institution. The second relates to the prevention of the spread of disease by milk and the disinfecting of premises and clothes and the letting of houses in which cases of infectious diseases occurred and the disposal of bodies of persons dying of infectious disease.

The Public Health Act, 1875, also provides for the provision of hospital accommodation for infectious diseases and the compulsory removal thereto of cases of such diseases.

In 1909 the Pulmonary Tuberculosis Notification Act came into force in England.

The Ministry of Health may at any time declare other diseases notifiable and issue special orders for the control of Plague, Cholera, etc.

In India the laws relating to the prevention of infectious diseases are framed on the above but the wording is different and the diseases are not always specified, the words "any dangerous diseases" being used.

SECTIONS OF THE BOMBAY MUNICIPAL ACT RELATING TO INFECTIOUS DISEASES.

Section.

421. Every medical practitioner who treats or becomes cognisant of the existence of any dangerous disease in any private or public dwelling other than a public hospital, shall give information of the same with the least practicable delay to the Executive Health Officer. The said information shall be communicated in such form and with such details as the Executive Health Officer, with the consent of the Commissioner, may from time to time require.

IV
No.—
6

(*Duplicate.*)

Name of the Street _____

No. of House _____

Name of Patient _____

Sex _____

Age _____

Disease _____

Date _____

Medical Practitioner.

Form of Notification in Bombay City.

NOTIFICATION OF INFECTIOUS DISEASES. (Original.)

Information for the Executive Health Officer, Bombay.

Diseases to be notified are Small-pox, Plague, Cholera, Relapsing Fever, Enteric Fever, Scarlet Fever, Yellow Fever, Diphtheria, Typhus, Tuberculosis, Leprosy, and Influenzal Pneumonia.

Bombay, dated .....192 .

Name of Street	No. of House.	Name of patient	Sex.	Age.	Disease.	Remarks.

N.B.—The attention of the Medical Practitioner is invited to Section 421 of the Bombay Municipal Act, 1888, quoted below. } *Medical Practitioner.*

Executive Health Officer, Bombay.

Section 421 :—"Every Medical Practitioner who treats or becomes cognisant of the existence of any dangerous disease in any private or public dwelling, other than a Public Hospital, shall give information of the same with the least practicable delay to the Executive Health Officer. The said information shall be communicated in such form and with such details as the Executive Health Officer, with the consent of the Commissioner, may from time to time require."

Section.

422. The Commissioner may at any time, by day or by night, without notice, or after giving such notice of his intention as shall, in the circumstances, appear to him to be reasonable, inspect any place in which any dangerous disease is reputed or suspected to exist, and take such measures as he shall think fit to prevent the spread of the said disease beyond such place.

423. (1) If it shall appear to the Commissioner that the water in any well, tank or other place is likely, if used for drinking, to engender or cause the spread of any dangerous disease, he may, by public notice, prohibit the removal or use of the said water for the purpose of drinking.

(2) No person shall remove or use for the purpose of drinking any water in respect of which any such public notice has been issued.

424. (1) The Commissioner or any police officer empowered by him in this behalf may, on a certificate signed by the Executive Health Officer or by any duly qualified medical practitioner, direct or cause the removal of any person who is, in the opinion of such Executive Health Officer or other medical practitioner, without proper lodging or accommodation, or who is lodged in a building occupied by more than one family, and who is suffering from a dangerous disease, to any hospital or place at which patients suffering from the said disease are received for medical treatment.

(2) The person, if any, who has charge of a person in respect of whom an order is made under sub-section (1), shall obey such order.

[The certificate is usually in the following form:—

I do hereby certify that in my opinion (Full name and race of patient to whom the certificate relates)——————————————————
is without proper lodging or accommodation, (lodged in a building occupied by more than one family) and is suffering from a dangerous disease, namely.....

Place and Date } Signature: Health Officer.
Medical Practitioner.

Order

On the certificate of——————————————————dated ——————————192 , I do hereby, pursuant to the provisions of section 424 (1) of the City of Bombay Municipal Act, 1888, direct the removal of——————————————————
who is certified to be suffering from the disease of——————————to ——————being a hospital or place at which patients suffering from the disease of——————————are received for medical treatment.

Place and Date. } Signature:

Municipal Commissioner.
Municipal Officer (empowered under §68)
Police Officer.]

Section.

425. (1) If the Commissioner is of opinion that the cleansing or disinfecting of a building, or of a part of a building, or of any article therein likely to retain infection, would tend to prevent or check the spread of any dangerous disease, he may, by written notice, require the owner or occupier of such building to cleanse or disinfect such building or part thereof or article therein and, if it shall appear to the Commissioner necessary, to vacate the said building for such time as shall be prescribed in the said notice.

(2) Provided that, if, in the opinion of the Commissioner, the owner or occupier is from poverty or other cause unable effectually to comply with such requisition, the Commissioner may cause the building or part of the building or article likely to retain infection to be cleansed or disinfected and defray the cost of so doing.

NOTE :—The person, if any, who has charge of the person in respect of whom the above order is made, is bound under sub-section (2) of section 424 to obey such order and failure to do so will render him liable under section 471 to a maximum penalty of Rs. 100.

[The notice under section 425 (1) is in the following form :—

To

The OWNER or OCCUPIER of building No. Street.

Whereas I am of opinion that the cleansing and disinfecting of the abovementioned building will tend to prevent or check the spread of a dangerous disease, namely,

and it appears to me necessary that such building be temporarily vacated. Now in exercise of the power in this behalf conferred on me by section 425 (1) of the City of Bombay Municipal Act, 1888, I do hereby require you to cleanse and disinfect the said building within days from the service hereof, and within the said period to vacate the said building and not to re-occupy the same until after the expiration of from the date on which the same shall be fully vacated as aforesaid.

Place and Date } Signature :— Municipal Commissioner. / Municipal Officer. / Police Officer.

426. (1) If the Commissioner is of opinion that the destruction of any hut or shed is necessary to prevent the spread of any dangerous disease, he may, after giving to the owner or occupier of such hut or shed such previous notice of his intention as may, in the circumstances of the case appear to him reasonable, take measures for having such hut or shed and all the materials thereof destroyed.

(2) Compensation may be paid by the Commissioner, in any case which he thinks fit, to any person who sustains substantial loss by the destruction of any such hut or shed ; but except as so allowed by the Commissioner, no claim for compensation shall lie for any loss or damage caused by any exercise of the power conferred by this section.

NOTE :—Failure to comply with the requisitions of this notice will render an owner or occupier so failing liable under section 471 to a maximum penalty of Rs. 100.

Section.

427. (1) The Commissioner may provide a place, with all necessary apparatus and attendance, for the disinfection of clothing, bedding or other articles which have become infected, and in his discretion may have articles brought to such place for disinfection, disinfected on payment of such fees as he shall from time to time fix, with the approval of the Standing Committee, in this behalf, or, in any case in which he thinks fit, free of charge.

(2) The Commissioner may, from time to time, by public notice appoint a place at which clothing, bedding or other articles which have been exposed to infection from any dangerous disease may be washed; and no person shall wash any such article at any place not so appointed without having previously disinfected the same.

(3) The Commissioner may direct the disinfection or destruction of bedding, clothing or other articles likely to retain infection.

(4) The Commissioner may, in his discretion, give compensation for any articles destroyed under sub-section (3).

428. (1) No person who is suffering from a dangerous disease shall enter a public conveyance without previously notifying to the owner, driver or person in charge of such conveyance that he is so suffering.

(2) Notwithstanding anything contained in any Act relating to public conveyances for the time being in force, no owner or driver or person in charge of a public conveyance shall be bound to carry any person suffering as aforesaid in such conveyance unless payment or tender of sufficient compensation for the loss and expenses he must incur in disinfecting such conveyance is first of all made to him.

429. The Commissioner, with the sanction of the Corporation, may provide and maintain suitable conveyances for the free carriage of persons suffering from any dangerous disease; and when such conveyances have been provided, it shall not be lawful to convey any such person by any other public conveyance.

430. (1) No person who is suffering from a dangerous disease shall,—

(*a*) without proper precaution against spreading such disease, cause or suffer himself to be carried in a public conveyance;

(*b*) cause or suffer himself to be carried in a public conveyance contrary to the provision of the last preceding section.

(2) No person shall go in company with, or take charge of, any person suffering as aforesaid, who causes or permits himself to be carried in a public conveyance in contravention of sub-section (1).

(3) No owner or driver or person in charge of a public conveyance shall knowingly carry or permit to be carried in such conveyance any person suffering as aforesaid, in contravention of the said sub-section.

431. The owner, driver or person in charge of a public conveyance in which any person suffering as aforesaid has been carried, shall immediately provide for the disinfection of the same.

432. (1) No person shall, without previous disinfection of the same give, lend, sell, transmit or otherwise dispose of any articles which he know or has reason to know has been exposed to infection from any dangerous disease.

(2) Nothing in this section shall be deemed to apply to a person who transmits, with proper precautions, any such article for the purpose of having the same disinfected.

433. (1) No person shall let a building or any part of a building, in which he knows or has reason to know that a person has been suffering from a dangerous disease, without first having such building or part thereof and every article therein likely to retain infection disinfected to the satisfaction of the Executive Health Officer or of some duly qualified medical practitioner, as testified by such officer's or medical practitioner's certificate.

(2) For the purpose of this section, the keeper of a hotel or inn shall be deemed to let part of his building to any person accommodated in such hotel or inn.

Special Sanitary Measures.

434. (1) In the event of the city being at any time visited or threatened with an outbreak of any dangerous disease, or in the event of any infectious disease breaking out or being likely to be introduced into the city amongst cattle, including under this expression sheep and goats, the Commissioner, if he thinks the ordinary provisions of this Act or of any other law at the time in force are insufficient for the purpose, may, with the sanction of Government,

(*a*) take such special measures, and

(*b*) by public notice prescribe such temporary regulations to be observed by the public or by any person or class of persons,

as he shall deem necessary to prevent the outbreak of such disease or the spread thereof.

(2) The Commissioner shall forthwith report to the Corporation any measures taken and any regulations prescribed by him under sub-section (1).

450. (1) In the case of a person who has been attended in his last illness by a duly qualified medical practitioner, that practitioner shall sign and forward to the Commissioner a certificate of the cause of such person's death in the form of Schedule P, or in such other form as shall from time to time be prescribed by the Commissioner in this behalf, and the cause of death as stated in such certificate shall be entered in the register, together with the name of the certifying medical practitioner.

(2) The Commissioner shall provide printed forms of the said certificates, and any duly qualified medical practitioner resident in the City shall be supplied, on application, with such forms, free of charge.

THE DANGEROUS INFECTIOUS DISEASES IN INDIA AND THE TROPICS INCLUDE :—

Intestinal.	Infectious, contagious or inoculable.	Conveyed by Insects.
	Tuberculosis.	
Cholera.	Small-pox.	Malaria.
Diarrhœa.		Relapsing Fever.
	Anthrax.	Plague.
Dysentery.	Leprosy.	Dengue.
	Erysipelas.	
Sprue.		Filariasis and Elephantiasis.
Enteric Fever. (Typhoid).	Measles.	
	Whooping Cough.	
Typhus Fever.	Diphtheria.	
Beri-Beri	Scarlet Fever. (Rare.)	*Kala Azar* and Oriental Sore.
	Chicken-pox.	
Tuberculosis.	Influenza.	
	Puerperal Fever.	Yellow Fever.
Malta Fever.	Epidemic Pneumonia.	Sleeping Sickness.
	Mumps.	
	Tetanus.	
	Actinomycosis.	
	Glanders.	
	Hydrophobia.	
	Cerebro-Spinal Meningitis.	

As regards the "intestinal" diseases, it may be stated that their prevention lies chiefly in sanitation, personal, domestic and public.

Infected food in some form, infected water or infected milk, infected carrier, human or animal, is the cause of these diseases.

Each of these diseases is conveyed by a special organism, in each case gaining access to the intestinal canal by the food, milk, or water, either directly or indirectly, and possibly by infected latrines and the methods of ablution. Flies, ants and other insects, also rats and mice may become carriers as well as infected human beings.

Koch has laid down certain conditions as to the microbial origin of communicable diseases, *viz.* :—

(1) The micro-organism must be found in the blood.

(2) The micro-organism must be isolated from the blood and cultivated in suitable media outside the animal body.

(3) A pure cultivation thus obtained produces the same disease when introduced into the body of a healthy animal.

(4) In the inoculated animal the same micro-organism must again be found.

The onset of an attack of most of the commonly recognized communicable diseases is characterised by fever. Hence the two expressions "fever" and "infectious disease" are commonly regarded as synonymous.

The first stage in the course of a fever is the "infection" or the time at which the germ of the disease enters the body. This period varies in different diseases. The manner in which the infective germ has gained access to the body varies considerably.

The period between the date of infection and the onset of the disease is called the *period of incubation*, and varies considerably in different diseases : in Small-pox from 12 to 15 days ; in Enteric Fever few days to 3 weeks, &c. It is important to know, as accurately as possible, the incubation period of those affections against which we wish to adopt measures of prevention.

We next come to the onset of the disorders which in most cases is sudden and marked by a rise of temperature and other symptoms such as shiverings, convulsions, &c. In some, the onset is insidious, the patient being scarcely able to fix the day on which his illness commenced. The fever subsequently passes through two more stages, which may be called the *height* and the *decline* of the fever.

Further there is a period of convalescence to follow, which may be short or long.

In regard to epidemic diseases, an informal conference of Sanitary Commissioners was held at Simla in May 1919. This body recommended the following measures, most of which were subsequently approved by Government (Resolution No. 11357 of 12th November 1920) :—

(1) Publication of correct vital statistics of larger towns in the provincial Gazettes and the modification of the form of weekly reports regarding the condition of health at principal ports;

(2) Early notification of all infectious diseases;

(3) Provision of properly qualified class of Medical Officers of Health for urban and rural areas;

(4) Security of appointment of urban and rural M.O.H.;

(5) Institution of State Faculty of Public Health for each province;

(6) Industrial hygiene in the prevention of industrial dust and the reduction of hours of labour; demand for additional staff of Inspectors;

(7) The hygienic education of the general public, inclusive of students and scholars;

(8) Necessity of securing to the Sanitary Commissioner the position of responsible technical adviser to the Local Government in all matters affecting public health;

(9) Establishment of a public health bureau for publishing a public health bulletin;

(10) Training staff for employment in epidemic times: the training to be confined to such primary matters as the disinfection of wells, treatment of cholera stools, rat trapping and baiting, &c.;

(11) Prevention of the importation of Yellow Fever. The reduction of facilities for the breeding of stegomyia mosquitoes in ports and legislation to enable ports to take action against the breeding of mosquitoes.

EPIDEMICS AND INFECTIOUS DISEASES—RULES FOR THE GUIDANCE OF CONSERVANCY AND SANITARY INSPECTORS.

1. In dealing with epidemic diseases, such as Cholera and Small-pox, all other duties should be put aside, and *immediate* attention given to cases brought to the Inspector's notice.

2. When a case of Cholera is reported to the Conservancy Inspector, he shall at once arrange to disinfect the privies, traps and receptacles with Izal fluid, and clean and flush the gullies with Pesterine.

3. Gullies, where dead rats have been found, should be well cleaned and flushed and then pesterined.

4. During epidemic seasons, all boarding-houses, Goanese clubs, *musafarkhanas* and *dharmashalas* shall be regularly visited and inspected by the Inspector or Section Sub-Inspector.

5. The following disinfectants shall be used :—

Pesterine or Kerosine for Plague-infected houses and where rats have been found ; also to prevent breeding of flies, &c., and in case of accumulations of water to prevent mosquito-breeding.

Izal Fluid for Small-pox, Cholera, Phthisis, Measles, etc., and mixed with Pesterine for Malaria as it has been found to be effective in killing larvæ.

Sulphur for fumigating after Small-pox, Measles, Phthisis, etc., and for vermin.

Izal powder for places where fluid cannot be used and for those fouled by human excreta and urine.

Permanganate of Potash for wells infected with Cholera vibrio.

PLAGUE.

The present epidemic of Plague in India was first noticed in Bombay in August, 1896. In spite of all attempts to

prevent it, it spread all over the island, and from the island to the mainland. The disease may be said to have become indigenous in Bombay from 1897. In 1898 a Plague Commission was appointed to inquire into the cause, &c., of the disease. The Commission spent four months in India and returned to England, and in 1901 issued a report on their investigations.

Evidence was taken from every one in India who was considered to have had any experience of the disease. In addition to this Commission, deputations were sent from Austria, Germany, France, Russia, Turkey and other countries to investigate the disease. The inquiries have all been published and comprise much that is of value. But the actual results of this Commission, so far as controlling the disease or throwing any light on its origin, its method of infection and measures to prevent its spread in India are concerned, have been practically nil, as evidenced by the virulence of the disease during succeeding years in India.

The present Plague Research Commission, appointed in 1905, publishes from time to time the results of its investigations and constantly produces new and interesting material bearing on the subject.

Col. Liston, C.I.E., I.M.S., Director of the Bombay Bacteriological Laboratory, and senior member of the Commission in India, has published memoirs on Plague prevention and Inoculation, which are very valuable contributions to the literature on the subject.

Col. Browning-Smith, I.M.S., working independently in the Punjab, deals with the prevention and epidemiology of the disease, while Major Kunhardt, I.M.S., also on the Commission in Bombay, has contributed some interesting notes on the epidemiology of the disease in villages.

To get an insight into the completeness of the investigations made, their reports should be consulted.

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INTRODUCTION INTO BOMBAY.

How the disease was brought to Bombay in the first instance is still unascertained. Several theories have been advanced, the most important being as follows :—

(1) The disease may have been brought to Bombay by sea from Hongkong or from the infected parts in southern China.

(2) It may have been conveyed from the Persian Gulf, the disease being endemic in Mesopotamia.

(3) The infection may have been carried from Kumaon and Garhwal Hills to Bombay by pilgrims.

(4) Another theory is that it was brought by pilgrims from Jeddah. It has been suggested that the infection may have been carried by rats, merchandise, infected clothing, food and grain.

(5) A reference to the map of southern China, India and Arabia will be of interest with regard to the theories suggested. It will be seen that in August, 1896, Plague first appeared in Bombay after an interval of 200 years. Plague was reported in Hongkong in 1894, 1895 and 1896; also in Arabia and China in 1893, 1894, 1895 and 1896.

Bombay is a large and important port and city on the west coast of India, and in constant communication with Arabia and the Persian Gulf and the Red Sea Coast, Assyr, &c., where Plague is endemic.

The disease first appeared at Bombay and spread inland to India, west to east. The disease did not come overland across the continent of India to Bombay. It is reasonable then to assume that it was introduced by shipping. The trade between Bombay and Hongkong is small, compared with the other Indian Ports, as Calcutta, Rangoon and Singapore, &c. Ships trading between Hongkong and Bombay touch at many ports before reaching Bombay, but no history of Plague is known previously at any of the ports of India and Burma, previous to the outbreak of Plague in Bombay in 1896, nor did Plague appear at any city inland between Kumaon and Bombay. It appears, therefore, more than probable that the disease came from the Persian Gulf or Arabia, being brought either by pilgrims who come and go to the extent of 20,000 per annum, or merchandise or grain, rats or vermin. The disease appeared first in grain merchants' quarters near the docks.

Once introduced into Bombay with its large population, all conditions were ready for its rapid diffusion.

Plague, thoroughly established, thrives when suitable conditions are found for its sustenance, and when the people are over-crowded in dark, dirty, ill-ventilated, badly lighted

houses ; when the houses and rooms are so dark as to require a light in the day time, when the sick and the healthy live together, when the conditions of climate, atmosphere and temperature and moisture favour its propagation, and when the habits and customs of the people prevent measures being taken to prevent the spread of the disease ; when the floors, walls, ceilings and collections of rubbish in houses form a suitable rendezvous for rats, fleas and all sorts of vermin ; when the primitive method of night-soil removal and drainage facilitate the accumulation of filth and garbage, and provide a happy hunting ground and food supply for rats.

The incidence of Plague follows closely insanitary surroundings, absence of domestic, personal hygiene, overcrowded insanitary areas, want of ventilation and light and the presence of filth—in fact, the incidence of the disease is directly related to the insanitary domestic surroundings which harbour rats.

SANITATION AND PLAGUE.

Sanitation, properly applied, influences the spread o Plague. Sanitation is the result of bacteriological, clinical and epidemiological investigation into the cause of disease, and embraces the whole of practical, preventive medicine as well as the every-day work of practical sanitation. It is not for a moment suggested that the insanitary surroundings mentioned are the cause of Plague ; but the insanitary condition of the people, due possibly partly to poverty and ignorance, is the cause of the persistence of Plague ; that Plague is now practically confined to that class, and that when it is contracted by those who pay more attention to sanitation, the disease is easy to control.

Sanitation includes not only the provision of sanitary houses and streets and proper method of drainage and water-supply, but everything which tends to improve public health and to prevent the spread of disease, including

investigation into the causes of sickness and death, the provision of hosiptals, medical relief, health visitors and instruction in personal hygiene and the spread of the knowledge of the cause of disease.

The development of sanitation and its effect on the health of the people during the past fifty years has been very marked, and is nowhere more striking than in the investigation into the cause and prevention of the spread of infectious diseases such as Yellow Fever, Sleeping Sickness, Malaria, Plague, Diphtheria, Small-pox, Enteric, &c.

CONVEYANCE OF THE DISEASE.

Certain diseases may, and doubtless do, depend upon highly specialised obligate parasites, incapable of thriving except in the tissues of hosts. Such organisms, though themselves a product of evolution, may have been evolved in the remote past under conditions of environment never since, and perhaps never again to be, reproduced.

Notwithstanding, therefore, that all pathogenic micro-organisms are doubtless, especially as regards their pathogenic function, subject from time to time to minor variations within the limits of the species, yet many species of such organisms may have long since attained a high degree of fixity of type and thus exhibit now but little tendency to variation beyond such limits. That such is actually the case with regard to the microphytic causes of some of the diseases, there seems ample epidemiological evidence to show.

In this connection it is important to note that occasional difficulty in tracing particular attacks of a given disease to previous cases is far from justifying hasty conclusions that such attacks have had another origin. The probability of such being the case must depend upon a comprehensive view of the ascertained facts, with regard to the disease in question at least, that is, pending definite knowledge of the life-history of the microphyte upon which the disease depends, the multifarious ways in which infection may have been carried and the difficulty of tracing its carriage by man: such ways must be fully taken into account. Allowance must also be made for errors of diagnosis, untreated and concealed cases, which largely add to the difficulty of following out the casual association between successive and connected attacks. If this difficulty is met with in the early cases of an outbreak, the possibility of tracing back the outbreak to some previous prevalence in a more or less remote neighbourhood, to which it may in reality have been due is entirely prevented.

Certain diseases appear to have special seat; or points of invasion, that is to say, the viruses upon which they depend usually attack the body

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by some special channel or channels, and possess little, if any, ability of primarily establishing themselves elsewhere. This appears to be the case with regard to the poisons of Diarrhœa, Cholera and Enteric Fever, which make their assault upon the intestinal mucous membrane, and with regard to the poison of Pneumonia which attacks the lungs, and Diphtheria which attacks tonsils and throat.

These facts are of considerable importance with respect to the spread of such diseases, for it is not sufficient, in cases of the kind, that the poison should simply be brought to the body, but it must be conveyed also to the particular part of the body which is vulnerable to it. Here we find an analogy in the behaviour of the parasitic fungi which produce the diseases of plants. Some of these attack the flowers, some the fruit, and some the roots.

Take, for instance, Enteric or Cholera; we know that these diseases are caused by a poison introduced directly into the intestinal canal either by mouth or rectum. We know that the food or water-supply is infected directly or indirectly from a previous case of the disease by these channels and this knowledge has enabled us to prevent the spread of these diseases by sanitary precautions outside the dwellings; with regard to Plague, we have no such knowledge to guide us. In fact, up to a short time ago, our knowledge on this point was negative. If our view of pathology of the disease is correct, we can eliminate food and water. Bubonic Plague is a direct contagion, and contact with the body either through the mucous membrane of the mouth and thorax or other mucous membrane or by the skin is necessary for invasion, and it is this which supports the view that the personal surroundings of the individuals are the factors which contribute to the spread of Plague.

STATEMENT SHOWING PLAGUE MORTALITY IN THE WHOLE OF INDIA AND IN BOMBAY CITY SINCE 1896.

Year.	No. of Deaths from Plague in India.	No. of Deaths from Plague in Bombay City.
1896	2,219	1,936
1897	53,816	11,003
1898	116,285	18,185
1899	139,009	15,796
1900	92,807	13,285
1901	283,788	18,736
1902	583,937	13,820
1903	865,578	20,788
1904	1,143,993	13,538
1905	1,069,140	14,198
1906	356,721	10,823
1907	1,315,892	6,389
1908	156,480	5,361
1909	178,808	5,197
1910	512,605	3,656
1911	846,873	4,006
1912	306,488	1,717
1913	217,869	2,609
1914	296,623	2,941
1915	380 501	599
1916	205,527	1,987
1917	437,036	1,706
1918	440,752	1,143
1919	74,284	702
1920	Not available	282
Total ..		

Plague is a specific, inoculable and otherwise communicable epidemic disease common to man and many of the lower animals. It is characterised by fever, adenitis, a

rapid course, a very high mortality and the presence of a specific bacterium, Bacillus pestis, in the lymphatic gland, viscera and blood. In a large proportion of cases, buboes form in the groins, armpits or neck.

The characteristic microbe appears in great profusion in the buboes, in the spleen, intestines, lungs, kidneys, liver and other viscera and also—though in smaller numbers—in the blood. In the Pneumonic type of the disease, it is present in the sputum in enormous numbers. It occurs also in the urine and fæces.

Yersin's experiments prove conclusively that Plague is communicable by ectozoa, especially rat fleas, principally Pulex cheopis, which act as passive intermediaries and carriers of the bacillus. The Baccillus pestis multiplies in the stomach of the flea, retaining its virulence for 7 or 8 days and being passed out in the fæces; so that the flea serves not only as a carrier, but also as a multiplier of the germs.

Recent researches by the Plague Commission working in Bombay show that Plague in man is intimately connected with Plague in rats, and that the flea from infected rats may convey the disease to man. As far back as the history of the disease goes, the rat has in some way been associated with the disease in man, and rats have been destroyed with the object of preventing it.

The following is a summary of the latest report of the Plague Commission's work. The opinion given by them recently published is—

(1) That epidemics of human Plague are directly dependent on the occurrence of epidemic Plague in rats.

(2) That there is no evidence that any animals except rats play an important part in Plague epidemics.

(3) That in the great majority of cases, during an epidemic of Plague, man contracts the disease from Plague-infected rats through the agency of Plague-infected rat fleas.

(4) That in large towns Plague may persist throughout the year since a few cases of acute Plague in man and rats occur during non-epidemic Plague season.

THE DIAGNOSIS OF PLAGUE IN THE RAT.

Post-mortem appearances :—

(1) *Rigor mortis.*—Well marked and prolonged, limbs project stiffly and the carcass has a *wooden rigidity.*

(2) *Subcutaneous congestion and hæmorrhages. Distinct reddish hue* on removing the skin, subcutaneous hæmorrhages seen commonly in the *submaxillary region* and *the flanks. Pink feet* in rats dead over one hour are quite characteristic and well marked in the fore-feet.

(3) *Buboes.*—In order of frequency, these are found in the neck, axilla, groin and pelvis. 75 % are in the neck.

In the *primary bubo*, the gland is enlarged and congested and when cut across shows hæmorrhagic points. It is recognised by the presence of enlarged hard masses in the situation of the lymphatic glands, and by the existence of infiltration and extravasation of blood in the vicinity.

In the secondary buboes, the gland is slightly enlarged and congested ; but there is an absence of infiltration and hæmorrhages.

(4) *The Liver*—Larger than normal—*paler and pinkish* in advanced cases.

It pits on pressure and is easily lacerated. Lobules clearly demarcated and this, *combined with the yellowish* appearance of the parts affected, contrasting with the reddish colour of the congested areas, constitutes what is termed *mottling.* Small necrotic foci scattered over its surface ; they are discrete and about the size of a pin's head and show as if it were dusted with pepper. This granular or mottled appearance is very characteristic.

(5) *Spleen*—Larger and firmer. A necrotic patch if combined with even slight "mottling" of the liver is very suggestive of Plague.

(6) *The Pleuræ*—Pleural effusion is very characteristic. The effusion is quite clear and is often very abundant.

Remarks.—The presence of a typical bubo ; after which, in the order of their importance, come the "granular" liver, subcutaneous hæmorrhages and pleural effusion.

If all these features are absent, then the rat is not Plague-infected. A rat poisoned with the "rat exterminator" may show granular liver, but in this case the absence of all other signs of Plague and the *presence of acute inflammation of the stomach and intestines,* a condition *never seen in Plague,* serve to render the diagnosis easy.

A large subcutaneous hæmorrhage without other signs of Plague is due to injury.

Rats with eczematous or hairless patches should be discarded.

NATURAL HISTORY AND HABITS OF RATS.

The habits of rats vary according to the species to which they belong. There are many different kinds of rats, but for convenience they may be divided into (*a*) house rats and (*b*) field rats.

This division is not strictly accurate, because some field rats enter houses and *vice versâ*.

The house-frequenting rats are of prime importance so far as Plague in man is concerned.

There are at least four common house-frequenting rats in India, but they do not all play an equally important part in the spread of Plague.

Two of these four kinds can be dismissed very shortly; they both belong to the genus Nesokia, a group of rats more familiarly known as bandicoots.

Before Plague was introduced into Bombay, the large bandicoot was frequently seen in houses, but it is now a rare rat in Bombay.

Occasionally, however, the lesser bandicoot (or Nesokia Bengalensis) is met with.

Among a very large number of rats found dead and caught alive in Bombay City and examined by the Plague Commission, this species constituted only 1% of the whole.

NESOKIA BENGALENSIS.

Short, stumpy, pig-like face. Broad fore-head. Large ears. Rough bristly fur. Short, comparatively hairless tail.

The other two kinds of house-frequenting rats with which we are more concerned are: (1) the Mus decumanus and (2) the Mus rattus.

MUS DECUMANUS.

This rat is comparatively rare in India. Indeed it is never found in inland villages, and has only recently established a footing in some of the larger Indian seaport towns.

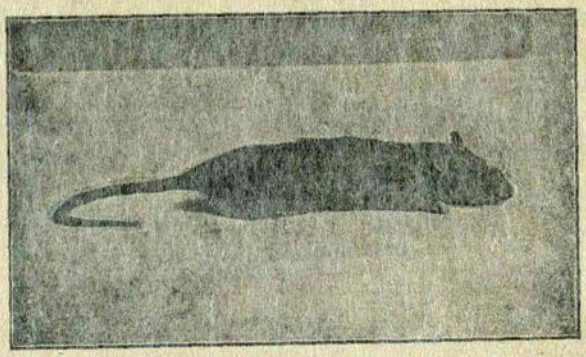
It is found in Bombay City where sewers and drains exist, but it cannot be captured in the suburbs where drainage systems are unknown. It lives in burrows and drains, for the most part constructed outside of houses, but it enters houses for food.

It feeds on garbage of all kinds, it is a dirty, shy, timid rat, shunning the society of man but living on the refuse he leaves. It first made its presence manifest in England and some other European countries coincidently with the disappearance of Plague from them.

The rat is said to have been imported from Norway; hence it has been called the Norwegian rat.

It gradually displaced in England another species, *viz.*, Mus rattus.

Characteristics of M. decumanus as compared with M. rattus.



Mus Decumanus.

(1) It has a longer and sharper snout. (2) Smaller ears. (3) Fur, less bristly. (4) A more hairy bi-coloured tail, the dorsal surface of which is darker than the ventral.

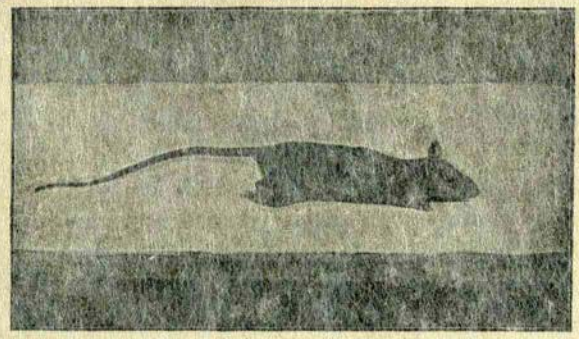
MUS RATTUS.

This rat was common in England in the early Plague period. It has, therefore, sometimes been called the old English black rat. It is the common house rat of India. It is a neat, clean-living creature, very domesticated and constantly associated with man.

It lives and breeds in human dwellings, in cupboards, beneath boxes or among any sort of lumber. It finds ideal conditions for existence in Indian houses. Intimately associated with man, it readily finds shelter on ships and trains among the materials placed on board for transport.

It frequently makes for itself burrows in the earthen floors and walls of huts in Indian villages, there it breeds and multiplies with great rapidity, feeding upon the grain and other materials stored in the house.

In the island of Bombay there are probably 3 sewer rats (M. decumanus) to every 7 of the house-rats (M. rattus)



Mus Rattus.

CHARACTERISTICS OF MUS RATTUS.

Size	..	Comparatively small.
Colour	..	Dark.
Head	..	Small and pointed.
Ears	..	Large.
Body	..	Shorter than the tail.
Habits	..	Prefers to live in roofs of houses, etc. (*see* above).

COMPARATIVE TABLE.

	Mus Decumanus.	Mus Rattus.
Size ..	Comparatively large.	Comparatively small.
Colour ..	Brown.	Dark.
Head ..	Thick and short.	Small and pointed.
Ears ..	Small.	Large.
Coat ..	Rough.	Smooth.
Body	Longer than tail.	Shorter than tail.
Habits ..	Burrowing. Lives in drains and cellars.	Lives in roofs and inside of houses.

Mus rattus is a Plague-spreading rat because of its habits. That *M. rattus* is the most important Plague-spreading rat in India has been amply proved by the Plague Commission. The Commissioners were enabled to secure for examination a large number of rats found dead or trapped alive in Bombay City. They were thus able to record each week the number and species of the Plague-infected rats found. The examination and record was continued for a year, and the mean weekly number of infected rats of each species for that period was calculated. The Commission was also supplied with figures of the weekly human mortality from Plague in the City, and so was able to calculate a mean weekly human Plague mortality figure for the year.

The Plague among *Mus rattus* precedes the Plague among men by an interval of a week to a fortnight.

THE RAT PROBLEM IN INDIA.

The rat problem in India falls under the following heads :—

A. Diseases caused by rats.—
- I. Plague,
- II. Rat bite fever.
- III. Spirochaetosis.
- IV. Other diseases in man and animals, *viz.*, Trichinosis, etc.

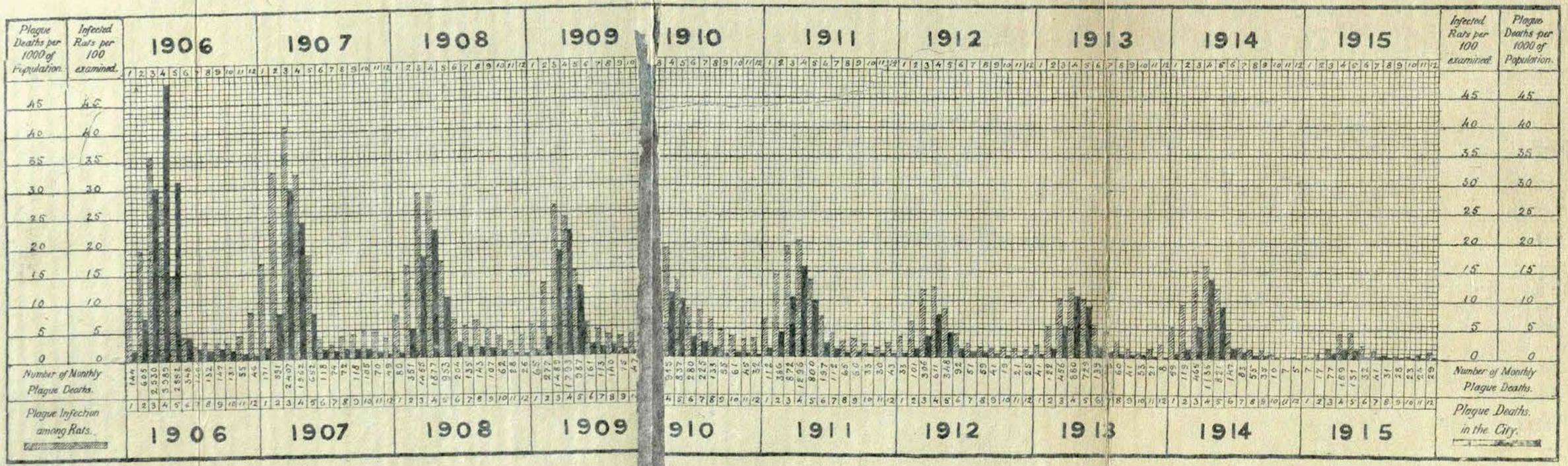
B. Material damage caused by rats.—
- I. Consumption of grain.
- II. Damage to standing crops.
- III. Damage to fabrics, structures, etc.
- IV. Accidental fires, &c.

C. Expenses incurred in rat destruction and in anti-Plague measures.—
- I. Payment of staffs.
- II. Traps and poison.
- III. Anti-Plague inoculation.
- IV. Evacuation, disinfection, etc.

DIAGRAM.

RELATION OF RAT PLAGUE TO HUMAN PLAGUE DURING 1906 TO 1915

IN BOMAY CITY—BY MONTHS



RATS AND PLAGUE.

The association of the rat with Plague is no new theory. The mortality amongst rats preceding a Plague epidemic has been quoted in the history of most of the Plague epidemics for many years. Since, however, the discovery of the Plague bacillus by Kitasato, and the presence of the bacillus in the rat during the Plague epidemics, the relation of rat Plague and human Plague has been more clearly demonstrated.

The relation of the epizootic and epidemic Plague has been carefully studied in outbreaks of the disease in Hongkong (Hunter), South Africa (Blackmore and Mitchell), Sydney (Ashburton Thompson), and other places, and was early recognised in India by Simond, Hankin, Weir, and the German Commission.

Some idea of the intimacy of the correlation between human Plague and Plague in *M. rattus* can be gathered when it is stated that it has been mathematically calculated from figures supplied by the Plague Commission that the correlation co-efficient of human Plague with the *rattus* Plague of the second previous week is ·9407 with a possible error of +·0096. Statisticians generally consider a correlation co-efficient very large when it is greater than ·75. We may conclude, then, that the relationship between the incidence of Plague in man and Plague in *M. rattus* is extremely close.

The Commission, as the result of exhaustive inquiries in certain small villages, where *M. rattus* was practically the only rat caught, were able to show that the correlation in time found to exist between Plague in *M. rattus* and Plague in man held good also as regards space. Where rats died, there, a week to a fortnight later, human cases commonly occurred. They were thus able to conclude that Plague in *M. rattus* is the direct cause of human Plague in India. It is the habits of *M. rattus*, the house-rat, that make this rat so important a Plague-carrier.

The common cause of Plague in the rat and man is the Plague bacillus, a delicate organism which can only exist

in the body of a living animal. The mere handling of Plague infected animals or living in contact with persons suffering from the disease, is not as a rule the means by which infection is conveyed from the sick to the healthy. Under ordinary circumstances, infection can only take place when the Plague germs are injected beneath the skin. In other words, the bacillus requires to be transferred from the blood of the sick to the blood of the healthy. This transfer of the germ from the sick to the healthy is generally effected by the blood-sucking rat-flea, the Pulex cheopis.

There is however another form of Plague, the pneumonic, which can be conveyed by direct infection.

BREEDING.

One female rat can have 6 litters of young every year and on an average either 7 or 9 in each litter and is thus capable of producing 48 rats per annum. Of these 48, 24 are female and at the age of a little more than two months each produces a litter of from 6 to 9.

FECUNDITY TABLE.

After Suschlag.

One pair of rats.

1 doe has a litter.	Dec. 29.	Feb. 15.	Apl. 1.	May 15.	July 1.	Aug. 5.	Litters. 1 by 6 of 8=48
1st generation:							
1st litter: 4 does have litters.	Apl. 15 (a)	June 1 (a)	July 15 (a)	Sept. 1 (a)	..		4 by 4 of 8=128
2nd litter: 4 does (b) have litters.	June 1	July 15	Sept. 1	..	..		3 by 4 of 8=96
3rd litter: 4 does (c) have litters.	July 15 (c)	Sept. 1 (c)	..	..	..		2 by 4 of 8=64
4th litter: 4 does have litters.	Sept. 1 (d)	..	..	..	..		1 by 4 of 8=32
2nd generation:							
1st litter: 16 does (a) have litters.	Aug. 1	Sept. 15	..	..	..		2 by 16 of 8=256
2nd litter: 16 does (a) have litters.	Sept. 15	..	..	..	..		1 by 16 of 8=128
1st litter: 16 does (b) have litters.	..	..	..	..	..		1 by 16 of 8=128
						Total	.. 880

The young Mus rattus at birth has the appearance of a tiny, hairless, red lump of flesh weighing about 5 grammes. The eyes are closed and open only after a period of two weeks. The young rat gains about a gramme per day in weight till it grows up to a weight of 100 grammes. After reaching this limit the increase in weight is not so regular as to enable one to tell the age of the rat. The young are weaned in the course of the 4th week, and reach a state of maturity on attaining a weight of 70 grammes or when a little over two months old.

DAMAGE DONE BY RATS.

Rats do great damage to property and material—by burrowing under foundations, through walls, gnawing through doors, partitions, ceilings, and house-gullies. In docks, warehouses and shops a large quantity of merchandise is annually destroyed. They have also been known to gnaw through gas and water fittings, through drains and sewers, occasioning thereby great inconvenience to the residents. Food, furniture, books, linen, pets, eggs, furs, leather and valuable textile goods, fruits, vegetable and standing crops are readily attacked and if not devoured are destroyed by rats. In India the annual loss due to rats from all causes is estimated at 60 crores of Rupees.

It is estimated by Mr. Boelter that there is a rat population in England and Wales of 40,000,000 rats, or 1 per head of the human population. Assuming that this ratio holds good in Bombay, the rat population in Bombay before rat destruction began would be 1,000,000. The natural mortality is estimated as 25 per cent. per annum and the mortality of rats accounted for by rat campaigns 25 per cent.

This does not represent the actual number destroyed, as many thousands are poisoned and their dead bodies washed out in the sewers and are never found; probably as many more are destroyed by rat campaigns, and the number is

thus kept down, because in a confined and limited area, the number could not go on increasing.

To give an idea of the damage done by rats in a city like Bombay, it is estimated by Mr. Boelter in his book ("The Rat Problem") that every rat will do one farthing's worth of damage every day.

In addition to the rats caught and collected, there must be about the same number dying of other causes, or roughly 1,000,000 per annum and this represents on the above basis about £400,000, or 60 lakhs of rupees per annum saved to the commerce of the City. But it means a great deal more than that, as, had these rats not been destroyed, after deducting deaths from natural causes, 25 per cent. of these could have increased to 200,000,000.

It might be argued that, by killing 500,000 rats annually in Bombay, the remaining become stronger and multiply faster. It has been compared to a war where the population of a country always become greater and stronger after a war; but in war the females are not killed, only males, while in inrat-war both are killed and very often, killing a female, 10 others are killed and the war is always going on and the number thus kept down. An increase of males in wild multiparous animals tends to decrease the population if there be not a corresponding number of females.

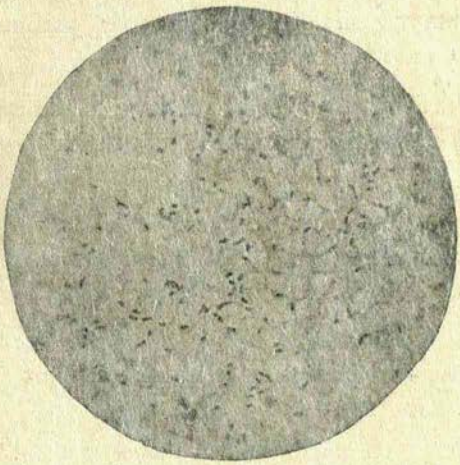
It is estimated that in the grain godowns in the City, there are rats doing a damage to the grain of at least Rs. 50,00,000 (fifty lakhs) per annum.

THE MAIN FOOD OF RATS.

The Mus rattus prefers as food, grain which is in common use in the locality or country. The Poona rats will prefer bajri grain, the Madras rats rice, the Sholapur rats jowar grain and so forth. In the hot weather and where an insufficient supply of water exists, the rats prefer fruit and vegetable to grain. The most popular with them are the sweet potato, melon, cucumber, coriander leaves, mango and the cocoanut.

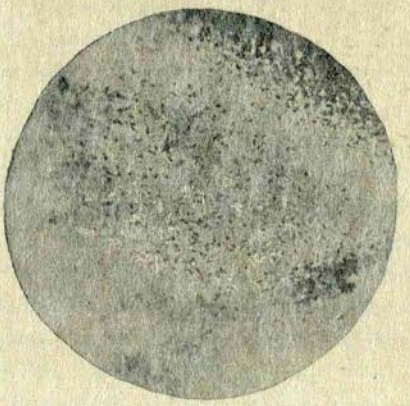
FLEAS.

The possibility of insects playing some rolè in the transfer of Plague from rat to rat and rat to man occurred to many investigators: Yersin 1894, Hankin 1897, Nuttal 1897, Ogata 1897, Simond 1898 and Liston 1903, recorded their observations that, whilst sucking, fleas were in the habit of discharging the contents of their intestines upon the skin in the neighbourhood of the puncture, and in consequence infected material might subsequently be rubbed in during the relief of the irritation (see Report of Commission). Liston in his paper on "Plague Rats and Fleas" in 1905 recorded many valuable observations and experiments. But during the



Blood of Plague-infected Rat containing Plague bacilli.

past few years the Plague Research Committee, working in Bombay, have made extensive observations regarding the relationship of rat Plague and human Plague, and the results of their work have supplied us with the data which place us in the position we are now in.



Stomach contents of flea showing Plague bacilli.

There are many kinds of fleas, some more particular than others in the selection of their host.

They are chiefly distinguished by their size and colour, the shape of their claws, and the presence of bristles at particular parts.

Besides having structural differences, fleas vary in the preference for different hosts. The rat flea generally remains on the rat, but when hungry may attack man or animal.

The flea seems to pass some time on the host, and the remainder in dirt, dust and sand.

The eggs, about 12 in number, are laid in dust and dirt, and sometimes in the hair and fur of animals, and hatch out in about 50 hours or more.

The young larvæ is a pearly white fourteen-segmented grub (about 105 m.m. in length) with a large brown head.

The larvæ live as such about 7 days and then spin cocoons and develop into chrysalids while in the dust.

These chrysalids remain in the cocoon for about 8 days, so that about 17 days altogether are occupied in the growth and development of the flea.

(Pearse on "Insects and Diseases," Calcutta Med. Journal.)

(*a*) PULEX IRRITANS.

♂ Pulex irritans

This is the human flea. It is very select in its choice of the animal on which it feeds. It is seldom found on others than man.

It is of large size, bright coloured, eyes distinct.

Found in dark and dirty habitations. No bristles behind the head but present on posterior extremity of the abdomen. Claws, large and scytae-like.

(*b*) PULEX CANIS.

Commonly called the dog flea, it is not very particular in the selection of its food. It will suck the blood of dog, cat, rat, man, horse, goat, guinea-pig, hedge-hog, kangaroo, rabbit, and a number of other animals, although it prefers to feed on a dog or cat and will select these animals in preference to others when they can be found.

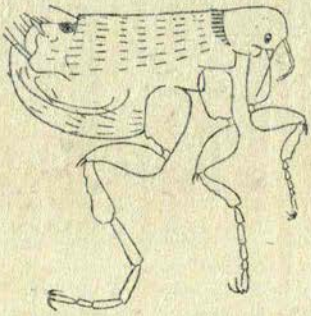
♂ Pulex felis.

(c) CERATOPHYLLUS FASCIATUS.

The common flea found on rats in Europe is more or less particular in its choice, being generally found on rats.

This flea has combs behind the head but no bristles around the mouth.

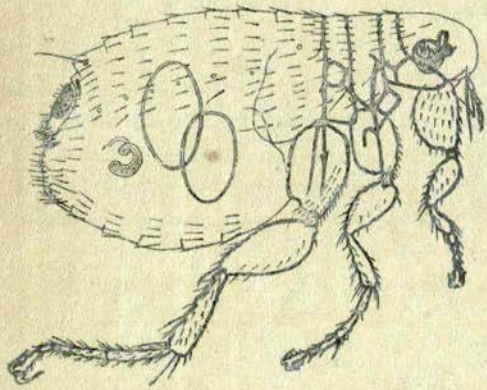
♂ Ceratophyllus fasciatus



(d) PULEX CHEOPIS.

The Indian rat flea is of small size, bright coloured. It loves darkness and is very sensitive to light.

At first sight it resembles the human flea.



Female.

Male.

It has no bristles behind the head. It has bristles on the posterior extremity of the abdomen, and possesses elegant sickle-shaped claws. These points are perhaps better seen in the subjoined illustration.

♂ Pulex cheopis

A small flea of dark colour. Not nocturnal in habits and frequently found in light places. Has combs behind the head and teeth-like bristles round the mouth.

Unlike the Ceratophyllus fasciatus, it readily feeds on a number of animals. In the absence of the rat it will bite man, especially when it has been starved for 2 or 3 days, but when rats are available, it will leave man to take to the rat.

This peculiar habit of fleas of selecting animals explains why Plague does not attack man until a few days after the death of rats. The order of events is recognised to be, first Plague among rats, then a lull, and this is followed by Plague among men. The lull can now be explained by the fact that rat fleas seldom attack man till forced by hunger to do so.

The flea, after having fed on an infected rat, escapes from the dead body of the rat and searches for fresh food; in its passage from the place where it is deposited by the dead rat, it comes in contact with human beings, and being hungry will attack man. Now, it is not asserted that the bite of the flea alone is sufficient to convey the disease, although it is possible, but the flea having lived on a Plague-infected rat contains in its stomach a large number of Plague bacilli and the bacilli are deposited where the flea abides. It is thus possible for fleas to gain access into rooms, clothes and bedding of human beings, and then to bite and deject the bacilli, which gain entrance to the skin either by the pricking and irritation of the bite or by the breaking of the skin or wound. The habits of the people who sleep on the floor with scanty clothing, their uncovered feet and bodies

constantly exposed to infected material, make them ready victims to this method of attack.

It has not been, however, clearly shown that it is absolutely necessary for the flea to actually bite or live on the human being, but it is possible for the Plague bacilli in the dirt or the body of the rat or in the fæces of the flea to gain access to the human being.

Rat fleas cannot travel far unless carried by a host. The rat is the common host of *P. cheopis*, but man occasionally carries these fleas on his person or clothing for long or short distances. Rat fleas cannot on their own legs travel great distances; twenty or thirty yards would constitute for them a long journey, but carried by a host they can cover some distance. *Pulex cheopis*, the rat flea, is most frequently carried by rats from place to place; but as rats usually confine themselves to comparatively small areas, and do not wander far from their holes, infection can only be spread in this way to a limited extent. At times, however, rats are carried in trains and in ships for long distances concealed among various articles of commerce, especially grain and rags. In this way rat fleas may be transported from place to place. Fleas spend a great part of their existence on the ground, and not on their host, and there too, the larva lives and feeds.

In this habit fleas differ from lice which confine themselves far more closely to a particular animal than do fleas.

Another method by which transference may take place is by the carriage of these insects by man on his person or in his clothing for long or short journeys. This means of transporting rat fleas is most likely to occur when, rats having suddenly become scarce, the rat fleas seek man to feed upon. These conditions are most often found in a Plague-infected house. People coming from such houses are liable, therefore, to harbour rat fleas on their person and some of these fleas may carry in their bodies the Plague germ. Thus it comes about that rat fleas are carried to healthy areas

and, when introduced there, they leave man and seek the rats. If the rats are bitten by infected fleas, Plague may break out among these animals and later, in turn, man may become infected. In short, it may be stated that rats are usually responsible for the spread of Plague in an infected locality, but man not infrequently carries infected fleas from an infected place to a healthy area at a distance.

The habit of using the street as a depository for filth and refuse affords a food supply for the rats.

A supply of food for the rats is to be found everywhere. Visit the gullies in the City and wait for a few minutes, when quantities of rice and other food materials may be seen thrown out of the windows.

Plague germs can multiply in the stomach of the rat flea. This makes the flea an ideal transmitter of the Plague organism. It removes the bacilli from the blood of a sick rat, the bacilli multiply in its stomach, and then it transfers them from one healthy rat to another, till at last the affected rats die of the disease and then from hunger the flea takes to man.

On dissection of the flea, Plague germs have never been found anywhere save in the stomach and rectum.

How then does the bacillus emerge from the stomach and pass to the mandibles and thence to man ?

A theory advanced by Messrs. A. W. Bacot and C. J. Martin is as under: From experiments made with certain Plague-infected fleas which were permitted to suck vigorously at the shaven abdomen of rats, it was seen that no blood entered their stomach. The flea, like many other insects, has at the opening of its stomach a sort of valve, covered with tooth-like cells, called the proventriculus, which closes during the process of digestion. When Plague germs enter the stomach of a flea, they soon form solid jelly-like masses of bacterial culture ; these drift forward into the proventriculus, choking the valve so securely that no food can enter the stomach. A flea in this state sucks and sucks, but merely distends its gullet. But the flea's frantic efforts to assuage its thirst drive some of the Plague germs forward from the valve chamber to the gullet, and when it relaxes, some of the blood it has sucked surges from the gullet into the puncture made in the man or the rat. The blood has meantime become infected ; and carries the Plague germs with it. Such is the scientific interpretation of the obscure problem—the channel of communication between the stomach of the flea in which the Plague germs multiply and the seat of puncture in either man or rat.

PREVENTION OF PLAGUE.

Measures for the prevention of Plague are :—

1. Compulsory notification and registration of the cause of death.
2. Rat prevention, killing, collection and examination.
3. Evacuation.
4. Disinfection.
5. Inoculation.
6. Improvement of insanitary areas.
7. Complete system of scavengering.
8. Free medical relief.
9. Circulation of knowledge by lectures, leaflets and diagrams.
10. Rat-proof dwellings.

(1) COMPULSORY NOTIFICATION AND REGISTRATION OF THE CAUSE OF DEATH.

This measure needs no particular comment, as the necessity for it is obvious.

When ten or more fatal non-imported cases of Plague occur during a single week in any place, it should be notified as infected. The Government of India emphasize the fact that the occurrence of a single, definitely non-imported case of Plague is strong presumptive evidence of the co-existence of an epizootic amongst the rats. For this reason they consider it inexpedient that a place should be declared free from Plague until several weeks have elapsed since the last Plague-infected rat was found. This surmises that measures for the destruction of rats are in force and that rats found dead are submitted to examination—both matters of very considerable importance in the larger parts in this country. (Paris Convention on Plague).

(2) RAT PREVENTION AND DESTRUCTION.

Considering the enormous loss of lives due to Plague for which the rat, owing to its close association with man, is solely responsible, and also the vast amount of damage done by

these rodents to property, material and standing crops, etc., the question as to how this problem should be successfully tackled arises. The key to the problem lies in carrying out the work of rat prevention which is the first and most important of the methods, and by rat destruction which is the second and must be persistently and without any relaxation put into force when the first, *viz.*, rat prevention cannot be efficiently worked.

RAT PREVENTION.

This can be effected in various ways :—

(1) By cutting off the access of rats to their food supply, especially grain, and by reducing the same.
(2) By reducing shelter to rats to the lowest possible level.
(3) By reducing easy opportunities for breeding.
(4) By separating important centres of rat infestation from areas inhabited by human beings.
(5) By educating people to consider the rat as one of their greatest enemies.

The first of these conditions can be met by enforcing the principles of rat-free and rat-proof construction. For rat-free construction it is important to bear in mind that a Mus rattus cannot stretch itself more than 7 inches, that its highest jump is $2\frac{1}{2}$ feet; its transverse jump 4 feet, that it burrows with its teeth and never to a greater depth than $2\frac{1}{2}$ feet, that it cannot climb up a hard, smooth and vertical surface, that its runs are close against walls and corners of rooms and that the situation of their burrows in the house or warehouse is invariably in the walls and especially at the corners at a distance of about 2 feet above the floor or a foot downwards below the ceiling.

The following rules are important for observance in rat-proofing structures :—

(*a*) The flooring should be of solid construction and fitted with stone slabs or minton tiles.

(*b*) Fixing of glazed tiles to walls to a height of 3 feet is an advantage, walls to be *pucca* and impervious to rat attack.

(*c*) The ceiling should also be of solid construction and the rooms well lighted and ventilated.

(*d*) The drains to be of sound construction and proof against rats gnawing through the joints. Disused drains should be removed and the opening at the sewer end cemented, or well protected. All holes and burrows to be well rammed in with cement or glass.

(*e*) Buildings in the docks and places where rats do congregate in large numbers should have metal protectors for the foundations extending downwards to a depth of 2½ feet into the soil and protruding onward at an angle, which angle must be filled with concrete.

(*f*) Rat-proof receptacles should be used for the storage of food and refuse.

The second condition can be met by making it impossible for rats to find shelter in our drains and sewers, in farmyards and stables, in our hay ricks and corn stacks, in our compounds by the removal of all ratty surroundings and dumps of accumulated refuse and in our residences by making the latter rat-free if not rat-proof.

The third condition can be met by disturbing the rats in various ways. House cleaning, and shifting of furniture at regular intervals, etc., are some of the easy ways of achieving the object. It must be borne in mind that their breeding appears to be a very delicate process and the slightest disturbance is quite enough to upset them.

The fourth condition can be met by locating granaries, ginning factories, stables, cowsheds, slaughter houses, etc., at some distance from human habitations.

The fifth condition needs no description, but it may be added that without the co-operation of the people, no success in the campaign against rats is possible

In many of the grain godowns and shops in Bombay, in B Ward especially, rats are not allowed to be killed. On the contrary they are encouraged to live. Tins of water can be seen placed in the godown for the rats to drink. These rats can be seen in large numbers in the godown any day coming to drink.

The aforesaid measures explain the logical basis of the following desiderata of grain stores :—

(*a*) Wherever possible, the wholesale storage of grain should be effected in buildings apart from those in which retail trade is carried on.

(*b*) Wholesale grain stores should not be situated in close proximity to densely-crowded areas of a city.

(*c*) Wholesale grain stores should never be utilized for purposes of human habitation.

(*d*) Bearing in mind that water is essential for the life of the rat, no water accessible to rats, or fresh vegetables should be allowed in wholesale grain stores.

(*e*) As rats are unable to circumvent a smooth horizontal projection of nine inches, such a ledge surrounding a grain store on the top of a plinth three feet high is effective in prohibiting the ingress of rats. On the sides of the building in which the doors are situated, this ledge can conveniently be enlarged into a platform 2 feet or 2 feet 6 inches in width. Reinforced concrete is a suitable material for such ledges and platforms.

(*f*) The roof of the godown should overhang this platform and ledge to prevent the accumulation of rain water thereon.

(*g*) No steps or similar means of facilitating ingress should be allowed. In practice the inconvenience caused by the absence of such steps will be found inconsiderable. For unloading sacks of grain designed for such a store, the bullock cart can be pushed close to the platform, which is also at a convenient height to facilitate the deposit thereon of sacks from a cooly's back.

(*h*) Rats will, from time to time, be introduced to such a store but they will be compelled to leave in search of water and should find their return extremely difficult.

(*i*) In villages and places where the cost of such pucca buildings is prohibitive, relatively rat-free stores can be made of almost any material, provided the roof is water-tight, by raising the floor on uprights surmounted by rat-guards similar in design to those commonly employed on ships' cables. These uprights should be at least three feet high and should support the beams on which the floor rests. This floor might be made of wood. The space underneath the floor can be left open and kept free from weeds and rank growth with but little trouble. The above suggestions should be sufficient to enable "rat-free" godown, suitable for any requirements, to be designed, provided the principles on which the suggestions are made are borne in mind, suggestions which are all based on an appreciation of the habits of rats. These godowns will be so constructed and kept as to ensure a remarkably decreased rat population.

Other means of diminishing the risk of the conveyance of Plague-infection through the medium of grain and similar merchandize will suggest themselves. The diminution of the facilities, at present existing, for rats to enter goods wagons and carts; the breaking of bulk of consignments of grain; the erection of platforms on which grain received loose can be bagged; these and similar measures all require attention in certain cases.

Section 384A of the Bombay Municipal Act gives powers for prohibiting "godowns or places for storage in connection with wholesale trade of grain, seed, or grocery in any building used for human habitation without Municipal permission."

Legislation similar to the one introduced in England and known as the Rat and Mice (Destruction) Act, 1919, needs to be urgently introduced in India and to be such as to be

easily and effectively worked by all the Municipalities, big and small, against the owners and occupiers of rat-infested premises and lands.

RAT DESTRUCTION.

The following are the methods of rat destruction :—

(1) With the help of its natural enemies, such as cats, terriers, ferrets, mangooses, kites, owls, stoats, weasels, etc.

(2) By means of trapping. Various forms of traps are on the market. There is the box trap, break-back trap, the toothed clap trap, the well, pit, varnish and barrel or tub traps, the wire cage trap, etc. The wire cage trap known as the "Wonder" or French pattern trap has proved most successful and is now being used extensively in the City of Bombay and other Municipalities with good results.

The efficacy value of different kinds of traps as compared with that of the "Wonder" trap expressed as 100 is as under :—

The Wonder trap	100
The Elongated Wonder	113
French pattern elongated	113
,, ,, ordinary	108
,, ,, by Army & Navy Stores	100
Rawalpindi Chitre pattern Wonder trap	100
Poona D type	90
Poona C type	52
Poona B type	33
Well trap	30
Barrel or tub trap	30
Poona B type (forked)	19
Poona A type	9
'Pindi pattern as used in Bombay previously	9

BAITS FOR TRAPPING.

The best bait to be used in a trap should consist of dough made of the flour in common use in the locality. This has been found to be more successful and attractive than substances such as meat, fish, cheese, fat, spices, oils of Rhodium, anisi, coriander, oil scented baits, paper baits, live rat as bait, etc.

HOW TO CONDUCT A TRAPPING CAMPAIGN.

In carrying out trapping campaigns, use traps equal in number to 5% of the human population. The work must be done systematically and must be well supervised and sustained. Special energy must be put into the work between baiting campaigns and before the commencement of and during each breeding season. Traps must always be in a thorough state of repairs.

(3) By means of poisons.

The following poisons have been used in connection with rat destruction: the Punjab Rat Exterminator, Common Sense Rat Exterminator, Arsenic, Rough on Rats, Sodium Arsenite and Arsenate, the Bombay Municipal Laboratory rat poison, Squill, and Barium Carbonate. Of these poisons, Barium Carbonate has been found to be one of the most reliable. Its advantages over other poisons are that it is non-inflammable and can be easily conveyed from place to place, that it is tasteless, odourless, and the cheapest of all poisons so far known.

Fatal doses of different kinds of Poisons.

Barium Carbonate	3 Grains.
Punjab Exterminator	3 ,,
Common Sense Poison	3 ,,
Bombay Municipal Laboratory Poison	3 ,,
Acid Arsenicum	$\frac{1}{3}$,,
Rough on Rats	$\frac{3}{4}$,,
Sodium Arsenate	$\frac{1}{3}$,,
Sodium Arsenite	$\frac{1}{3}$,,

The average fatal period.

	Hrs.		Hrs.
Barium Carbonate	.. 15	Acid Arsenium	.. 30
Common Sense	.. 20	Rough on rats	.. 32
Punjab Poison	.. 21	Sodium Arsenite	.. 53
Bombay Municipal Laboratory Poison	.. 24		

Comparative consumptive value of baits made of different rat poisons as compared with those of Barium Carbonate expressed as having a comsumptive value of 100.

3 grs. Barium Carbonate baits	100·0
⅓ gr. Acid Arsenium	104·2
¾ „ Rough on Rats	100·8
3 grs. Common Sense Poison	11·0
3 „ Bombay Municipal Poison	8·5
½ gr. Barium Hydrate	37·3
⅓ „ Sodium Arsenite	32·8
½ „ Barium Oxide	14·8
3 grs. Punjab Exterminator	·5

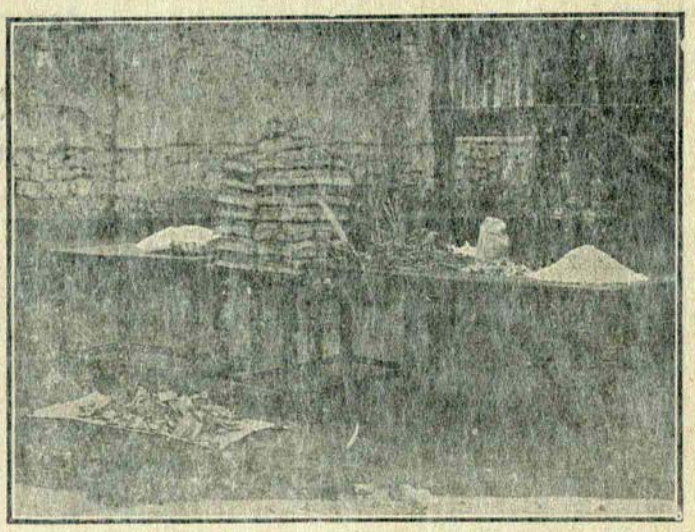
DESTRUCTION OF RATS AS CARRIED OUT IN BOMBAY.

The Health Department of Bombay are destroying over 500,000 rats in Bombay every year.

Deducting 10 per cent., *i.e*, 50,000 for rats that do no harm, small rats, mice and musk rats, there will be 450,000 *Mus rattus* and *Mus decumanus*, the black and brown rats. Half of these are females. Thus 225,000 female rats are destroyed annually.

Poisoning and Trapping.

Poisoning.—The initial process in the destruction of rats in Bombay as a Plague preventive measure is that pieces of bread are used for making poison baits. Each loaf is cut into half-inch cubes, which are smeared over with the poison which is prepared at the Municipal Laboratory, and dipped in powdered sugar and flour. The cubes are all counted before distribution.

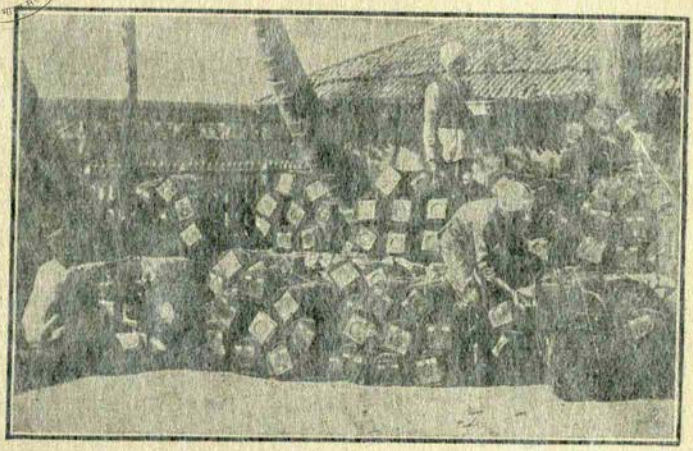


PREPARING POISON BAITS.

Another method.—Parched Indian corn is soaked in the poison and distributed in the same way. This has been found to be more economical and efficacious and easier of preparation.

3-grain Barium Carbonate baits, made up to 15 grs. with Bajri dough, are now being used more extensively throughout the City and with very satisfactory results.

The area to be treated is marked out in sections and circles, a certain number of men are told off under a Mukadam and a Sub-Inspector. Each man has 200 to 300 baits given to him which he lays between 5 and 7 P.M. Next morning, between 6 and 8 he goes round his area and picks up the baits not used, counts and returns them to the Ward stables. Dead rats are collected and the house, place and locality noted down on a card attached to the rat with the name of the collector. Each rat thus collected is put in a tin box and labelled and sent to the Bombay Bacteriological Laboratory for examination. The result of



SHOWS THE TRAPS BEING BAITED.

the examination is sent to the office of the section in which the rat was found, and if the rat was infected with Plague, action for disinfection of the place, house and passage where the rat was found is taken. In this way the phase of the rat epidemic or epizootic is known.

Trapping.—Pieces of bread, Bajri dough, fish, cocoanut, &c., are used for baiting the traps. There are 7,000 traps in use and between 1,800 to 2,000 rats are collected daily. Before the traps are sent out, they are baited with pieces of cocoanut, bread, fish, &c., as stated above. In this manner traps are made ready to go out for a rat campaign. Each man carries 12 traps under the supervision of a Mukadam. These traps are distributed by the subordinates in houses and gullies in the City.

All results are daily sent to the Head Office and tabulated. The rise in the epizootic is noted, as it is always the precursor of the epidemic in man. The rat index is thus of immense value.

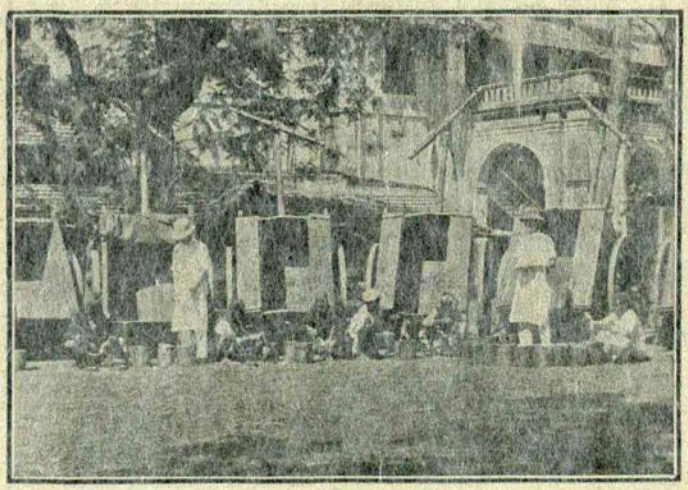
A map of each section is kept and the daily rat mortality and human mortality marked thereon with red and blue dots, with the date of occurrence of each case.

There is a great deal of opposition on the part of certain castes of Indians, who refuse to allow rats to be killed or caught in their houses, and have notices put up "No rat-catchers allowed here."

Live and dead rats are brought into the Ward stables, and registered and marked.

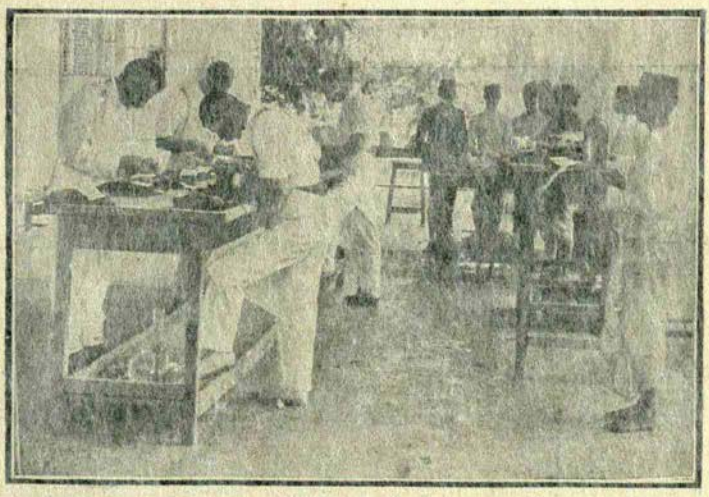
Traps and boxes containing live and dead rats are then placed in carts and sent to the Bacteriological Laboratory at Parel for examination. On the arrival of the carts there, the box numbers and the number of rats are checked by the authorities there with the statement sent from the Health Department stable, as each rat-catcher has to be paid for the rats he brings.

Every rat-catcher must bring 7 rats per day free and he is paid at anna ½ each only for those rats over and above this original seven per day. Moreover, to prevent slackness, he is not allowed to bring less than 9 rats per day on more than three occasions in a month. The original 7 free rats per day are taken as such in return



SHOWS THE CARTS ARRIVING AT THE LABORATORY

CHECKING THE RATS WITH THE STATEMENT SENT FROM THE HEALTH DEPARTMENT, AS EACH RAT-CATCHER HAS TO BE PAID FOR THE RAT HE BRINGS.

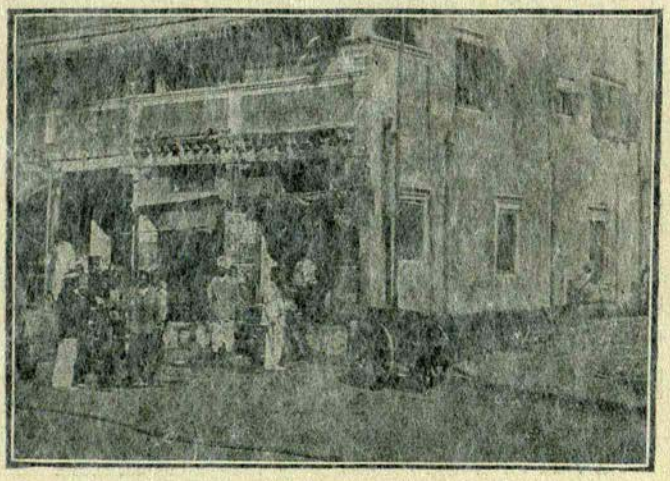


EXAMINATION OF THE DEAD RATS AT THE LABORATORY. A VERY UNSAVOURY PROCESS BUT A VERY VALUABLE INDEX OF THE STATE OF PLAGUE.

for his fixed wage of Rs. 15+Rs. 5 (allowances) per mensem. Any catch over and above that number represents so much extra profit to the man. This rule applies only to the "special rat-catchers." Men not employed as such are given anna ½ per rat irrespective of numbers brought. If a rat is missed or lost on the way from the stables to the Laboratory, a distance of 5 miles, the rat-catcher loses his fee. Empty traps and tins are returned to the Wards concerned.

Though the examination of the dead rats at the Bacteriological Laboratory is a very unsavoury process, it is a very valuable index of the state of Plague. The operators are British soldiers who are experts in this business. A *post-mortem* examination of rats is made, and it takes about 2 minutes to determine the presence of infection by the examination of the glands, of the groin, neck, organ, &c. From 500 to 700 dead rats are thus examined daily. The live and putrid rats are not examined.

The house, where a dead infected rat is found, is flushed and disinfected with Pesterine; the inmates are asked to



SHOWS THE PRACTICAL RESULT IN THE CITY.

move out, while the house is being disinfected, into a camp provided for them, and the locality treated again with poisoned baits and traps.

COST OF POISON.

The cost of the poison is annas 8 per tin, enough for 500 bread baits or 2,000 cereal baits.

COST OF PREPARING 3,500 BREAD BAITS.

	Rs.	a.	p.
35 *breads* of 1 lb. each at 8 per rupee ..	4	6	0
Sugar	0	5	0
Flour	0	4	0
Laboratory Poison at 0-8-0 per tin (7 tins)	3	8	0
Labour for preparing baits	0	5	0
(One cooli for 4 hours at 10 annas a day of 8 hours.)			
	8	12	0

COST OF PREPARING 3,500 BARIUM CARBONATE BAITS.

Barium Carbonate 1½ lbs.	0	6	0
Bajri flour 4 lbs.	1	0	0
Labour for preparing baits	0	5	0
	1	11	0

There should be no relaxation in the efforts at rat destruction. The aim must be to secure at least the destruction of

rats equal in number to twice and preferably thrice the human population of the area treated. Any lull in the operations will soon be followed by rapid breeding, and the town or country will soon find itself in the same position, if not worse in respect of rats, as when the operations were first started.

Dr. Howarth in his report on "Rat Repression in the City of London" says :—

"At the present time two chief conclusions seem to be justified :—

(*i*) Rats apparently multiply to the limit of the means of available subsistence. Under favourable conditions litters are large, since reproduction is carried out under a maximum of satisfactory circumstances. When food supply is less than is necessary to maintain in a satisfactory condition the rats which exist in an area, there probably results an automatic control owing to increased mortality and reduced fecundity.

(*ii*) Intermittent attempts at rat diminution almost certainly result in constant maintenance of maximum rat prevalence. The reduction which takes place as a consequence of sporadic efforts results in additional advantages being the legacy of those that remain, and a subsequent increase follows until the normal level is regained."

BAITING *versus* TRAPPING.

Baiting is a violent method, trapping is not so. Wiliness after baiting is absolute and prolonged, not so after trapping. Rat population is reduced markedly after intensive baiting, not so under trapping. Baiting is comparatively a cheap method, trapping is expensive. Baiting is suitable for short campaigns, trapping suitable for prolonged campaigns. Bait-

ing is more suitable for evacuated areas, trapping for populated areas. Baiting is extremely unpopular in populated areas owing to rats dying in inaccessible situations and the risks to children and pet animals, etc. Trapping is preferred in populated areas.

The other methods of rat destruction are :—

(4) By means of viruses.

There are many viruses on the market, but the use of them has been found to be unpopular, owing to the likely risks of infection man is liable to from the rats that may act as carriers.

(5) By means of gas. The one found most popular is Sulphur dioxide. This gas is easily generated and always indicates its presence by its pungent odour. The other gases are Harker's flue gas, Hydrocyanic acid gas, Phosgene gas, and Carbon oxide gas, and are not much resorted to on account of their very dangerous nature.

(6) By making a search for rat-holes and destroying the blind baby rats.

(7) By introducing the Rodier system, which has for its object the reduction of the rat population by bringing about an inequality in the numerical sex relationship—the males being turned down and females slaughtered : and which process in course of time renders the male population sufficiently in excess of the females to harass the latter, and render propagation difficult with the result of smaller litters, and the destruction of the young.

(3) EVACUATION.

Of all the measures that are organised for combating Plague, evacuation of the infected areas or houses as soon as

the epidemic symptoms are notified, or even before that time, is the only measure the people voluntarily resort to. They have great faith in this measure.

In the early days of Plague, perhaps, they were averse to leave their homes for various reasons, as they were to every measure, but when they began to understand the cause of the spread of the disease, they eagerly resorted to camps.

The principle of evacuation is a sound one and, when combined with rat destruction and examination of dead rats, is of great utility in controlling the disease.

Previous to the anticipated outbreak, well-built temporary structures should be erected on suitable places not far removed from the area which will be affected. The huts should be built on a plinth in rows 20 to 30 feet apart with proper bathing places and a good supply of water, with the floor and passages tarred, and receptacles for the deposit of refuse provided as well as latrines and urinals.

It is possible in some cases to vacate large areas before the outbreak begins but the people generally wait until rats begin to die.

Every dead rat should be examined and the result registered; action should then be taken to vacate the building where the rats are found; the whole building baited and trapped, pesterined and lime-washed, when it can be re-occupied 10 to 14 days later.

Rat campaigns should be organised during the off-season and continued all through the year.

In Bombay this procedure is followed; in some instances difficulty is experienced in moving people out, but with patience and perseverance, much can be done. The task is no light and easy one and requires tact and perseverance—

as in all such measures for the control of infectious diseases in India.

It is argued by some that disinfection and evacuation are of little use in the prevention of Plague but the concensus of opinion of those who have had actual experience is in favour of both. It is argued that it is too late to take action after Plague rats have been found but this argument is fallacious, as has often been proved in Bombay.

A dead rat is found in a room or passage, it is examined and found infected. It may be assumed that other rats are infected which may have not been picked up and not examined. It may also be assumed that each rat had one or more infected fleas on it before death and that the fleas have left the rat to find another temporary host. The passing of the flea from one rat to another means that it has to travel some distance and takes a certain amount of time in getting to the next host. In the meantime if the surroundings are properly pesterined, the fleas vacating one rat will have to pass through pesterine which they fail to do and die in the attempt.

To say it is too late to evacuate or disinfect after the death of a rat or human being is to forget what happens in every other infectious disease, where the cause is due to direct infection and not relying on the fleas. Take Small-pox, Tuberculosis, Diphtheria: a case or death occurring in a room. The room cannot be disinfected while the patient is alive, but are no disinfecting precautions to be taken to prevent the spread of the disease after the death or removal of the case?

In this City as soon as a case is brought to the notice of the staff and the room can be vacated, one or more guinea-pigs are put into the room in suitable cages and they are subsequently examined for the presence of any Plague-infected fleas. The room is locked and subsequently, when the guinea-pigs are removed, disinfected.

(4) DISINFECTION FOR PLAGUE.

In disinfecting against Plague infection, it was necessary to look for an insecticide.

The work done by the Plague Commission showed that the usual chemical disinfection had no effect on fleas.

In 1906, the Health Officer of Bombay, seeing the results obtained in France from the use of L'huile de Schiste in killing flies and their larvæ, procured a small quantity and experimented on fleas in rat-infected houses. The result was so satisfactory that the crude fuel oil is now used as the standard method of treating all rat-infected places. The name given to the substance was "Pesterine" and its use has become universal in India.

For further information, see the Health Officer's Report 1906, and the Asiatic Petroleum Company's pamphlet "Liquid Fuel as a Disinfectant."

Disinfection with pesterine should be carried out thus: the articles required are:—(1) pesterine, (2) wooden or zinc buckets, (3) brushes, (4) brushes on long handles, (5) brooms, (6) a watering can.

The men who do the disinfection should wear long coats and protect their feet with shoes or *chuppals*.

Begin by sprinkling a little pesterine on the floor of the room to be disinfected. Then remove all the furniture, etc., out of the room. Any fleas dislodged during this process will be caught in the pesterine already sprinkled on the floor.

All clothing should be collected in sacks and sent to a sterilizer for disinfection with steam.

After the room has been emptied, begin by spreading pesterine with a long brush, first over parts of the walls—up to 3 feet. Carefully go over all the nooks and cracks and ledges. Walls can be quickly done, if the brushes are used in a horizontal manner. Then sprinkle a little more pesterine on the floor, and with a broom spread it all over in an even manner. Generally, it will be found that the

quantity sprinkled at first, together with that splashed while doing the walls, will be quite sufficient for the floor.

Finally, pour a little quantity into every rat-hole seen on the floor.

Disinfection is now complete and the pesterine should be allowed to stand for twenty-four hours; the room is then fit for re-occupation.

Pesterine may also be used for disinfecting latrines and night-soil receptacles and accumulation of filth, and to kill flies, mosquitoes and other insects and their eggs and larvæ, and to prevent fermentation. Two pints or more of the oil to a superficial yard should be used, mixing it up with the contents of the receptacle.

Flies deposit their eggs in human and animal excreta and decomposing animal matter. Flies may convey germs of Cholera, Typhoid and Tuberculosis and other infectious diseases.

Pesterine is useful in horse and cattle stables, and for ground contaminated with urine and fæces; collections of water should be treated by pouring the oil on the surface and allowing it to remain.

Crude petroleum oils answer the same purposes, but are more expensive.

Experiments are being conducted in the Bombay Bacteriological Laboratory on fumigation by Hydrocyanic acid gas as a preventive measure against the spread of Plague. The gas is generated by the action of dilute Sulphuric acid on lumps of Potassium cyanide.

HOW THE CLOTHES OF PEOPLE FROM PLAGUE-INFECTED PLACES MAY BE DISINFECTED BY THE SUN.

It is now well known that Plague is conveyed from rats to people by means of fleas. It has also been found out that people going from a Plague-infected place to another that is free from Plague may carry with them in their clothes,

bedding or baggage the infected fleas of that place. On arrival at the end of the journey, the bedding is unrolled and the baggage unpacked, and the fleas being at liberty to hop out do so, and immediately go to the rats of the place to feast upon their blood. These fleas at the same time infect the rats, with the Plague-germs they have in their insides, and thus the rats get Plague and die, and soon the people of the village will begin to die of Plague also, for they will catch it from the rats. Now, as this is the way Plague comes to a village, it is possible to prevent its arrival by killing all the fleas in the baggage, clothing and bedding of all new arrivals.

It has been discovered by experiment at the Bombay Bacteriological Laboratory that it is quite easy to kill all fleas in clothings, bedding and baggage by spreading the things in the sun for an hour or so.

It is necessary to choose a smooth, sandy place where no grass or bushes grow and which is fully exposed to the sun, and there spread out the clothes in a single layer; in a short time all the fleas will be dead. Then the clothes will be quite safe and the owner may be allowed to enter the village with safety to its inhabitants.

The rules which are given in Chapter VIII (Disinfection) should be carefully followed, however, so as to make quite sure that all fleas are killed.

The great thing to remember is that the surface must be quite smooth and that the sand is hot enough before the clothes are laid on it.

(5) INOCULATION.

Col. Liston, C.I.E., I.M.S., Director of the Bombay Bacteriological Laboratory, where the Plague vaccine is prepared, says in his pamphlet on "Plague Prevention":—

"This means of acquiring temporary immunity to the disease has generally been called in India "Inoculation." It has the advantage of being a measure of personal prophylaxis,

which can be carried out easily and cheaply, and it matters little who else does or does not co-operate in the measure. This is a great advantage in a country like India. The inoculated acquire a high degree of protection, and the mortality from the disease among them has been shown to be about one-sixth of that of the uninoculated under the same conditions.

"The following statistics are selected not because they demonstrate the best results obtained by inoculation, but because in each instance they have been very carefully examined; the records in every case having been accurately kept.

"A very virulent epidemic of Plague was raging in the village of Undhera in the Baroda State. The village was visited and a nominal roll of all the inhabitants then living in each household was made, and as nearly as possible one-half of the members of each household were inoculated. It was found that there were 950 persons then alive in the village, and of these 513 were there and then inoculated. No selection was made other than that required to make the inoculated and uninoculated groups as similar as possible as far as age, sex and physical fitness were concerned. Plague continued in the village for 42 days after the inoculations were performed. The disease occurred in the houses occupied by 28 families. These families were composed of 71 inoculated and 64 uninoculated persons. The 71 inoculated had 8 attacks with 3 deaths, while the 64 not inoculated had 27 attacks with 26 deaths. We may infer that in this single village no less than 26 lives were saved by inoculation.

"In the Punjab a large number of people have been inoculated. Major Wilkinson, late Chief Plague Medical Officer, has given us the figures referring to villages in which more than 10 per cent. of the inhabitants were inoculated four months or less before Plague occurred in them. In these villages there were 1,86,797 inoculated as compared with 6,39,630 uninoculated persons. Among the inoculated there were

314 deaths from Plague. Among the uninoculated there were 29,723. From these figures it is easy to calculate that nearly 8,000 lives were saved in these villages by inoculation.

"Quite as good, if not better, results have been obtained in Bombay City.

"In a *chawl* near Pilot Bunder, inoculation was carried out two months before Plague broke out in it. 61 persons lived in this *chawl*, and of these 24 had been inoculated. Only one of the 24 was attacked by Plague and he recovered, while of the 37 uninoculated, 19 were attacked by the disease and 12 of them died. In this single building 12 lives were saved by inoculation.

"Dr. Turner and his staff inoculated a large number of the Municipal servants living in certain Municipal chawls, with the following results:—3,317 were inoculated, while only 838 remained uninoculated. Among the large number of inoculated there were 3 deaths from Plague, while among the small number of uninoculated there were 18. Sixty lives were saved by inoculation.

"In Karachi a similar saving of life was effected. 1,245 inoculated had 4 deaths while 60 uninoculated had 5. It is easy to calculate that 100 lives were saved by inoculation.

"Among the Police in Khandesh, great saving of life was effected by inoculation. 1,508 inoculated policemen had 3 deaths from Plague, while of 230 uninoculated 4 died. 23 lives were saved.

"Railway Companies have had a like experience. The Southern Mahratta Railway Company had 1,260 of their hands inoculated in Hubli, and 760 living in the same places refused to be done. The former had 2 deaths among them, while the latter had 21. Inoculation in this case saved 33 lives.

"Millowners can confirm the advantages of inoculation. Mr. Bezonji Dadabhoy, Manager of the Empress Mills at Nagpur, found that 1,116 inoculated mill hands had 6 deaths

from Plague among them, while 2,663 uninoculated mill-hands had 179 deaths from Plague. Sixty-nine lives were saved by inoculation in this case.

"So much then for the value of the protection afforded by inoculation. Although inoculation cannot eradicate Plague from a country or district, nevertheless every case which is saved from the disease is so much gain; and, moreover, affords less opportunities for the spreading of infection by friends who would have come from other towns and villages to attend the funeral ceremonies.

"Inoculation, too, has the great advantage of instilling into those who undergo the operation that confidence which is so necessary to avert a panic. When the majority in a village are inoculated, the epidemic assumes such moderate proportions that it can be dealt with easily, nor is it difficult to adopt measures to prevent the spread of infection to adjoining areas."

HOW TO STERILISE AND FILL THE SYRINGE.

The first step in the operation of inoculation is to sterilise the syringe and needle. For this purpose Kapadia's sterilising apparatus is conveniently used. The apparatus consists of a pot for heating oil or vaseline. The pot is placed on a block tin stand, which at the same time serves to protect the flame of a spirit lamp placed beneath from draughts of air. Methylated spirit is used in the lamp. *Never pour in spirit while the lamp is alight.*

The oil for use in the cup may be olive, cocoanut, or any similar oil which has not an acid reaction, but vaseline is very convenient, as it becomes solid when cold, and does not spill when packed for travelling.

Fit up the sterilising apparatus and light the spirit lamp. See that the thermometer is in good order and adjust it properly in the vaseline. Then take out the syringes and needles.

1. See that the needles are sharp, clean and patent. If these points are attended to, work is greatly facilitated, and

the operation is much less painful. Place the needles in the vaseline.

2. See that the syringe is air-tight. This is done by placing a finger over the nozzle and at the same time pushing home the piston; if the syringe is working properly, resistance will be felt to the pressure against the piston and it will slip back when released, provided the finger has been retained firmly over the nozzle. The tightness of the plunger in the barrel can be regulated by the screw in the handle.

3. When the temperature of the vaseline has reached 90° C., fill up the syringe with the heated vaseline and empty it again into the pot. This is done to get rid of moisture in the syringe; at temperature above 100°C. any moisture is immediately converted into steam, and this causes the vaseline to crackle and splash and may, perhaps, fracture or burst the glass barrel.

4. Now wait till the temperature has reached 160° C. Then completely fill and empty the syringe twice with the hot vaseline. A temperature higher than 160° C. injures the India-rubber plunger, and a temperature lower than 160° C. is not so efficient in effecting sterilisation.

5. With the dissecting forceps fish out a needle, which has been lying in the hot vaseline, and adjust it firmly to the nozzle of the syringe by means of the pliers, which should, previous to grasping the needle, have been dipped momentarily in the hot vaseline.

6. Now for the third time draw up and eject the hot vaseline from the syringe; on this occasion with the needle in position. The syringe may now be carefully laid on one side, preferably supported on the lid of the syringe box and allowed to cool. The needle should not be allowed to come in contact with any article or surface.

7. A bottle of anti-Plague vaccine is then taken in hand. The number of the brew and the number of the bottle and dose to be used is noted.

Examine the neck carefully for any cracks or flaws. By handling the bottle in the same way that the index of a clinical thermometer is shaken down, leakage, through such cracks, may be detected. Faulty bottles should invariably be rejected, and the contents thrown out.

The bottle should then be well shaken, so as thoroughly to mix the sediment, which will be seen at the bottom of the bottle, with the fluid. *The sediment consists of the dead bacteria and is an essential part of the vaccine.*

8. To open the bottle, hold the neck in a flame, turning the bottle round all the time so as to sterilise every part of the neck. When the glass is sufficiently heated, jerk up a little of the fluid, and the neck will crack. The tip may then be knocked off by a sharp blow from a pair of sterilised forceps.

9. Now take up the syringe, draw into it a small quantity of hot vaseline, and again eject it. While the needle is still hot, draw into the syringe two or three cubic centimetres of the anti-Plague vaccine. Place the bottle on its side on the table. Then draw out the piston of the syringe to its full extent, and shake up the small quantity of the vaccine within the barrel of the syringe. Eject the contents of the syringe. This is done to get rid of some of the excess of vaseline which adheres to the interior of the syringe.

10. Again dip the needle in the hot vaseline, pass the point of the bottle through the flame, and then fill up the syringe. Get rid of excess of air by adjusting the piston. Note the graduation marks on the piston-rod, and read off four marks counting from the nozzle-end of the syringe. Screw up the discs (to be found at the handle end of the shaft of the piston) to the point noted. The syringe is now ready to deliver 4 cubic centimetres or one dose of the vaccine.

HOW TO CARRY OUT THE OPERATION OF INOCULATION ?

The most convenient site for the operation is the back of the left upper arm about midway between shoulder and elbow. The skin at this spot should be well scrubbed with

5 per cent. carbolic lotion (1 in 20). The skin being then puckered up between the thumb and fingers of the left hand, the needle should be pushed through the skin in a sloping direction, more or less parallel to the surface, carefully avoiding the big vessels and not penetrating the muscles. but taking care to enter the subcutaneous tissue. Then slowly inject the dose. Withdraw the needle of the syringe and apply for a few seconds a pad of cotton wool dipped in 1 in 20 carbolic lotion.

The next patient is operated on in the same way. The needle of the syringe is first dipped momentarily in the hot vaseline, which is kept at hand at a temperature of 160° C. The screw on the shaft of the piston is again adjusted to four spaces from the nozzle-end of the syringe, each space being equal to one cubic centimetre. The arm of the patient is scrubbed with 1 in 20 carbolic lotion. A drop or two of the vaccine should be ejected from the syringe to get rid of any oil or vaseline within the needle. The needle is then inserted and the dose injected.

Between each operation the needle of the syringe is sterilised by dipping it into the hot vaseline.

As only sterile fluid has been introduced into the syringe, if proper precautions have been taken to sterilise the needle before each operation, the interior of the syringe need not be sterilised between the filling of each bottle. At the close of the operations the syringe should be thoroughly washed out with 1 in 20 carbolic lotion, and the needles should be covered with vaseline.

Quarantine.—The incubation period being recognised as ten days, ten days is the minimum period that should elapse before the time of departure from an infected place. Kitasato has shown that the specific bacillus persists in the bodies of those who have recovered from Plague for at least three weeks from the cessation of the active disease and hence convalescents should be isolated for a month before they are allowed to mingle with an uninfected community.

Tuberculosis.

Tuberculosis means the changes taking place in the animal body when it is invaded by the organism called the "Tubercle bacillus."

The Tubercle bacillus discovered by Prof. Koch in 1882 is an organism capable of living, not only within, but also outside the animal body; it may be cultivated on various artificial media. Like other organisms, it exhibits certain morphological characters, which may be observed by means of the microscope; it grows and multiplies in certain ways, and possesses certain physiological properties through which it acts upon and is acted upon by its environment, whether that environment be a living animal body or a lifeless artificial medium.

Tubercle bacilli, when stained with carbol-fuchsin, are seen to be delicate cylindrical pink rods, slightly curved or straight, with a granular appearance; they are "acid fast," that is, when stained and treated with acid, they retain the original stain. The difference in the microscopical and morphological appearance of human and bovine Tubercle bacilli is very slight. What difference there is, is cultural and one of degree only.

Tuberculosis occurs in many, if not all, of our domestic mammals, in the ox, pig, horse, sheep, cat, dog and others.

It has also been observed in many wild mammals, the monkey for instance, when kept in captivity. A disease called Avian Tuberculosis is known to occur in certain birds; and reptiles have been described as suffering from Tuberculosis. Hence the phrase Tuberculosis in "animals other than man" opens up a very wild field of inquiry.

The principal form in which Tuberculosis affects man is "Pulmonary Tuberculosis," "Phthisis," or "Consumption"; but all parts of the body may be affected as in Tabes Mesenterica, Tubercular Meningitis, and Tuberculosis of the joints and organs.

Tuberculosis may be spread from man to man, by the inhalation of dust containing Tubercle bacilli, or by direct infection from the sputum, also by infected milk and meat and by flies.

At the British Congress on Tuberculosis in July 1901, Prof. Koch said that bovine and human Tuberculosis were different; that the former could not be transmitted to man except under exceptional conditions; and that precautions against bovine Tuberculosis were not necessary. This came as a thunder-clap to the medical world, and the result was a Royal Commission appointed in 1901: from the Report published, it has been shown that there is very little difference between the Tuberculosis of cattle and man, and that they can be transmitted from one to the other.

The Royal Commission state that the cases of Tuberculosis and the Tubercle bacilli found in the intestinal glands of children were similar to those of bovine Tuberculosis, and the disease was due to infection by food and milk.

There can be no doubt but that in a certain number of cases the Tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine Tuberculosis, and that, in the majority at least of these cases, the bacillus is introduced through cow's milk. Cow's milk containing bovine Tubercle bacilli is clearly a cause of Tuberculosis and of fatal Tuberculosis in man.

A very considerable amount of disease and loss of life, especially among the young, must be attributed to the consumption of cow's milk containing Tubercle bacilli.

The Tubercle bacilli may be present in the milk of cows which are otherwise apparently healthy; they are found in large numbers in the fæces of infected cows.

Shröeder in an interesting paper states that 40 per cent. of the dairy cows, that retain the appearance of health and are not known to be affected till they are tested with tuberculin,

actively expel Tubercle bacilli from their bodies in a way dangerous to the health of other animals and persons; that a considerable proportion of the dairy products is infected with Tubercle bacilli owing to the frequency with which cow fæces are found in milk: for it has been proved that the commonest way for Tubercle bacilli to pass from the bodies of Tuberculous cows is with their fæces, and once milk is contaminated with Tubercle bacilli, the latter enter the various articles of diet prepared from it, and are specially numerous in butter, in which they may remain alive seven weeks or longer without diminishing in virulence. The practical importance of this is that herds of Tuberculous cattle can be cleaned by the periodic application of the tuberculin test.

These results clearly point to the necessity of measures, more stringent than those at present enforced, being taken to prevent the sale or consumption of the milk of tuberculous cattle.

BOVINE AND HUMAN TUBERCULOSIS.

It is now definitely settled that Tuberculosis in cattle may and does cause Tuberculosis in man, and this is especially important with reference to the disease in children in India.

The interest taken in the cause and control of this disease in England, France, Germany, America, Australia and other countries of the world and the investigations undertaken by them have tended to reduce the incidence of the disease considerably.

But in India little has been done to ascertain whether the conditions which obtain in other countries exist here, or how they may vary.

It is generally assumed that bovine Tuberculosis is rare in India and, with a view to ascertaining the truth, some investigations were undertaken by the Executive Health Officer, Bombay.

WORK DONE IN INDIA.

In considering the possibility of children in India contracting Tuberculosis, both general and pulmonary, from tuberculous cattle—either by milk or infected fæces and also by milk infected by human agencies—the following questions present themselves for solution :—

(*i*) Whether cows or buffaloes in India suffer from Tuberculosis.

(*ii*) Whether milk could be infected by human or bovine agencies, after it had been drawn from a healthy animal,—by the habits and customs of the attendants and by infected fæces.

(*iii*) Whether the human being, especially children, could not contract Tuberculosis, because of the intimate relation of the working classes with cows, bullocks and buffaloes, and the enormous use made of cow dung, some of which must be infected.

EXAMINATION OF SAMPLES OF MILK AND HUMAN SPUTA.

To ascertain the truth, the examination of samples of milk and human sputa from milk shops and milch cattle stables in the City was undertaken in Bombay at the Municipal Laboratory by Dr. Ghadially and Dr. Joshi.

The milk was collected from different milk shops, by the Deputy Health Officers of the Wards, in sterile glass bottles and sent to the Laboratory; 20 c. c. of each sample were centrifuged and the sediment examined, and if acid fast bacilli resembling Tubercle bacilli were found, the Deputy Health Officer was asked to trace the source of milk.

This was not easy, as the milk sold at the retail shop is mixed; only in 6 cases could the infected milk be traced to cows. Milk of these cows was then drawn into sterile glass bottles and again examined and a positive result obtained in the case of all the six cows.

Tuberculin test.—The animal is first allowed to become cool and quiet; then the temperature is taken per rectum, the thermometer being allowed to remain in for 5 minutes.

The *normal temperature of bovine animals is from* 100·5° to 102·5° F. It is convenient to inject the tuberculin into the neck or shoulder late in the evening, so that the observation of the reaction temperature may be made early next day. The animal must not be regarded as certainly tuberculous unless the morning temperature shows a rise of at least 2·5° F. above that of overnight.

The test should not be repeated until at least a month has expired.

All the six cows were treated with tuberculin: four of them reacted 2·5 and two only ·7.

Milk of these four cows was injected subcutaneously into guinea-pigs with no result.

In all 217 samples of milk were examined, of which 9 were repetitions; thus out of 208 examined, an acid fast bacillus was found in 30 or 14·4 per cent.; of these, 9 were traced to cows; these were tested with tuberculin and 6 reacted.

A *post-mortem* examination could not be made. Much difficulty is experienced in getting permission even for testing with tuberculin.

In all, 105 cows and buffaloes were tested with tuberculin:—

34 at Bandra Slaughter House—none reacted;
5 buffaloes and 31 cows at Panjrapole—2 cows reacted;
26 cows privately—3 reacted—no *post-mortem*;
9 buffaloes privately—no reaction.

The fæces of the two cows reacting to tuberculin were examined and found to contain an acid fast bacillus of the same type as in milk.

On *post-mortem* examination of these cows, no Tubercle bacilli could be found in any of the organs, but cystic degeneration and cysts were plentiful.

To find Tubercle bacilli in milk, unless the animal is suffering from acute Tuberculosis of the udder, is difficult and requires care; other acid fast bacilli may be present, and to differentiate, the infected milk must be inoculated into a guinea pig. This, however, is not always decisive, as milk may contain very few bacilli and then no reaction takes place.

This process was followed on nine occasions with no result. The tuberculin test, when followed by a high and maintained rise of temperature, is considered sufficient evidence of tubercle in cattle, which can be verified by a *post-mortem* examination. Unfortunately, it could be carried out only on two occasions—with a negative result.

The other three cows reacting to tuberculin lived and calved thereafter; on re-inoculating them 3 months later, no reaction occurred.

In 30 cows selected at Bandra Slaughter House as looking suspicious of Tuberculosis, Tubercle bacilli were found only in the organs of one—brought for slaughter at Bandra Slaughter House. The acid fast bacillus found in the milk was not Tubercle.

Samples of human sputa collected from bathing places, washing places for cows and buffaloes, and from milk shops and the streets were examined for Tubercle bacilli.

Out of 271 such samples examined, 33 or 12 per cent. contained Tubercle bacilli: the object in examining the sputa was to ascertain, if possible, whether the milk could be infected in that way.

Since the above was written, an outbreak of Tuberculosis occurred amongst the animals at the Victoria Gardens, Bombay. *Post-mortem* examination made revealed the presence of tubercle pathologically and bacteriologically. Many of the animals had been bred in confinement and others had been introduced from Europe and India.

The following is an extract from the report of Mr. Doctor, (now) Superintendent of Victoria Gardens, Bombay:—

"A female spotted deer having died on the 19th December 1915, she was sent as usual for *post-mortem* examination at the Parel Laboratory. On the 20th December 1915, Col. Liston reported her to have died of bovine Tuberculosis. Subsequently, on the 9th January 1916, another female spotted deer, which was off feed for a few days, was reported to have died of Tuberculosis also. After this, on the 11th January 1916, a very old male specimen of spotted deer which had been living in the Garden, for some years past, was destroyed, as he was much emaciated though apparently quite healthy and feeding properly. His lungs showed tubercles and nodules on both lobes but no bacteriological examination of this animal was made.

" A Ilama died on the 12th January 1916, and was reported to have died of septic Pleurisy at first, but subsequently from cultures and microscopical tests taken by Col. Liston it was found to have died of Tuberculosis.

"It was after the death of another Ilama on 2nd February 1916, by the same disease, that the suspicion of the disease having spread amongst all the spotted deer and the Ilamas was aroused and after consultation with Col. Liston and the Executive Health Officer, the Commissioner ordered on the 16th February the whole stock of these animals to be destroyed. Altogether 15 spotted deer and 5 Ilamas were destroyed and, with the exception of 3 or 4 young spotted deer and one young Ilama, lesions of the disease were found on the lungs of all the animals in a more or less degree.

" A male Sambar deer being off feed and showing signs of wasting was destroyed on 1st March 1916, after consultation with Dr. Turner, who was present with the students of the Sanitary Surveyors' Class at the *post-mortem* examination of the animal which showed extensive disease of both the lungs. This was the worst and most typical case of the disease I had observed amongst all the animals that were

destroyed and the presence of Tubercle bacilli was found by Dr. Joshi from smears taken from his lungs.

"On the 28th February, a male Nilgai, which was living in an enclosure at some distance from the place where the Ilamas and spotted deer were located, was reported to have died of Tuberculosis also, but the animal had lived for some time in the Sambar's enclosure near the original place of infection before his removal to his last quarters.

"Since the last case of this Nilgai up to the date of writing (14th April 1916), there has been no fresh case of the disease.

"Col. Liston is of the opinion that the disease must have been introduced by the Ilamas, a pair of which had been originally obtained from Europe for the Gardens on 19th November 1908. Another female was purchased from Porebunder on the 27th July 1909 and from her and her offspring, a herd of six more animals was bred in the Gardens during the last seven years.

"It may be stated that the Ilamas, spotted deer and Sambar were located in adjacent compartments of the deer paddocks.

"Col. Liston reported all the animals sent to him, *viz* :—
2 Ilamas and 4 spotted deer, to have tuberculous lesions, and in 1 Ilama and 2 deer the result of bacteriological examination was positive."

MILCH CATTLE STABLES AND ATTENDANT EVILS.

Any one with any experience of milch cattle stables, dairies and milk shops in India, and the habits and customs of the *gowlies*, their methods of milking and of washing themselves and their milk vessels, can easily appreciate that milk could be infected in this way, and that possibly the samples examined may have become infected by human agency and not bovine. The results of the tuberculin test and *post-mortem* examination of the cows tested, however, showed that this could not be the only source of infection. The

results of the Royal Commission, moreover, prove clearly that the fæces of the tuberculous cow are loaded with Tubercle bacilli, and a visit to a milch cattle stable in Bombay will readily show how this may be a possible means of infecting milk.

Facilities for Transmission of Tubercle bacilli.

The milk-vessels are cleaned with cow-dung and dirt, the buffaloes and cows wallow in their excrement, and the buffaloes are washed at the same place and well as the milk vessels are cleaned at, and with the same water.

This, then, is a common way of infecting milk and is peculiar to India; because in England and Europe, the value of the cleanliness of the cow and the utensils is much more appreciated, and the regulations concerning the milk supply are much more strict. Although the buffalo is washed regularly in some stables in India, its surroundings and the habits of its attendants are much more insanitary.

Again, the traffic in cow-dung is enormous. Cow-dung mixed with urine and mud is used for plastering walls and floors and roofs of houses; it is stored in the house.

Even in large cities, the cow and bullock are inmates of the dwelling house, and all the cooking pots and vessels used are scoured with cow-dung and dirt from the street.

The facilities then for the transmission of the Tubercle bacilli from animal to man are greater in India, because of the intimate connection between them.

Fortunately, the climate has some influence on the life of the bacilli, and the exposure to the heat of the sun checks the growth; but the dust of the streets, where there is so much of bullock traffic, must contain a large number of Tubercle bacilli, while flies and dust must convey the infection to food and milk.

Again, it is a very common sight to see crows eating sputum in the streets or stables; to see crows, after picking up sputum

fly to a milk or water vessel and dip in their beak, or pick the meat and fish in the market, or from the open basket on the head of a cooly, or drink milk out of milk vessels in the stables or open cans in the streets or shops.

RESULTS OF INVESTIGATION IN BOMBAY.

In Bombay City there are 1,985 cows, 17,328 she-buffaloes and 22,817 bullocks.

The results of the investigation are (*i*) that cattle in Bombay, and presumably other parts of India, do suffer from Tuberculosis to a slight extent; (*ii*) that it is possible for milk to be infected by human agency owing to the habits and customs of the attendants and the methods of distributing milk; (*iii*) that a possible source of infection is the fæces of infected cattle—due to the intimate connection between the labouring class and the cattle and the enormous use made of cow-dung in the houses and surroundings.

It is not meant to suggest that Tuberculosis in India is caused only by infected milk or food; but that it is one cause which has hitherto not been investigated. Nor is it maintained that the experiments carried out cover the whole ground, or are complete, or free from the possibility of error, but with the pressure of other work in a very large and busy Department, complete research cannot be undertaken; they are, however, sufficient to warrant further inquiry and more stringent regulations regarding the milk and food supplies in India.

Statistics show that the mortality from Tuberculosis is higher in India than in England; the milk and sputa examined show that there is risk of disseminating the Tubercle bacillus while the presence of this bacillus in the fæces of infected animals is a greater danger in India than in other countries. The argument that all milk is boiled before being used is applicable to any milk-borne disease; but the majority of people would prefer to know that the milk comes from healthy animals and is pure.